Chapter IV - Implementation of the Area-wide Plan

COORDINATING THE AREA-WIDE PLAN WITH PARTNERS AND ONGOING PROGRAMS

NRCS in Vermont administers and implements a variety of water quality related programs that are funded by the Conservation Title of the U.S. Farm Bill. For the last five years, NRCS has obligated approximately 10 million dollars per year to farmers and other rural landowners in Vermont. Most of these funds, such as for the Environmental Quality Incentives Program (EQIP) funds are targeted primarily to projects where water quality is a resource concern. Other programs, such as the Farm and Ranchland Protection Program (FRPP) have significant secondary benefits for water quality protection by helping ensure land does not go into development. Farm Bill funds associated with these programs are obligated in partnership with other on-going State programs and initiatives. This includes the VAAFM BMP program that provides funding for many of the same practices as EQIP.

A fundamental objective of the Missisquoi Area-wide Plan is to provide NRCS and its partners additional information to better target and coordinate these kinds of state and federal expenditures in the Missisquoi Sub-basin.

Prioritization of Resource Concerns and the Targeting of Conservation Practices

As discussed, intensive agriculture comprises a large part of the Missisquoi Sub-basin. Because of this, the highest priority resource concerns are related to agricultural; they include issues such as runoff of manure and feed wastes from farmsteads, nutrient and sediment rich runoff from cropland and erosion associated with streams and rivers. Other resource concerns, identified by the VTDEC Watershed Planning initiative include: forest and urban related issues such as erosion from logging activities and urban stormwater runoff. This Area-wide Plan addresses only the agricultural and stream related resource concerns. As such, the targeted efforts discussed in the Area-wide Plan need to be coordinated with those of other conservation agencies already underway in the Sub-basin.

The studies and data analyses are specific to several different resource concerns, such as erosion from cropland. The analyses provided here do not attempt to compare or prioritize between different resource concerns. For example, no effort was made to quantify and prioritize runoff from farmsteads with the runoff from cropland. Additionally, there are already established, ongoing federal and state programs that provide funding to address each of the resource concerns identified in this Plan.

It is not the purpose of this Plan to recommend changes in programs or funding levels currently directed at each of these concerns. Rather, this Plan has provided further data and analysis that can help target and direct conservation in each of these areas of concern. For example, conservation funds obligated to treat erosion on cropland may be more effective in

reducing phosphorus runoff if additional funds are targeted to erosion control on a smaller number of corn acres, but only to those fields with slopes greater than eight percent.

Using Synoptic Water Sampling to Identify Problem Areas

Phosphorus and sediment loadings within a watershed can be highly variable and discontinuous. Phosphorus loads do not always increase proportionally downstream and may be due to specific problems associated with small areas. A study was discussed in Chapter 3 that collected water quality data on tributaries throughout the Hungerford Brook Watershed. A few tributaries were shown to have higher sediment and total phosphorus loads and concentrations than other tributaries, indicating that these areas are transporting sediment that is highly enriched with phosphorus. In one case the higher loading could be attributed to one specific farmstead and problems associated with it. In other tributaries the higher loading appears to be watershed wide.

This synoptic approach to water quality sampling can provide important information to help target conservation efforts within a watershed or region. It can provide information on tributaries with higher sediment and phosphorus loads and can help identify specific problem areas that need remediation. Further sampling of this type could be a valuable targeting tool in the Missisquoi Sub-basin.

Treating Resource Concerns on Farmsteads

Currently there is no comprehensive agricultural database for the Missisquoi Sub-basin that details farm numbers and type. NRCS maintains contract specific information for only those farmers who are active program participants. The type and extent of this information varies greatly depending on the program and the amount of land included in the program contract. The VAAFM maintains information on all Large Farm Operations (LFOs) and is in the process of compiling information on all Medium Farm Operations (MFOs) as is required by State Law. An attempt to collect information on small farms in the Missisquoi Sub-basin has been discontinued and there is no indication when or if it might resume. Under the LFO and MFO rules, all discharges from these farms have either already been addressed or will be in the next few years. However there are a large number of small farms with the potential for continued, undocumented farmstead discharges.

Chapter 3 discussed a method developed to identify and map all farmsteads in the Hungerford Brook Sub-watershed. This effort needs to be extended throughout the Sub-basin and expanded to include critical farmstead information that would include the presence and type of any discharges. This information could be compiled by combining data already collected by the VAAFM for LFOs and MFOs with data that would be collected through a small farm survey or some alternative procedure. One alternative is the identification of farmstead discharges using high resolution color photography. This photography has already been purchased for small “special project” areas in other parts of Vermont. The benefits associated with the use of this type of photography are further explained in Appendix C.

Interpretation of this photography could provide information for this Sub-basin wide farmstead database in lieu of other methods such as on-farm surveys.

NRCS and VAAFM cost-share programs for agricultural conservation practices are obligated through voluntary programs. These programs all use ranking procedures to ensure that funds are obligated to those farmers with the most significant resource concerns. These programs generally rely on the farmer to initiate an application for cost share. As such, these programs cannot be used to effectively target all significant water quality problems in the Sub-basin. A farmstead database would greatly aid the targeting of conservation cost-share funds to the most significant existing problems in the Sub-basin. Farmsteads with significant discharges could be identified and the farmers targeted for outreach efforts to participate in cost-share programs to eliminate the discharge. This process would help eliminate ongoing discharges that are not being adequately addressed. Critical farmsteads may become eligible for piggyback funding from other agencies to further lower barriers to conservation implementation. The Missisquoi Area-wide Plan was designed to foster such cooperation between agencies when critical needs are understood and agreed upon.

Treating Resource Concerns on Cropland

The Missisquoi Sub-basin has substantial acres dedicated to hay and corn production. As discussed in Chapter 2 the acreage of annually tilled corn has increased significantly over the last 25 years. Conservation programs such as EQIP and the VAAFM BMP program have continued to cost-share a wide variety of cropland practices. The location and type of practices implemented is often the decision of each farmer; this often does not address the more critical resource concerns. In addition, the relative effectiveness of some conservation practices is largely unknown for specific situations. The Area-wide Plan has identified several cropland situations where priorities should be established to reduce sediment and phosphorus loss in an efficient manner. For example, corn fields on slopes greater than eight percent have been shown to deliver much higher rates of sediment and phosphorus directly to surface waters than corn fields on flatter slopes.

Based on the analyses in this Plan, the following practices or combinations thereof appear to be most effective in reducing sediment and phosphorus losses from cropland:

- Corn fields with a predominance of slopes greater than eight percent, should be seeded down, and permanently maintained in hay.
- Implement no-till cropping systems on fields having a good potential for no-till.
- Convert silage corn cropping systems to grain corn cropping systems or other cropping systems with permanent vegetation or high residue levels.
- Inject manure on hay land instead of using surface applications,

These scenarios were discussed in detail in Chapter 3. The specific location of steep corn fields, hay fields and fields with no-till potential were provided as part of the analysis. Conservation planners can now use this information to target specific fields and farms for conservation practices. Federal and state programs will need to be modified to ensure that

sufficient incentives are available to get farmer participation. Further spatial information was provided for one Sub-watershed, the Rock River, identifying areas with a high potential for gully erosion. This information should be used by planners to target areas for site visits to assess whether gully erosion is occurring. This could also be conducted as part of the overall resource inventory process when working with a farmer to develop a conservation plan.

Targeting the fields identified above with a new array of conservation practices will ultimately result in a much more significant and efficient reduction of sediment and phosphorus loss from cropland in the Missisquoi Sub-basin.

Treating Resource Concerns Associated with Stream and River Systems

Vermont landscapes have undergone significant historic modifications due to extensive land clearing and forest clear cutting over the past 150-175 years. In more recent times, our stream and river systems have suffered from a variety of impacts and encroachments including: gravel mining, straightening, man-made re-alignments and construction of bridges and other permanent structures. As a result, up to 75 percent of our stream and river reaches are currently undergoing adjustment due to geomorphic instability[26]. This instability creates conditions where accelerated rates of stream bed and stream bank erosion are common. These accelerated erosional processes have the potential to deliver significant amounts of sediment and phosphorus to Lake Champlain. The Missisquoi Sub-basin and its sub-watersheds are typified by many stream reaches in a state of geomorphic adjustment.

The data collected through the Phase I and Phase II stream geomorphic assessments is now readily available through the VTDEC Stream Geomorphic Assessment Data Viewer. Described in Chapter 3, this Data Viewer provides conservation planners with a variety of stream and river data as both map products and databases. The information can be used to assess various reaches of streams and rivers in the Missisquoi Sub-basin in order to target practices to areas with the greatest need. Several different conservation measures, such as channel re-alignment and floodplain restoration can be targeted to those sites where the greatest benefits will be realized. NRCS and its partners now need to develop a process to include these high priority areas in project application ranking for on-going programs such as WHIP and EQIP.

Historically all natural community types associated with riparian areas were dominated by woody vegetation (forested or scrub/shrub). The exceptions were beaver meadows, a successional stage of an alder swamp and some lake influenced streams dominated by sedges, rushes, and grasses. The geomorphic instability of rivers and streams can be accelerated or even created by the lack of natural boundary conditions associated with woody vegetation on streambanks. The removal of woody vegetation from stream and river banks has the potential to significantly alter these boundary conditions, resulting in accelerated erosion. This loss of woody riparian vegetation is often a result of agricultural activities, either from clearing for crop production or from the grazing by livestock. As a result, large

[26] Mike Kline, VTDEC River Management Group, Personnel Communication, 2008.

sections of most river and stream corridors are now devoid of woody vegetation. Livestock still have access to the stream banks in some areas, creating further instability and erosion. Forested riparian buffers can help to reduce sediment and phosphorus runoff associated with adjacent crop and pasture fields. Fencing livestock from stream access, combined with watering facility development, has been shown to be successful in substantially reducing phosphorus delivery to streams, by stabilizing stream banks.

As part of this Plan, a comprehensive interpretation of aerial photography was performed to identify stream and river reaches without woody vegetation. This analysis was discussed in some detail in Chapter 3. Of the 2,815 streambank miles assessed in the Missisquoi Sub-basin, 919 appear to have inadequate riparian buffers. A minimal buffer from a water quality perspective was considered to be 25 feet. The location of these "riparian buffer gaps" has been identified and included in a GIS database. This gap information can now be overlain with other information on the riparian corridor, such as stream bank erosion susceptibility data. This overlay identifies areas along the river corridor that have soils susceptible to erosion and without woody vegetation. These are areas where stream restoration and stabilization practices are likely a priority.

This riparian gap data can also be used in conjunction with erosion information available in the Stream Geomorphic Data Viewer to identify high priority areas for stabilization and tree planting and establishment. Further efforts are needed to coordinate the use of VTDEC programs and funds for restoring and protecting river corridors with USDA programs such as CREP to re-establish forest riparian buffers.

Treating Resource Concerns Associated with Degraded Wetlands

Vermont has lost approximately fifty percent of its natural wetlands since the time of European settlement.[27] Incremental loss of wetlands continues today due to both urban development and agricultural conversions. One important function of natural wetlands is sediment and nutrient retention. On a watershed wide basis there has been a significant reduction of this wetland function throughout Vermont, including the Missisquoi Sub-basin.

The Lake Champlain Wetland Restoration Plan discussed in Chapter 3 identified approximately 16,000 acres of degraded wetlands that could have restoration potential in the Missisquoi Sub-basin. Many of the potential restoration areas occur in landscape positions, such as floodplains, that could provide sediment and nutrient retention functions. In general, these areas received a higher priority ranking in the Wetland Restoration Plan.

Several wetland restoration programs operate in the State. NRCS administers the Wetland Reserve Program (WRP) and has been restoring 2-3 wetlands each year since 1998. WRP funds are available for protection of wetlands through easements and for restoration. The Partners for Fish and Wildlife program (PfW) of the USFWS also has funding to restore

[27] Wetlands and Agriculture: Private Interests and Public Benefits. Ralph E. Heimlich, Keith D. Wiebe, Roger Claassen, Dwight Gadsby, and Robert M. House. Resource Economics Division, Economic Research Service, U.S> Department of Agriculture. Agricultural Economic Report No. 765. p. 80.

wetlands. More recently, The VT DEC funded an initiative to restore wetlands under the Clean and Clear Program. Funds from this program can also be used to protect wetlands with easements and restore them to natural conditions.

To date, most applications for wetland restoration were submitted by interested landowners. Many of these voluntary applications, if approved for funding, would have provided marginal benefits to improving wetland functions. In order to maximize wetland restoration benefits, especially for water quality, a more targeted approach to wetland restoration is needed. The three agencies, NRCS, USFWS and VTANR, need to establish a targeted outreach program with a goal of restoring wetland sites that provide the greatest increase in wetland functions. The Lake Champlain Wetland Restoration Plan provides the basis for this targeted outreach program. Landowners with high priority wetland restoration sites can be contacted and the merits and benefits of restoring their sites can be discussed. Although still a voluntary program, this targeted effort will help ensure high priority sites will be the first to be restored.

Use of the Area-wide Plan by Partner Organizations

This Area-wide Plan was prepared for use by NRCS and its partner organizations. In most cases, NRCS will be an active partner in any initiatives relating to this Plan in the Missisquoi Sub-basin. NRCS will take the lead to develop any additional maps or other applications of the data submitted in this report. In some cases, partner organizations may undertake an initiative without NRCS involvement. In these situations it may become necessary to develop additional maps or displays of data not provided in this Plan.

The Plan provides data and examples of output that is now readily available for use by resource managers from any organization. In some cases, examples of compiled data are provided for specific watersheds, such as cropland data for the Rock River and Hungerford Brook sub-watersheds. When working in other watersheds, it may be necessary to develop GIS data and maps specific to these sub-watersheds. The methods to produce the more complex maps shown in this report are provided in the Appendix.

FUTURE DIRECTIONS AND NEEDS

The Missisquoi Area-wide Plan serves as a guide for future conservation efforts in the Missisquoi Sub-basin. Future initiatives in the Sub-basin should evolve and change over time as knowledge increases and new tools become available. Some possible initiatives and tools are described below that could help meet the goals of this Plan as well as the goals outlined in the LCBP's "Opportunities for Action" and the VTDEC Center for Clean and Clear Work Plan.

Use of Adaptive Management

Adaptive Management is defined as a structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously maximizes one or more resource objectives and, either passively or actively, accrues information needed to improve future management. Adaptive Management is often characterized as "learning by doing."[28]

There are several key elements associated with adaptive management. These elements must be recognized and incorporated into the decision making and management process. For resource management in the Missisquoi Sub-basin, the following elements must be developed and incorporated into the long-term process of improving water quality in Missisquoi Bay.

1. Recognize our gaps in knowledge and the risk associated with implementing programs and practices in such uncertainty;
2. Develop a conceptual understanding of how sediment and phosphorus enter the Bay and the relative magnitude of those sources. This conceptual understanding can be adjusted over time based on new data and knowledge of how the system works;
3. Develop a water quality monitoring program to provide input to the decision making process and use the data as insight to adjust our conceptual understanding of how the system works; and;
4. Build iteration into the decision making process. Sufficient data needs to be collected in order to evaluate the results of our decisions and then make needed adjustments. The results from collecting data can then be used to further refine the monitoring program.

Additional Data and Tools Needed

During development of this Area-wide Plan it became clear to the authors that there is a need for additional data and tools to further evaluate resources.

Farmstead Database

The lack of a formal database for agricultural farmsteads has been described. As part of this Plan an initial farmstead database was created for the Hungerford Brook Sub-watershed. This example included farmstead locations and type of operation. A Sub-basin wide database is important in order to track existing resource concerns. It can also be used as a tool to estimate workload and funding needs, and can also be used to measure success. A farmstead database that includes all significant farming operations is an important first tool needed in the Sub-basin. The information included in the database should be expanded to include information on resource concerns associated with the operation.

[28] Wikipedia contributors, 'Adaptive management', *Wikipedia, The Free Encyclopedia*, 24 January 2008, 20:29 UTC, http://en.wikipedia.org/w/index.php?title=Adaptive_management&oldid=186658915

Crop Field Database
An initial cropland database for the Missisquoi Sub-basin was developed for this Plan. The location of cropland fields as of August, 2003 was determined, their slope was measured, and their use for corn or hay was identified. A more complete cropland database could be developed that would include a variety of additional useful data including active or idle pastureland. This database could include information on RUSLE2 erosion rates, cropping systems and rotation schedules, soil test results for phosphorus, and P Index values.

This additional information would prove valuable in targeting additional fields for specific conservation practices. It could also be used in the development of computer-based models in order to better understand sediment and phosphorus export on a watershed and field level basis and to help determine which conservation practices would be most effective in controlling it.

High Resolution Digital Photography
The most recent available digital imagery is the NAIP imagery. The imagery from 2003 has a pixel resolution of 1.0 meter, while the 2006 imagery has a resolution of 2 meters. This imagery is not generally suitable for developing accurate spatial agricultural use data, either alone or in conjunction with other data such as the CLU and crop report data. A detailed description of the NAIP imagery and its limitations is located in Appendix C.

Data collected for the NRI in 2001 and later with digital imagery with a pixel size of 1.0 foot (0.30 meter) has proven to be much more effective. Used in GIS, this imagery, coupled with the hard copy color diapositives, provides greater sharpness and resolution. The NRI photography is natural color, is flown at the height of the growing season, and is flown at a scale of 1:7,920.

Examples of uses of the high resolution photography include:
- Assess condition of farmsteads, farmland, residential land, and other built-up areas;
- Distinguish active versus inactive farmstead areas;
- Assess farmstead runoff and determine its proximity to drainage ditches, streams, and water bodies;
- Distinguish idle pasture land from pasture that is being grazed;
- Distinguish the presence or lack of fencing in pastures along streams;
- Assess pasture vegetative health, watering facility distribution, and overgrazed pastures;
- Identify and map built-up (developed) areas with high accuracy, including residential, commercial, industrial and recreational areas;
- Ability to assess these factors in regard to their proximity to streams and water bodies;
- Identify and map wetlands and other water features (where Color Infra-Red CIR is also available)
- Identify stream bank areas devoid of vegetation, stream bank erosion, and snags in streams; and
- Provide a permanent record of current growing season conditions.

This type of photography could prove invaluable. It would greatly aid in the targeting of specific problem areas, especially if on-site access is difficult to obtain. Additionally, it will assist in targeting where further on-site assessments and conservation activities are necessary.

LiDAR Data

Light Detection and Ranging (LiDAR) is a remote sensing system used to collect highly accurate elevation (topographic) data. These data are collected with aircraft-mounted lasers capable of recording elevation measurements that have a vertical precision of 15 centimeters (6 inches). The LiDAR data provides much greater resolution than the currently available 10 meter DEM data.

The LiDAR data could be used to more accurately determine the slope of crop fields. It could even be used to identify steep areas and areas of concentrated runoff within field areas. The data also provides sufficient resolution to identify classic gullies within fields or gullies that form in steep areas adjacent to fields. Annually tilled fields in floodplains often include areas that are susceptible to recurring scour erosion. LiDAR data would be an effective means of identifying scour erosion in floodplains. These identified problem areas could then be targeted for remediation with appropriate conservation practices.

Water Quality Impacts of Surface and Tile Drainage

The installation of drainage systems in cropland fields used to be a very common practice. In many instances, drainage systems installed years ago are still functioning. Field drainage installation is still done, but to a much lesser extent than 2-3 decades ago. There are many advantages to the removal of excess surface and ground water from fields in crop production. Improved drainage allows for crop production and extended periods of access for activities such as the application of manure, tilling and planting, and the harvesting of crops as well as for improved production. Both surface ditches and subsurface (tile) drainage are common agricultural practices in the Missisquoi Sub-basin due the prevalence of poorly and somewhat poorly drained soils.

The alteration of natural hydrologic conditions on farm fields impacts the export of sediment, manure, and phosphorus to surface waters. In some cases the improved crop field drainage may decrease contaminant export due to less surface runoff over the field. In other cases, the establishment of more direct hydrologic links between the field and surface waters may increase contaminant runoff. More research is needed to determine drainage effects on water quality with different soil types and with different cropping systems.

As part of this initiative more information is needed on the remediation of contaminants in ditch and tile water outflows with best management practices. This may require the development of new BMP's that fit these particular situations.

Sediment and Phosphorus Contributions from Streambank Erosion

A high percentage of stream and river reaches in the Missisquoi Sub-basin are undergoing geomorphic adjustments due to historic changes in landuse and to more recent modifications of stream alignments. During the process of geomorphic adjustment, erosion and deposition are accelerated in these stream and river systems. These accelerated erosional processes have

the potential to increase the amount of sediment and attached phosphorus moving into surface waters, and ultimately being deposited in Missisquoi Bay.

The accelerated rate of erosion has not been adequately quantified; nor has the amount of phosphorus associated with this increased load of sediment and resulting deposition. Further research is needed to quantify the effects of these processes resulting from geomorphically unstable rivers and streams. Research is also needed on the quantity of phosphorus associated with different soil types and strata within the active floodplain of these systems.

RECOMMENDATIONS

Below are 13 recommendations that are the highest priority for consideration in implementing the Missisquoi Area-wide Plan. These recommendations were developed as a result of completing this Plan.

1. Complete farmstead identification and maps for the entire Sub-basin.
2. Create a farmstead GIS database for the entire Sub-basin.
3. Determine where discharges from farmsteads are occurring and their relative severity, either through on-farm surveys or through photo interpretation.
4. Target conservation practices to specific crop fields that have the greatest risk of sediment loss and phosphorus export.
5. Use cropland conservation practices that have the greatest anticipated impact on sediment and phosphorus loss reduction, including: no-till planting, permanent seeding for targeted annually tilled land, manure injection on hayland, and conversion from silage corn to grain corn or other cropping systems which provide increased crop residues on the soil surface.
6. Identify highest priority riparian buffer gaps for treatment through programs such as CREP and contact landowners about participation.
7. Identify high priority river and stream reaches in need of treatment.
8. Initiate an interagency effort to contact landowners with high priority wetland restoration sites for participation in federal and state programs.
9. Initiate synoptic water quality sampling in targeted areas.
10. Identify additional map and data products that need to be developed.
11. Implement a work plan based on the components of Adaptive Management that includes adequate monitoring.
12. Complete existing databases and develop new databases for use in the Missisquoi Sub-basin.
13. Develop new resource evaluation and inventory tools for use in the Missisquoi Sub-basin.

SUMMARY

The Missisquoi Area-wide Plan was developed by NRCS in conjunction with several partner agencies and organizations. The purpose of the Plan was to aid the parties in targeting high priority resource concerns associated with agriculture in specific geographic locations with conservation measures to reduce sediment and phosphorus export to the Missisquoi Bay. The identified high priority resource concerns included farmstead discharges, erosion, sediment loss and phosphorus export from annually tilled crop fields, manure and phosphorus loss from hayland, loss of riparian buffers, geomorphic instability in rivers and streams, and the loss of wetland function.

Databases were developed to include information on the extent and geographic location of these high priority resource concerns. These data were analyzed and displayed in GIS systems and maps. Other tools were also used, including conceptual modeling, RUSLE2 and the Vermont P Index. These efforts have culminated in a series of maps and databases that can be used together to target conservation measures for addressing each of these resource concerns with increased efficiency and effectiveness. These targeting efforts need to be incorporated into ongoing conservation programs of all involved agencies. This includes such programs as EQIP and the VAAFM BMP program. In some cases, new conservation initiatives will need to be developed to address these resource concerns in a targeted fashion.

This Plan does not provide a final, conclusive answer to addressing resource concerns in the Missisquoi Sub-basin. A process of Adaptive Management needs to be developed and used in the Sub-basin. This process will allow agencies to learn from their efforts and refine their conservation programs over time. In addition, several new tools and initiatives are described that could greatly aid in continued conservation efforts, including new high resolution digital photography and LiDAR derived elevation data.

As in the past, involved partners must continue to work closely together and coordinate their efforts. Hopefully, the establishment and implementation efforts of the Northern Waters Clean and Clear Center will greatly aid in this future coordination and in the implementation of more targeted conservation measures in the Missisquoi Sub-basin.