

**TOTAL MAXIMUM DAILY LOAD
for
PATHOGENS**

**WINOOSKI RIVER
BELOW CABOT VILLAGE**

Waterbody ID: 08-09

January, 2001

Prepared by:

State of Vermont
Department of Environmental Conservation
Water Quality Division
103 South Main Street
Building 10 North
Waterbury, VT 05671-0408

Submitted to:

U.S. Environmental Protection Agency-Region 1
One Congress Street
Suite 1100 (CVT)
Boston, MA 02114-2023

Table of Contents

Introduction and Waterbody Description	1
Problem Assessment and Pollutant Sources	1
Problem Assessment	1
Priority Ranking	2
Pollutant of Concern	3
Pollutant Sources	3
Applicable Water Quality Standards and Numeric Water Quality Target	4
State Water Quality Standard	4
Management Objectives	4
Numeric Water Quality Target	5
Antidegradation Policy	5
Linkage Analysis	6
TMDL Allocations	9
Wasteload Allocations	9
Load Allocations and Background	10
Margin of Safety	10
Seasonal Variation	11
Monitoring Plan	11
Reasonable Assurances	11
Public Participation	12
References	13
Figures	
Appendix A - Fact Sheet for: Draft NPDES Permit to Discharge to Waters of the United States, Cabot Wastewater Treatment Facility	
Appendix B - Published Public Notice for: Total Maximum Daily Load for the Winooski River at Cabot Village	

Introduction and Waterbody Description

The impaired water for which this TMDL was developed is identified on the 1998 Vermont 303(d) List as Winooski River-Cabot Village and is located by the Waterbody ID VT08-09. The impaired segment is located in the uppermost portion of the Winooski River Basin (upstream from Lower Cabot Village) in waterbody 08-09, as defined by the State of Vermont River Basins map. The stream is classified as Class B in the Vermont Water Quality Standards effective July 2, 2000. This TMDL aims to restore the impaired waterbody to at least the minimum level described in those standards.

The Winooski River watershed at Lower Cabot Village and its associated land use is identified in Figure 1. The watershed has an area of 21 square miles, 70% of which is forested. Breakdown of the major land use categories in the watershed is given below in Table 1.

Table 1. Land use breakdown in the Winooski River watershed at Lower Cabot Village.

Land Use Category	Percent Composition
Forested	70 %
Agriculture	17 %
Urban/Developed	6 %

Source Data: *LANDSAT Thematic Mapper Imagery, 1997, The Vermont Center for Geographic Information, Inc.*

The above categories are the major land uses identified in the watershed and represent about 93% of its total area. The remaining uses comprise open water and non-forested wetlands.

Problem Assessment and Pollutant Sources

Problem Assessment

The area in and around Cabot, Vermont has historically had problems finding suitable sewage treatment and disposal. Possible solutions to these problems have been investigated for many years by various parties including Cabot Village, the School District, Town of Cabot, the Agency of Natural Resources and local planning groups.

In May 1992 a feasibility study was prepared for the Village by Phelps Engineering, Inc. This study discussed eight options for the Village and School District with respect to wastewater management and did not recommend any specific alternative other than to continue to work with the Department to

discuss project direction.

Due to growing concerns about possible contamination of the Winooski River in the Cabot area caused by failing septic systems and illegal discharges, a sanitary survey was conducted by the VT-DEC between November 23, 1992 and December 4, 1992 and on April 14, 1993 of the same area the feasibility study addressed. The survey found six properties with pipes that were illegally discharging untreated or improperly treated sewage directly into the Winooski River. Twelve more properties were found to have failed septic systems.

As a result of the findings of the sanitary survey the Department issued an Order under 10 V.S.A. Section 1277 to the Town of Cabot on September 15, 1993. This order required the Town to evaluate treatment options for correcting the wastewater problem, select a treatment option, and construct and operate a wastewater treatment system to correct the untreated sewage and the failed septic systems.

Based on the data generated by the sanitary surveys, impairment of the Winooski River in the area of Cabot Village was determined to exist and the waterbody was placed on the 1998 Vermont 303(d) List. The waterbody had not been listed on previous 303(d) lists. Because of the clear understanding and the magnitude the identified direct discharges and failed septic systems can have on a small river, it was determined that instream sampling was not required to determine impairment based on the Escherichia coli (E. coli) numeric standard (77 organisms/100 ml - instantaneous).

Other potential sources of E. coli contamination were not investigated for two reasons. Firstly, no further information was required to determine the violation of Vermont statutes concerning direct discharges and the need for their removal. Secondly, other possible sources were believed to be minor compared to the domestic sewage sources, which were considered the most obvious and largest sources of fecal contamination.

Priority Ranking

According to the 1998 Vermont 303(d) List, TMDL development for the Winooski River at Cabot was scheduled for 2000, which represents a high priority scheduling for TMDL development. Waters listed on the 1998 303(d) List were prioritized over a period of 15 years, through 2013.

Pollutant of Concern

The Winooski River at Cabot TMDL was developed for pathogens from fecal contamination; however, more specifically the Vermont Water Quality Standards identify *E. coli* as the indicator organism for which pathogens are detected. Therefore, this TMDL has been developed for *E. coli*.

Pollutant Sources

Sources of *E. coli* to a waterbody can vary greatly and can be from both point sources and nonpoint sources. Poorly treated or untreated sewage can be a major source of *E. coli* contamination as can untreated runoff from urban and agricultural areas. The identified as well as potential sources of *E. coli* contamination are discussed below.

Point Sources

As identified in the Introduction, significant point source *E. coli* contamination to the Winooski River in the Cabot region was identified from the investigations conducted in 1992 and 1993. These investigations revealed six (6) direct discharges of domestic sewage to the Winooski River. Subsequent investigations by the State of Vermont during 2000 discovered further direct discharges of fecal contamination from septic systems. The total point sources identified to date include thirteen (13) direct discharges of domestic wastewater to the river.

Currently there is a single NPDES permitted direct discharge in the watershed from the Cabot High School which contributes *E. coli* to this portion of the Winooski River. Discharge is authorized under Discharge Permit # 3-0376 which dictates a maximum flow of 6,000 gallons per day and an *E. coli* maximum concentration of 77 organisms/100ml. Under the proposed remediation measures of constructing a new wastewater treatment facility, this discharge will be eliminated and connected to the new facility.

Nonpoint and Background Sources

Associated with the watershed investigations conducted to identify domestic wastewater disposal irregularities, several problematic residential septic systems were identified. In addition to the direct discharges (point sources) listed above, seven (7) surfacing systems were identified with potential to

ultimately discharge to the river. As of the latest investigation, an additional 21 systems are considered problematic with significant potential for fecal contamination to the river. A distinct trend has developed as investigations of septic systems progressed. While perhaps all sources of fecal contamination to the river may not have been identified, sufficient evidence exists to document a real and significant problem and a violation of the Vermont Water Quality Standards. Considerable variation in the magnitude of contamination from such sources may exist, but a conservative loading scenario developed under critical conditions is given in the Linkage Analysis portion of this document.

No specific sampling data exists for the enumeration of nonpoint background sources of E. coli. However, there are also no indications of problematic E. coli loading from background sources and this TMDL assumes there are no significant background sources of fecal contamination. The high degree of forest cover (70%) and pervious surfaces within the watershed supports this assumption. This dominant land use is expected to produce the lowest E. coli loading rates of all land uses identified.

Applicable Water Quality Standards and Numeric Water Quality Target

State Water Quality Standard

The Winooski River at Cabot is designated as a Class B water. As a Class B water, the current Vermont Water Quality Standards state in §3-04(B)(3) that E. coli concentrations are:

Not to exceed 77 organisms/100ml. The Secretary may, by permit condition, waive compliance with this criterion during all or any portion of the period between October 31 and April 1, provided that a health hazard is not created. The Secretary shall provide written notice to the Vermont Department of Health prior to issuing a permit waiving compliance with the Escherichia coli criterion.

Management Objectives

The Vermont Water Quality Standards in §3-04(A) state that:

Class B waters shall be managed to achieve and maintain a level of quality that fully supports the following designated uses:

including:

5. Swimming and other primary contact recreation - suitable for swimming and other forms of water based recreation where sustained direct contact with the water occurs and, where attainable, suitable for these uses at very low risk of illness based on Water Management Type designation.

Numeric Water Quality Target

The water quality target for this TMDL is set equal to the E. coli water quality standard of **77 organisms/100 ml.**

Antidegradation Policy

In addition to the above standards, the Vermont Water Quality Standards contain, in part, the following antidegradation policy in § 1-03(B)(1):

Existing uses of waters and the level of water quality necessary to protect those existing uses shall be maintained and protected regardless of the water's classification. Determinations of what constitute existing uses of particular waters shall be made either during the basin planning process or on a case-by-case basis during consideration of an application. The use of waters to receive or transport discharges of waste shall not constitute an existing use for purposes of these rules. In making a determination of the existing uses to be protected and maintained under this section and all other sections of these rules, the Secretary shall consider at least the following factors:

- a. Aquatic biota and wildlife that utilize or are present in the waters;
- b. Habitat that supports existing aquatic biota, wildlife, or plant life;
- c. The use of the waters for recreation or fishing;
- d. The use of the water for water supply, or commercial activity that depends directly on the preservation of an existing high level of water quality; and
- e. With regard to the factors considered under paragraphs (a) and (b) above, evidence of the use's ecological significance in the functioning of the ecosystem or evidence of the use's rarity.

Linkage Analysis

The linkage analysis is a necessary TMDL element that establishes the cause-and-effect relationship between measurable water quality targets and identified sources. This can be accomplished through a number of methods from qualitative assumptions based on sound scientific judgement to the use of sophisticated predictive models. The method chosen should be supported by monitoring data or observations that associate waterbody responses to specific loading conditions.

The cause of impairment to the Winooski River in Cabot was determined to be excess *E. coli* loading based on the presence of direct domestic wastewater discharges and failing septic systems. Prior to a discussion on the sources, loading and water quality targets for *E. coli* bacteria, it first must be understood how *E. coli* is used in the water quality standards. *E. coli* is an indicator organism used to identify the high probability of fecal contamination and human pathogens present in a waterbody. While the presence of *E. coli* over the state standard of 77 organisms/100ml is indeed a violation of the numeric standard, it is primarily an indicator of potentially more harmful contaminants. This type of information often prompts investigations into possible sources. In the instance of the Winooski River in Cabot, the sources of the impairment were identified without the use of the indicator organism *E. coli*. Direct and poorly treated domestic wastewater discharges, a violation of water quality standards themselves, were identified through direct investigation without the usual screening step of identification through water quality monitoring.

By understanding the link between pollutant sources and water quality targets, the loading capacity of the river must be understood. EPA regulations define loading capacity as the greatest amount of pollutant loading a waterbody can receive without violating water quality standards (40 CFR §130.2(f)). The loadings are required to be expressed as either mass-per-time, toxicity, or other appropriate measures (40 CFR §130.2(i)). For this TMDL, neither mass-per-time nor toxicity were seen as an appropriate means of representing the loading capacity for *E. coli*, so the loading capacity has been set equal to the maximum concentration of *E. coli* allowed in the water quality standards, 77 organisms/100 ml. This method was seen as the most appropriate method for several reasons.

Expressing the loading capacity in terms of concentration establishes a clearer link between water quality standards attainment and the allowable loading from various *E. coli* sources. Since the water

quality standards are expressed in terms of concentration (a maximum instantaneous concentration of 77 organisms per 100 ml) comparison of water quality data to the TMDL is simplified.

Another reason to relate the E. coli loading capacity in concentration rather than mass-per-time is that the NPDES point sources of E. coli are monitored and permitted based on concentration. Again, the correlation between their values and the standards can be more directly compared by water quality managers and the public. From the standpoint of assuring attainment of the standards, it is preferable that the bacteria sources be controlled so the magnitude of each source is equal to or less than the water quality standard that is expressed in terms of concentration.

Considering the knowledge of the untreated domestic wastewater, critical conditions are considered to occur during low-flows when they will have their greatest impact on instream E. coli concentrations. Assuming discharges from the sources are somewhat constant, low river flows will result in a higher instream E. coli (and presumably other human pathogens) concentration. Also, the potential impact of pathogens on contact recreation uses is perhaps greatest during periods of dry weather (lower river flow) rather than during wet weather. The calculated 7Q10 flow for this portion of the Winooski River is 2.8 cubic feet per second (cfs).

Quantification of the identified illicit discharges that contributed to the water quality violation was based on the following information: the number of households with direct discharges, the number of households with failing septic systems, an average of 2.5 people per household, an assumed average daily discharge of 120 gallons per person per day, and an assumed effluent discharge E. coli concentration of 10^6 organisms/100ml (Berg, 1978).

Also to be considered when determining the level of E. coli contamination in the Winooski River is the contribution from background sources. In this instance, background sources consist of all upstream nonpoint sources of E. coli. No data is available to quantify the E. coli loading from these sources but the reasonable assumption is made based on land use statistics that large nonpoint sources of E. coli or fecal pathogens are not anticipated. As the land use breakdown, Table 1, indicates 70% of the watershed is forested.

Additionally, during low flow, when the discharges have their greatest impact, impacts from upstream

background sources are expected to be minimal. Presumably, the most common mode of transport for E. coli to reach the stream is via overland runoff, and as indicated above, the most critical period for known significant contamination is during dry weather, low flows. Even though background sources are presumed to be minimal, the estimated E. coli loading under critical conditions described below in Table 2, is set at the limit of the water quality standards, 77 organisms/100 ml.

Table 2. Estimated E. coli concentrations during low-flow, 7Q10 conditions.

E. coli sources		Flow	E. coli concentration
Background			
	Winooski R. @ Lower Cabot	2.8 (cfs) (1,809,561 g/d)	77 organisms/100ml
Identified Nonpoint Sources			
	Failing Septic Systems - approx. 7	7,500 (g/d)	10 ⁵ organisms/100ml
Identified Point Sources			
	Cabot High School	6,000 (g/d) - max	77 organisms/100ml
	Direct Discharges - 13	3,900 (g/d)	10 ⁶ organisms/100ml
Approx. instream E. coli concentration			2,300 organisms/100ml

A slight distinction was made between direct discharges and failing surfacing systems with regard to the E. coli concentrations reaching the river. The thirteen (13) observed direct discharges were allotted an E. coli concentration of 10⁶ organisms as noted in the literature. Since the other seven (7) failing systems required some overland travel and presumably incurred some E. coli die-off prior to reaching the river, their contributing concentration was considered an order of magnitude less.

The approach used in making the linkage between pollutant sources and water quality standards is most appropriate in this instance because of the clear linkage between the identified point sources and violations of the water quality standards. It is a protective approach by eliminating the problematic discharges and limiting the combined discharge of the treatment facility equal to the E. coli concentration set in the water quality standards. This approach also provides an adequate margin of safety.

Another aspect to this method was that no instream bacteria sampling was conducted. Since identification of both E. coli and pathogen sources was extensive through the sanitary surveys conducted, the usefulness of instream sampling was diminished. However, for the purposes of this TMDL, violations of the E. coli limits in the standards were shown through dilution calculations (Table 2).

The actual current condition of the enumeration of the bacteria is of little real importance, since the solution calls for a complete removal of the problematic discharges and rerouting them to a new planned wastewater treatment facility (WWTF). What is of consequence is that the discharges identified and their potentially high E. coli and pathogenic organism concentrations cause violations of the water quality standards, a problem that needs correction.

TMDL Allocations

The TMDL allocation is composed of the sum of individual waste load allocations for point sources, load allocations for nonpoint sources, and natural background levels. In addition, the TMDL must provide a margin of safety that accounts for any uncertainty in the allocation being able to attain water quality standards.

Wasteload Allocations

As a new permitted wastewater treatment facility is being proposed in the Town of Cabot, all identified direct discharges are to be connected to the new facility. This process will eliminate one of the primary sources of fecal contamination to the river. Therefore, the wasteload allocation for this group of sources is set at zero. The other existing E. coli point source, the Cabot High School, is to be connected to the new facility, so its corresponding wasteload allocation is also set at zero. Following project implementation, the Cabot wastewater treatment facility will be the sole point source E. coli contributor, and through its regulated permit limits, its wasteload allocation is set at the maximum allowable by the standards, 77 organisms/100 ml. Table 3 summarizes the wasteload allocations.

Table 3. Wasteload allocations

Current / Planned Point Sources	E. coli. Allocation
Identified direct domestic wastewater discharges (13)	0
Cabot High School	0
Proposed Cabot WWTF (50,000 gal/day - max.)	77 / 100 ml

Load Allocations and Background

No changes are currently anticipated for the background nonpoint sources and the allocation to them, divided by land use, are set equal to the Water Quality Standards of 77 organisms/100ml. The identified problematic septic systems are to be redirected to the proposed treatment facility so their load allocation is set at zero. Table 4 summarizes the load allocations.

Table 4. Load allocations

Land Use Designation	E. coli. Allocation
Identified failing or surfacing septic systems (7)	0
Forested	77 / 100 ml
Agriculture	77 / 100 ml
Urban/Developed	77 / 100 ml

As mentioned previously in the description of sources, no specific sampling data exists for the enumeration of background sources of E. coli. However, there are also no indications of problematic E. coli loading from background sources. This TMDL assumes there are no significant background sources of fecal contamination based on the low degree of development and the high degree of permeable land cover. Forested land cover represents 70% of the watershed area and is expected to produce the lowest E. coli loading rates of the land uses identified.

Margin of Safety

There is an inherent margin of safety incorporated in the TMDL allocation by setting the allowable pollutant sources (wasteload allocation and load allocation) less than or equal to the water quality standards. While the holding of discharge concentrations at the planned WWTF equal to the standards

would ensure standards attainment, it does not consider the likely instream dilution, die-off and loss due to settling of bacteria. Within these conservative assumptions is an added margin of safety.

Seasonal Variation

The expression of this TMDL in terms of concentrations set equal to the water quality standards applies for all seasons and environmental conditions. It is protective of the standards under all seasonal variations.

Monitoring Plan

As detailed in the draft NPDES permit Fact Sheet (Appendix A) for the planned WWTF, there is an E. coli effluent limitation of 77 organisms/100 ml instantaneous maximum. E. coli monitoring is required twice per month and is consistent with other similar discharges using ultraviolet disinfection in the State of Vermont.

For the purposes of this TMDL, reasonable assumptions were made indicating that background loading of E. coli from the watershed was expected to be consistently below acceptable levels. This assumption was based on the low degree of development and high level of forested land cover in the watershed. In an effort to verify these assumptions and compliance with the water quality standards, periodic ambient monitoring will be conducted at the bottom of the impaired segment. Monitoring will not be conducted until all connections to the constructed WWTF are complete. Monitoring will likely be incorporated into the Vermont Rotational Watershed Assessment Program which conducts watershed assessments on a five year rotating basis.

Reasonable Assurances

As outlined briefly in the introduction of this TMDL and more extensively in the Fact Sheet (Appendix A), issued in association with the draft NPDES permit, considerable effort and investigation by the Town of Cabot and VT-DEC has been expended to solve this wastewater discharge problem to the Winooski River. Through years of effort, a plan has been developed to construct a new WWTF to eliminate the sources of fecal contamination to this portion of the Winooski River. As required by the original 1277 Order issued to the Town of Cabot on September 15, 1993, and subsequently amended

Orders, all identified problematic discharges are to be remedied through connection to the proposed WWTF. All planning efforts and design criteria for the new facility have been finalized and a final permit for the discharge was issued on April 11, 2000.

Public Participation

Issued to the public, in association with the draft NPDES permit for the construction of the new Cabot WWTF, the Fact Sheet (Appendix A) contained notice that this project would result in the attainment of the water quality standards in this impaired waterbody as required by section 303(d) of the Federal Clean Water Act. Text of that notice is provided below:

V. Compliance with Water Quality Standards

The Winooski River in Cabot Village (Waterbody ID VT08-9) is listed on the Vermont 1998 Part A list of Impaired Surface Waters due to pathogens resulting from the discharge of untreated or improperly treated sewage. Section 303(d) of the federal Clean Water Act requires that for impaired waters, states determine and implement strategies that reduce pollutant loading and achieve compliance with the applicable water quality standards. Upon completion of the Cabot Wastewater Treatment Facility (as defined by Condition A.I.4 of the permit) the discharge of untreated and improperly treated sewage will be eliminated and compliance with the Vermont Water Quality Standards will be achieved.

In addition to the public comment period associated with the NPDES Permit, public notice was given and comments were solicited for this Total Maximum Daily Load document. A 30 day public notice was posted on the Vermont Department of Environmental Conservation web site as well as in two daily newspapers serving the area, The Burlington Free Press and The Times Argus. The period for public comment was from December 13, 2000 to January 12, 2001. No comments were received. Copies of the public notices are given in Appendix B.

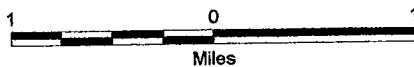
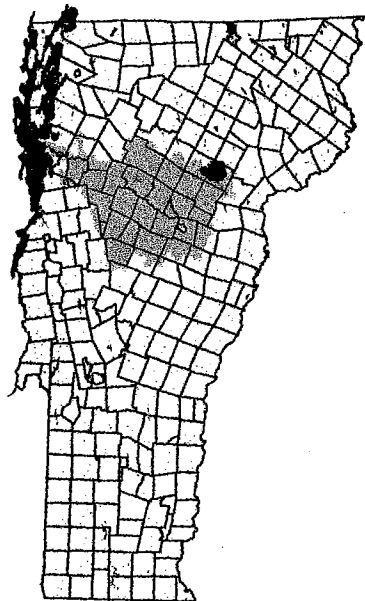
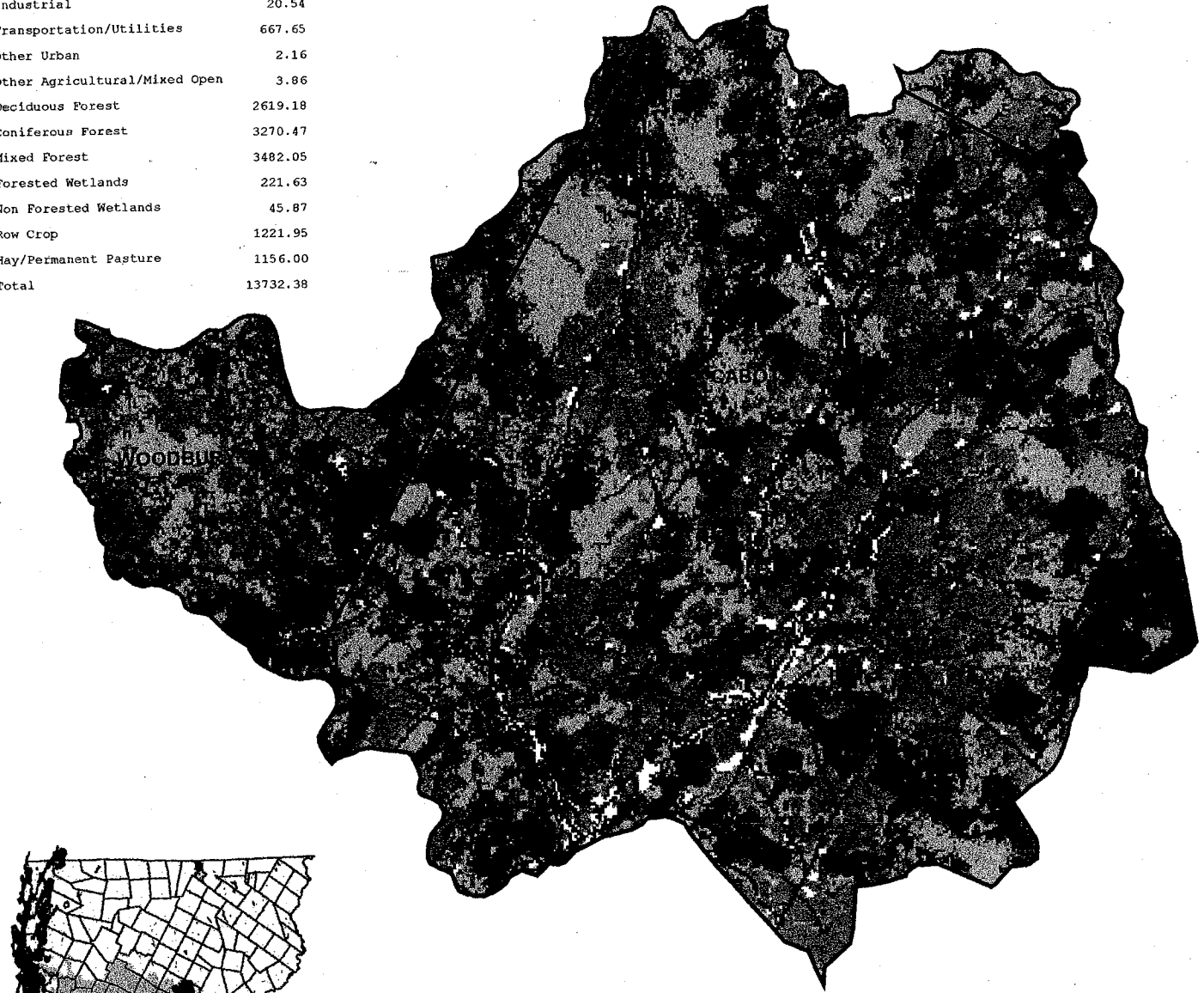
References

Berg, Gerald, ed.; Indicators of Viruses in Water and Food (Ann Arbor, MI: Ann Arbor Science Publishers Inc, 1978) p.179.

FIGURES

Figure 1: Winooski River watershed at Lower Cabot and associated land uses.

Land use/land cover	acres
Brush or Transitional	4.48
Water	824.88
Residential	182.24
Commercial	9.42
Industrial	20.54
Transportation/Utilities	667.65
Other Urban	2.16
Other Agricultural/Mixed Open	3.86
Deciduous Forest	2619.18
Coniferous Forest	3270.47
Mixed Forest	3482.05
Forested Wetlands	221.63
Non Forested Wetlands	45.87
Row Crop	1221.95
Hay/Permanent Pasture	1156.00
Total	13732.38



- Land cover / Land use
- Barren Land
 - Brush or Transitional
 - Commercial
 - Coniferous Forest
 - Deciduous Forest
 - Forested Wetlands
 - Hay/Permanent Pasture
 - Industrial
 - Mixed Forest
 - Non Forested Wetlands
 - Orchards
 - Other Agricultural/Mixed Open
 - Other Urban
 - Residential
 - Row Crop
 - Transportation/Utilities
 - Water

APPENDIX A

Fact Sheet for:

Draft NPDES Permit to Discharge to Waters of the United States

Cabot Wastewater Treatment Facility

AGENCY OF NATURAL RESOURCES
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WASTEWATER MANAGEMENT DIVISION
103 SOUTH MAIN STREET
WATERBURY, VERMONT 05671-0405

FACT SHEET

February 2000

DRAFT NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
PERMIT TO DISCHARGE TO WATERS OF THE UNITED STATES

FILE No. 12-105

PERMIT No. 3-1440

NPDES No. VT0101257

NAME AND ADDRESS OF APPLICANT: Town of Cabot
PO Box 36
Cabot, VT 05647

NAME AND ADDRESS OF FACILITY WHERE DISCHARGE OCCURS:
Cabot Wastewater Treatment Facility

RECEIVING WATER: Winooski River

I. Proposed Action, Type of Facility, and Discharge Location

The above named applicant applied on 4/29/99 to the Vermont Department of Environmental Conservation for a discharge permit to discharge into the designated receiving water. The facility is engaged in the treatment of municipal wastewater. The discharge will be from the proposed Cabot Wastewater Treatment Facility to the Winooski River.

II. Description of Discharge

A quantitative description of the discharge in terms of significant effluent parameters is based upon state and federal laws and regulations.