



## Section 319

# NONPOINT SOURCE PROGRAM SUCCESS STORY

# Vermont

## Ski Resort Improves Stormwater Management and Restores Rice Brook

### Waterbody Improved

Sediment in stormwater runoff from the Sugarbush ski resort's parking lots, driveways and roadside ditches degraded biological communities in Vermont's Rice Brook over many years. As a result, Vermont placed the brook on its 1996 Clean Water Act (CWA) section 303(d) list for aquatic life use impairments caused by polluted stormwater runoff. The resort designed and installed numerous runoff treatment and control projects, which reduced sediment levels. Monitoring data in 2008 and 2009 showed that Rice Brook complied with Vermont's aquatic life water quality standard, prompting the state to remove it from the CWA section 303(d) list in 2010.

### Problem

The 1.6 mile-long Rice Brook (Figure 1) flows through the Sugarbush Resort, a ski area and resort in central Vermont. The Vermont Department of Environmental Conservation (VTDEC) has classified the brook as a Class B water—a designation defined as “suitable for bathing and recreation, irrigation and agricultural uses; aquatic biota sustained by high quality habitat; good aesthetic value; acceptable for public water supply with filtration and disinfection.”

Over the years VTDEC has assessed the biological integrity of Rice Brook using several biomonitoring techniques, including the EPT index (short for the macroinvertebrate order names Ephemeroptera, Plecoptera and Trichoptera). The index is a measure of the number and types of pollution-sensitive aquatic insects inhabiting a waterbody. Streams with a high EPT value contain a greater richness (diversity) of pollution-sensitive aquatic insects, indicating higher water quality. VTDEC also assessed macroinvertebrate densities (total number of organisms present) and the percentage of macroinvertebrates consisting of pollution-tolerant worms of the taxonomic class Oligochaeta.

Biological monitoring conducted in the mid-1990s found that the stream did not comply with Vermont's Class B water quality standards for aquatic life. The stream had low EPT values, relatively low macroinvertebrate densities, and biotic communities with high percentages of oligochaetes (indicating poor water quality). As a result, VTDEC placed the brook on its CWA section 303(d) list of impaired waters in 1996. VTDEC attributed the impairment to sediment loading in the stream from gravel roadways, driveways and parking lots.



Photo by Sandy Macoy, Sugarbush Resort

Figure 1. Rice Brook flows through Sugarbush Resort, Vermont.

### Project Highlights

Sugarbush Resort completed a comprehensive water quality remediation plan in 2002 to comply with Vermont's land development law (Act 250), which regulates expansions and new developments involving more than 10 acres. The remediation plan included a survey of all sites and sources believed to contribute to the water quality impairments in the Rice Brook watershed (regardless of whether the lands/activities were controlled by the resort) as well as a list of recommended actions to address these sources.

The Mad River Valley Planning District received a CWA section 319 grant in 2003 to help prepare detailed design plans and to work with Sugarbush Resort to implement improved stormwater management practices at certain Rice Brook watershed sites outside the resort area. Between the fall of 2003 and

the summer of 2005, the resort installed 29 swales (Figure 2) to stabilize 6,700 linear feet of eroding ditches in 10 subwatersheds in the upper Sugarbush Village area. About one-third of the swales had slopes greater than 4 percent and were stabilized



Figure 2. Sugarbush Resort built treatment swales to control stormwater flow in ditches along private roads in the Sugarbush Village area.

with 8 to 12 inches of crushed stone. The remaining swales were vegetated. In addition, the resort replaced two degraded and undersized culverts and removed approximately 200 cubic yards of sediment from sediment basins and check dams in the drainage system. The resort also contracted with a local vendor to ensure regular maintenance of all runoff control measures.

When redeveloping the Lincoln Peak base area, much of which is in the Rice Brook watershed, the resort implemented enhanced stormwater treatment and control practices consistent with its water quality remediation plan. Between 2005 and 2007 the resort implemented nine best management practices (BMPs), including the construction of wet ponds, dry ponds and infiltration systems. The resort also constructed grass treatment swales and paved high-use driveways and parking areas. As a result of these efforts, stormwater runoff from all existing impervious surfaces within the Lincoln Peak base area is controlled and treated prior to discharge to receiving waters.

## Results

The aquatic habitat of Rice Brook has improved. Biomonitoring conducted in 2007 to 2009 showed that the macroinvertebrate densities and EPT indices had increased, while the percentage of oligochaetes had decreased (Table 1). All recent data indicate that Rice Brook meets the Class B guidelines for EPT index score (>16), macroinvertebrate density (>300 individuals), and percent oligochaetes (<12 percent). As a result, VTDEC assigned ratings of "good" or "very good" for four out of the five monitored reaches of Rice Brook in 2008 and 2009. The fifth monitored reach received ratings of "good-fair" and "good" for 2008 and 2009, respectively. All of these ratings indicate compliance with Vermont's water quality standards.

**Table 1. Biomonitoring Data for Rice Brook (1994–2009)<sup>1,2</sup>**

Date	Assessment Rating	EPT Index	Macroinvertebrate Density (Individuals/Square Meter)	Percent of Individuals from Oligochaeta
9/9/1994	Poor	11.5	88	17.8
9/1/1996	Fair	11.5	233	2.1
9/8/1997	Fair-Poor	10.5	140	19.5
9/2/2001	Fair	14.5	441	3.7
9/7/2003	Good-Fair	15.5	450	1.3
8/12/2005	Good-Fair	15.5	424	3.7
9/4/2007	Good	19.0	572	0.2
9/19/2008	Good	16.5	502	0.6
9/18/2009	Very Good	19.0	418	4.6
<b>Class B Guideline</b>		<b>&gt; 16.0</b>	<b>&gt; 300</b>	<b>&lt; 12.0</b>

<sup>1</sup> Data shown are from the lowest of the five stream reaches monitored. Data from the other four reaches are similar and reveal consistent trends.

<sup>2</sup> Red values indicate noncompliance

In addition, stream embeddedness, which measures the extent to which fine sediment fills in gaps around rocks and cobbles in the streambed, has declined. Before the restoration effort, most Rice Brook reaches were more than 50 percent embedded. After restoration, embeddedness decreased to less than 50 percent at all reaches, and two of the five monitored reaches were less than 25 percent embedded during 2008 and 2009. These data indicate that remediation practices reduced sediment delivery, improved stream habitat, and allowed the stream to meet the state's standards. As a result, VTDEC removed Rice Brook from its CWA section 303(d) list in 2010. Monitoring will continue at the stream for at least the next five years.

## Partners and Funding

The Mad River Valley Planning District received a CWA section 319 grant of \$40,000 to work with the Sugarbush Resort on stormwater BMP design and implementation. The resort provided matching in-kind labor, equipment and materials to construct the BMPs. Sugarbush Resort invested an additional \$500,000 to implement the site upgrades and treatment practices to manage stormwater runoff from existing impervious area in the Lincoln Peak base area. The resort also spends \$15,000 to \$20,000 annually for operation, monitoring and maintenance of the BMPs.

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