April 2017

Corrie Miller
Executive Director
Friends of the Mad River
friends@madriver.com

RE: Key Findings of Stone Environmental's Ridge to River Phase 1 Final Report

Dear Corrie,

In order to create ARC GIS Story Maps for Ridge to River Action Framework, Watershed Consulting Associates, LLC (WCA) on behalf of the Friends of the Mad River has reviewed and summarized the key findings found in the report entitled "A Framework for Action on Stormwater: Ridge to River Phase 1 Final Report."

This report includes a review of existing policy and recommendations for improvements geared toward water quality protection and stormwater volume reductions as well as a technical section assessing environmental data utilizing a geographic information system (GIS). The goal of this assessment was to identify areas in the watershed that may disproportionately contribute to concerns related to both stormwater quality and quantity. The GIS data was used to target and prioritize the 41 subwatersheds within the Mad River watershed.

WCA has summarized the report in the following bullet points. The findings are divided into five sections to better organize and convey the findings of this complex and lengthy report.

Policy Summary:

- According to interviews with those involved in land use, municipal management, road crews, agriculture, and forestry in the Mad River Valley, small, unregulated sites including minor land disturbing activities such as culvert replacements, residential activities, and small "quasi" forestry operations are a major source of erosion, sedimentation, and flooding in the watershed.
- Larger, regulated subdivision design, permitting, and implementation has improved. These projects are designed by professionals and implemented from site-specific design plans.
- Towns in the watershed have regulatory programs that greatly vary. Watershed towns have some standards that are protective, but others that are deficient. There is questionable assurance that even strong regulations can be enforced at the time of implementation and for the life of a project.

- A central recommendation of the report is to evaluate a reduction in threshold for both construction and post construction stormwater management standards for Town regulations. This recommendation is tempered however, with the acknowledgment that programmatic resources are not sufficient to manage a program that would require additional permit review and post-implementation inspection and maintenance.
- A lack of enforcement for and clarity in existing regulations is problematic, and without sufficient funding, staffing, and well-defined goals, this is unlikely to improve.
- Funding options are suggested that including a stormwater utility, as well as loan options including SRF. Bonding has also been suggested as an option to ensure stormwater measures are implemented.

GIS Analysis caveats:

- Impervious areas are not well mapped due to a lack of a high spatial resolution impervious dataset for the whole watershed. As such, fairly poor resolution land cover data from 2011 was used for the analyses.
    - This means that the data presented reflects that each of the pixels in this dataset span 900 m^2 (9,687.5 ft^2), so land cover types tend to be generalized. For example, a house with a 2,000 ft^2 footprint with forested land around it would not be represented in this data and this pixel would be classified as forested. This may suggest that forest loss may be underrepresented in this dataset.
    - Stone Environmental proposed calculating many metrics that may have been indicative of poor water quality, but they were not able to be calculated due to lack of this data.
- Recreational trails, though likely a minor contributor to issues in the watershed, are not well mapped. As such, this potential impact was not assessed.

Watershed summary:

- The Mad River watershed covers 144 mi^2 (92,122 acres) and is broken up into 41 subwatersheds, many of which are unnamed.
- The area is primarily forested (86%) with some agricultural (7.3%) and developed areas (4.3%).
- Mapped land cover comparisons between 2001 and 2011 showed that <1% (573 acres) of the watershed changed land cover type. Changes were widely distributed with changes in >70% of subwatersheds. Most changes were:
    - Shrub-dominated to Forest: 0.1% (50 acres; attributed to forest regeneration)
    - Forest to Shrub-dominated: 0.5% (468 acres; attributed to development such as ski areas and scattered rural development)

- Forest to Developed: 0.05% (34 acres; primarily attributed to scattered rural development)

Existing conditions as water quality risk factors:

- The overall watershed is 0.6% impervious, and this value varies by subwatershed. Two subwatersheds, Rice Brook and unnamed tributary 12, have >4% impervious cover. This 4% value is important as literature states that above this threshold water quality can be degraded following development.
- Three subwatersheds, Rice Brook and unnamed tributaries 9 and 11, have <65% forest cover. Literature shows that downstream stream condition can move from minimally to severely degraded when forest cover is below this 65% threshold.
    - Five other subwatersheds are nearing this threshold (<75% forested), and thus water quality in these areas may be at risk depending on subwatershed-specific conditions.
- Developed lands also present a risk to water quality and are associated with greater stormwater impacts and decreased flood resiliency. As of 2011, 3,993 acres (4.3%) of the watershed was classified as developed. Other indicators in relation to developed land were assessed:
    - The density of developed lands in proximity to water resources was calculated. These areas were in unnamed tributaries close to the VT Route 100-100B corridor along the Valley floor or in subwatersheds with village centers.
    - Existing development in on steep slopes (>15%) was also categorized as these areas are more vulnerable to erosion. Most of these areas are related to ski areas and roads. The largest areas are in Clay Brook, Rice Brook, and Mill Brook subwatersheds.
- Transportation networks were also assessed to determine stormwater-related impacts. There are 147 miles of private driveways and 291 miles of roads (437 miles combined) in the watershed. Approximately 34 miles of these roads are managed by the Vermont Agency of Transportation (VTrans).
    - Of the 147 miles of driveways, 41% (60 miles) have slopes >15%, putting them at higher risk of erosion.
    - Road density in 19 subwatersheds is high enough (>2.2 km/km^2) that similar densities reported in previous studies were associated with increased nutrient and sediment levels, declining habitat quality, and geomorphic instability. Highest road densities are generally associated with relatively concentrated development (village or ski areas).
    - Road-stream crossing density and driveway-stream crossing density were assessed. In half of the subwatersheds (21), road-stream crossing density was >1.3 crossings per km^2, a threshold that has been associated with decreased water

quality and geomorphic instability. These subwatersheds were those where roads closely parallel streams or where roads cut across the upper reaches of smaller tributaries.

- Agricultural areas, particularly those with steep slopes (>15%), highly erodible soils, and those near water resources were identified as especially vulnerable to erosion following disturbance, which is common in agricultural areas. Approximately 7.3% (6,715 acres) of the watershed is used for agriculture. These areas are concentrated in 8 subwatersheds that have >15% agricultural cover (Folsom Brook, Freeman Brook, High Bridge Brook, and unnamed tributaries 7, 8, 9, 11, and 13).
    - 21% of agricultural areas (1,436 acres) or 1.6% of the total watershed area have one or more indicator of potential erosion; they are steep, have erodible soils, or both. Of this area, 608 acres (0.6%) are in proximity to water resources. Most of these areas are in Mill Brook and Shepard Brook.
- Logged areas with highly erodible soils and very steep slopes (>30%) are also at risk for erosion following disturbance from logging activities. These at-risk areas that are located near water resources are even more concerning.
    - 80% (63,439 acres) of forested land had one or more erosion indicators (i.e., highly erodible soils or on very steep slopes), which represents 69% of the watershed. Of this area, 3,708 acres (4% of watershed area) are near water resources.

Existing water quality and aquatic ecosystem health:

- Biomonitoring assessments use the health and diversity of fish and benthic macroinvertebrates to assess water quality.
    - Macroinvertebrates assessments were made at 23 locations, 13 of which are associated with the Sugarbush Resort and Mt. Ellen developments. Generally, assessments indicated good to very good condition. There were some exceptions, such as Bradley Brook (good-fair condition in 2006) and Clay Brook (fair-poor to fair condition in 2015).
    - Biomonitoring locations in this watershed may also be positioned to monitor potential impacts from the resort's wastewater treatment systems, so caution should be used in ascribing potential ecological impacts to stormwater runoff in this subwatershed.
    - Fish population health is important as it integrates the conditions of lower community types. Fish population assessment data are available for four monitoring locations: Lincoln Brook, Shepard Brook, Dowsville Brook, in the Mad River headwaters. All sites had fish populations characterized as "very good" to "excellent," and all were recently assessed (summers of 2014 or 2015).
- Although water quality data have been collected by Vermont Department of Environmental Conservation (DEC) at a total of 64 locations in the watershed, this data

was not assessed as a part of this report due to the limited scope of the report and lack of consistency with both water quality parameters assessed and sampling intervals.

- The Friends of the Mad River have also collected water quality data for 10 years in consistent locations at regular intervals. Parameters include: total phosphorus (P), turbidity, and E. coli.
    - The water quality data (collected from 2006 to 2015) indicates that of 19 monitoring locations, mean turbidity was over the Vermont Water Quality Standard in three locations (High Bridge, Pine, and Dowsville Brooks) while mean P exceeded standards in 8 locations (Bradley, Rice, Folsom, High Bridge, Pine, Dowsville, and Welder Brooks) during baseflow conditions.
    - Turbidity near ski resort development in Bradley, Clay, and Rice Brooks was elevated at baseflow, but still below the water quality standard.

The "Ridge to River Phase 1 Final Report" provides a thorough analysis of existing regulations in the watershed towns and identifies the core water quality issues of small unregulated development, inconsistent and lacking regulations, and lack of program funding. GIS data was utilized to map and identify areas that may be disproportionately contributing to water quality concerns related to the quantity and quality of stormwater runoff within the Mad River watershed. Due to data limitations (i.e., lack of availability or poor spatial resolution), these findings are summarized on a subwatershed scale and some analyses had to be omitted. The key findings, summarized in this memo, will be used to further focus the efforts to create an "Action Framework" for the Mad River watershed stakeholders.

Sincerely,

Andres Torizzo
WCA Principal

Kerrie Garvey
GIS Specialist