Interpretation of the LLRM Report

The watershed consultants approached this watershed by identifying 7 sub-basins and characterized 5 models (1-5) where model 5 included three sub-basins in Alton involving the Merrymeeting River, Coffin Brook and Coffin Brook Tributaries.

Land cover analysis identified 4 different urban settings, 3 different agricultural settings, 4 different forest settings, plus water, meadow, excavated land, unpaved roads, and logging.

Due to the irregular size of the sub-basins and complex routing and attenuation, the watershed area was normalized into 1000 SF mapped grids (Figure 5). In Figure 6, pie grafts depict the watershed land cover into 4 categories with forest making up 79% of the total, water and wetlands making up 11%, developed land making up 8% and agriculture making up 2%, However, when the total phosphorus(TP) load was calculated by land cover, 55% of the load was from developed land, 31% for forest ,11% from agriculture and 3% for wetlands. From the standpoint of phosphorus load, developed land is by far the greatest contributor yet it is actually quite small as a % of total land cover.

Inputs into the models included: precipitation (see Figures7 and 10), lake volume, septic systems, waterfowl, and water quality data (phosphorus, chlorophyll-a and secchi disc transparency). Water Quality Data for Merrymeeting Lake was taken from 2009-2018 and summarized by day, then month, and finally by year. Monthly data were flow weighted for Marsh, Jones, Downing Ponds and Alton Bay to give median annual water quality summaries for TP, Chlorophyll and secchi disc transparency. Tributary or mainstem River data(2016-2018) were summarized by day, then month, and then year to get median annual water quality summaries for phosphorus. The annual TP for Merrrymeeting Lake for summer months was 3.5 ppb and a figure of 4.2ppb was selected as the annual average phosphorus to calibrate the model. Table 1 shows the annual total phosphorus for the 4 models downstream from MML, note that when flow weighted annual averages are used the TP concentrations were 17.7-14.3(Alton) for downstream models, much lower than the concentrations seen during the summer months. For instance, Marsh Pond had an average of 43.1ppb measured from May-September but had an annual flow weighted average of 17.7ppb. Figure 8 shows the average flow volume for PMSFH outfall 001 and 002 and for Merrymeeting Lake non-hatchery outflow. From this figure it can be seen that most MML outflow stops by April and the Lake actually has decreasing water levels as the summer months goes by loosing about two feet in water between July and September to evaporation. From June to September almost all the water into Marsh Pond comes through the hatchery. The hatchery has near constant flow throughout the year and discharge water has 12 times higher phosphorus compared to the out flow from Merrymeeting Lake. This is the period where cyanobacteria blooms occur.

Internal loading of phosphorus refers to the movement of phosphorus from the sediment into the water column and occurs when the water above the sediment is anoxic and when the sediment mainly contains phosphorus bound to iron. Refer to the document I copied on internal loading. Marsh, Jones and Downing Ponds have are pretty shallow waterbodies with a high rate of flushing (Marsh 54 times a year, Jones is 112 times a year and Downing is 141 times a year). To a certain extent they behave more like a river than a pond or lake. However, water quality testing through the water column in these ponds show stratification and anoxic conditions in Marsh and Jones Ponds but not Downing. Figure 9 shows the difference in phosphorus concentration when collected from the surface or the metalimnion(deep) and clearly the phosphorus concentrations in the metalimnion are higher in the summer months in Marsh and Jones Ponds suggesting internal loading is occurring. Merrymeeting Lake and Downing Pond do not

display this effect. This is important because internal loading of phosphorus may continue to add phosphorus to the water column even after the hatchery discharge is curtailed, serving as a continuous source of phosphorus for cyanobacteria blooms. Sediment analysis would show how much phosphorus is bound to aluminum and how much is bound to iron. In iron-enriched sediments the internal loading will become a problem and needs to be dealt with differently.

The system in model 5 Alton is also more complex due to the effect in attenuation of phosphorus and water. Phosphorus can be taken up by infiltration, filtration, and detention while water is lost to evapotranspiration, deep ground water, and wetlands. Because complex routing occurs in Model 5, adjustments to attenuation factors had to be made. Headwaters have less flow compared to mainstem river systems allowing for infiltration, adsorption and uptake. This was critical to take into account for the tributaries of Coffin brook.

A number of limitations were identified in this modeling including the lack of water quality data during the winter, and lack of bathymetry for Marsh Pond. Both Marsh and Mill Pond had bathymetry conducted by the NH DES on May 6, 2019 ( email me if you want copies). And monthly river water sampling also started on May 6 and will continue for 12 consecutive months to provide this missing data.

Findings: Total Phosphorus load by source is shown in Figure 11 for each of the 5 model systems. The total P load to Merrrymeeting Lake is 284 Kg/y with 56% from watershed runoff, 19% atmospheric, 18% from septic systems and 7% from waterfowl. Attention must be given to stormwater runoff and septic systems around the lake in the future-Table 4). Model 2 -Marsh Pond is dominated by the hatchery outfall discharge, note that Figure 11 separates the hatchery load from the other MML load coming over the sluiceway or from the dam gates. While 83% of the total P comes from the hatchery and lake, 75% of that is from the hatchery alone. This contribution from the hatchery continues into all other models representing about 50% of all P in model 3( Jones) and 40% in model 4(Downing) and 25% in model 5 Alton Bay. However, model 5 has an enormous contribution from the direct watershed with major contributions from the village urban area and Mill Pond, as well and the far reaches of Coffin brook where agricultural areas appear to be a factor. The detailed contributions in each of the models are presented in Table 4. Please note that the projected load to the river in model 5 (amount of P into Alton Bay) is 867 Kg/Y, an enormous amount. I have detailed high resolution map grids identifying the areas in the water shed where phosphorus loads per acre are the highest. Email me if you want copies.

The Watershed management planner conclude that the Merrymeeting River downstream from the Lake has degraded water quality ( Figure 12) primarily from one point source, the Powder Mill Fish Hatchery. However, they note that P loading from current and future development including septic systems and internal loading, are important sources to address. They recommend conservation of intact forestland and zoning ordinance amendments that encourage low impact development. Specific recommendations will follow in the final WMP. Three attachments detailed phosphorus export coefficients and land use categories by aerial viewing.