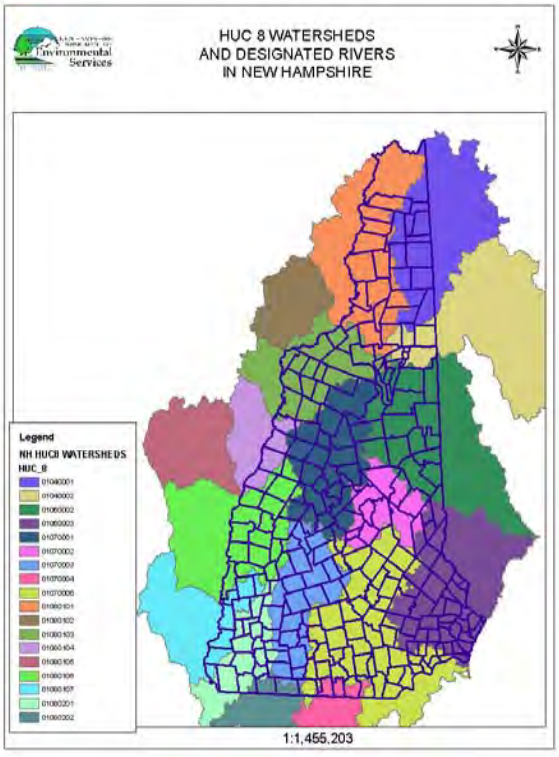
BUILDING A WATERSHED MODEL
FOR
ENHANCING WETLAND PROTECTION
IN NEW HAMPSHIRE

COLLIS ADAMS

MARY ANN TILTON



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Project Title: Building a Watershed Model for Enhancing Wetland Protection in New Hampshire

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I. INTRODUCTION

New Hampshire is the fastest growing New England state with approximately 260,000 (20 percent) more people expected to move to the state between 2005 and 2030 (New Hampshire Office of Energy and Planning, 2006). With this growth more lands adjacent to and in wetlands will be developed. There is increasing fragmentation of wetlands for roads and driveways, and there is an increasing concern that upland development poses indirect and cumulative impacts on the function and value of the wetlands.

Wetlands are of great importance for flood control, water purification, and wildlife habitat and reproduction areas. The value of these functions only increase with increasing development and the increase in occurrence and severity of storm events expected with climate change.

With funding from this USEPA grant, DES was able to develop a GIS-based desktop screening tool to evaluate wetlands based on three important functions; flood storage, water quality and wildlife habitat. Wetlands within each watershed were ranked relative to all of the other wetlands within their HUC 8 watershed. Previously ranking was only available statewide under the Wildlife Action Plan. The modules for wildlife habitat and water quality take into account the integrity of the surrounding landscape. This tool was developed through the work of the DES Geology Unit (flood control), DES Watershed Bureau (water quality) and the NH Fish and Game Department (wildlife habitat). The tool will be useful in looking at the resources on a watershed scale. Information from these GIS models will be used by DES technical staff in their review of wetlands applications, mitigation proposals, and for recommendations to the Site Selection Committee for the In Lieu Fee program. DES proposes a new screening protocol using this new GIS tool combined with Fish and Game's Unfragmented Block layer, for the Corps and EPA to screen for potential secondary impacts, under the PGP.

Seventy-four towns were provided with permitted mitigation plans and conservation easement parcel information to encourage local stewardship and tracking of protected lands and mitigation projects.

As a commitment under this grant, DES has fully integrated Wetlands and Alteration of Terrain (AOT) compliance. A new Land Resources inspection report has been developed. One hundred and nine (109) wetland permit inspection were conducted and 242 AOT inspections were done. Construction sequence and erosion control violations were the most common permit violation observed. A Compliance Review Team (CRT) was established to improve coordination, consistency and upper management support for compliance in all Land Resources Management programs (Wetlands, AOT, Subsurface Systems Bureau, Drinking Water, and Shoreland).

II. GIS MODEL DEVELOPMENT

DES developed a preliminary multi-agency GIS tool to integrate the review and protection of three primary wetland functions: flood storage, water quality and wildlife habitat. Three independent modules were developed for these three functions. The flood storage function module was developed by the DES – Geology Unit. The water quality function module was developed by the DES – Watershed program. The wildlife habitat function module was developed by the Fish and Game Department. Each of these layers was linked to the statewide wetlands basemap developed by the Watershed Management Program. This wetland basemap ties in the streams and rivers and other surface waters with the wetland layer of the National Wetland Inventory maps and was divided into separate assessment units based on the "Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire" (NH Method) wetland breakout rules. These maps are available with statewide coverage. Each function module was ranked separately based on each HUC 8 watershed mapping unit. The HUC 8 mapping units correspond to the Aquatic Resource Mitigation (ARM) Fund mitigation watershed divides. DES also retained Vanasse Hangen Brustlin, Inc. (VHB) to apply its Merrimack watershed GIS model to three other watersheds. A report documenting this work has already been submitted to EPA under separate cover.

FLOOD STORAGE MODULE

Preparation for Analysis

Prior to implementing the analysis for wetland flood attenuation function, the New Hampshire Geological Survey (NHGS) evaluated current field methods and relevant GIS techniques that could be employed. The literature is relatively rich on these topics and offered considerable insight into approaches that could potentially be adapted for application in NH. The Automated Assessment Method for Northeastern Wetlands (AMNEW) developed by the School of Natural Resources at the University of Vermont (Cedefeldt, et al, 2000) was initially investigated as a potential model. However, NHGS determined that this method could not effectively accommodate the datasets available for New Hampshire or the desired level of sophistication and accuracy. No other existing method could be identified that met all NHGS criteria. Outcomes of any analysis should evaluate how well/how much a wetland can store runoff from extreme precipitation events and how well it desynchronizes flood flow in a watershed.

Wetland Flood Function Analysis

A key component in evaluating how a wetland interacts with overland flow of precipitation is to quantify the amount of potential storage a given wetland might provide. The metric developed was the ratio of the area of wetland assessment unit (WAU) inundated by a hypothetical 1-foot rise in water level at the outlet to the total surface area of the WAU. The area of each wetland was derived using a GIS. Following that, the minimum elevation for each wetland was determined using our best available digital elevation model (DEM). One foot was added to the minimum elevation value as a way to simulate one foot of flood storage for each wetland. An analysis of the DEM was then performed to determine the area one foot of flooding created within the wetland. The ratio of flooded area to original area for each wetland was derived as a relative index of how much flood storage was provided by each WAU. The ratios were then ranked on a state-wide basis as wells as a HUC 8 basis. Based on this analysis, a user can readily distinguish wetlands that provide significant flood storage from those that provide little storage capacity.

Figures 1 and 2 provide examples of how the flood storage ranking displays the range of wetlands based on flood storage rankings. In figure 1, notice the old oxbow in Walpole adjacent to the Connecticut River with associated valuable flood storage wetlands. In figure 2, flood storage values for the City of Keene are shown.

Figure 1. Flood Storage Score for Walpole NH ox-bow wetland.

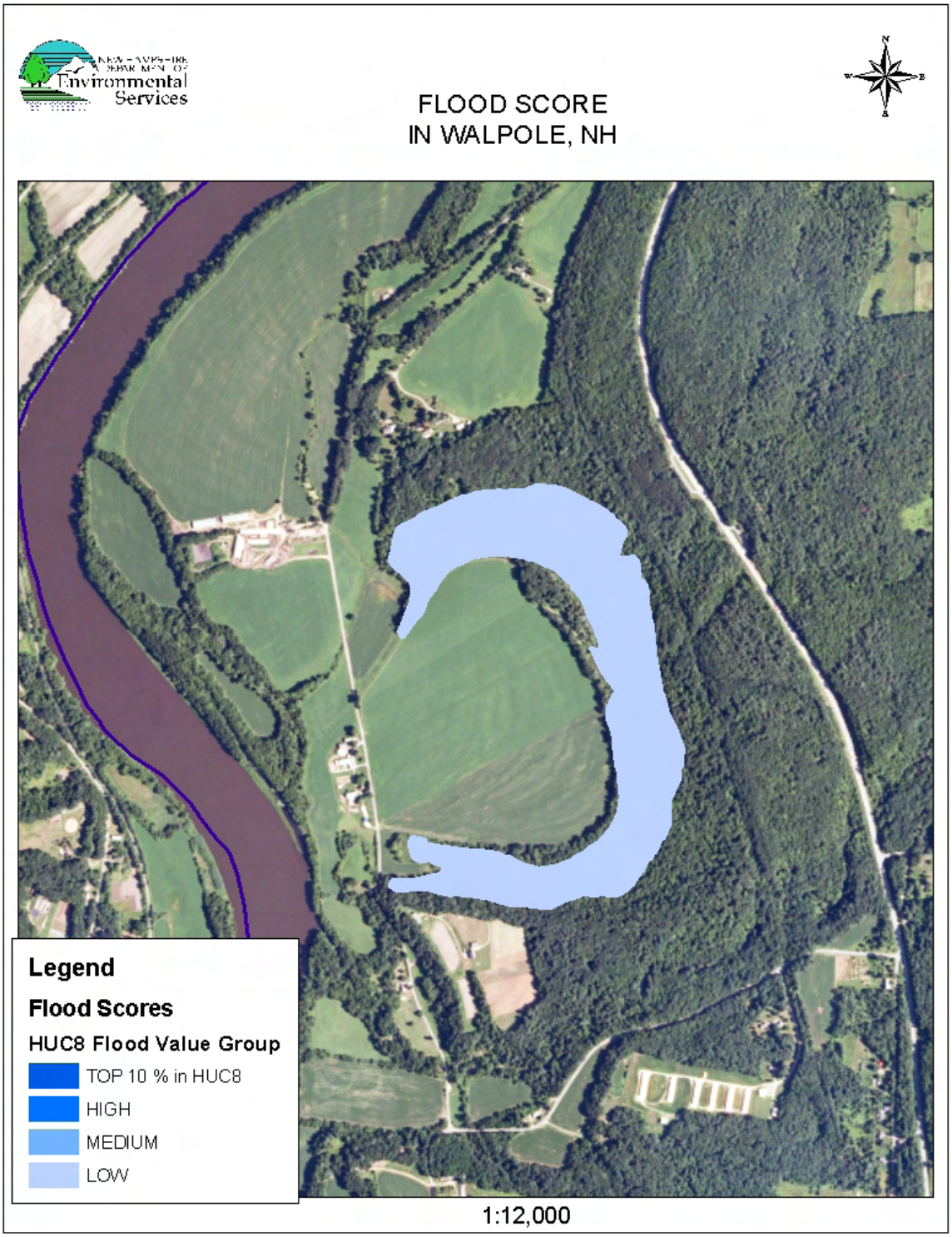
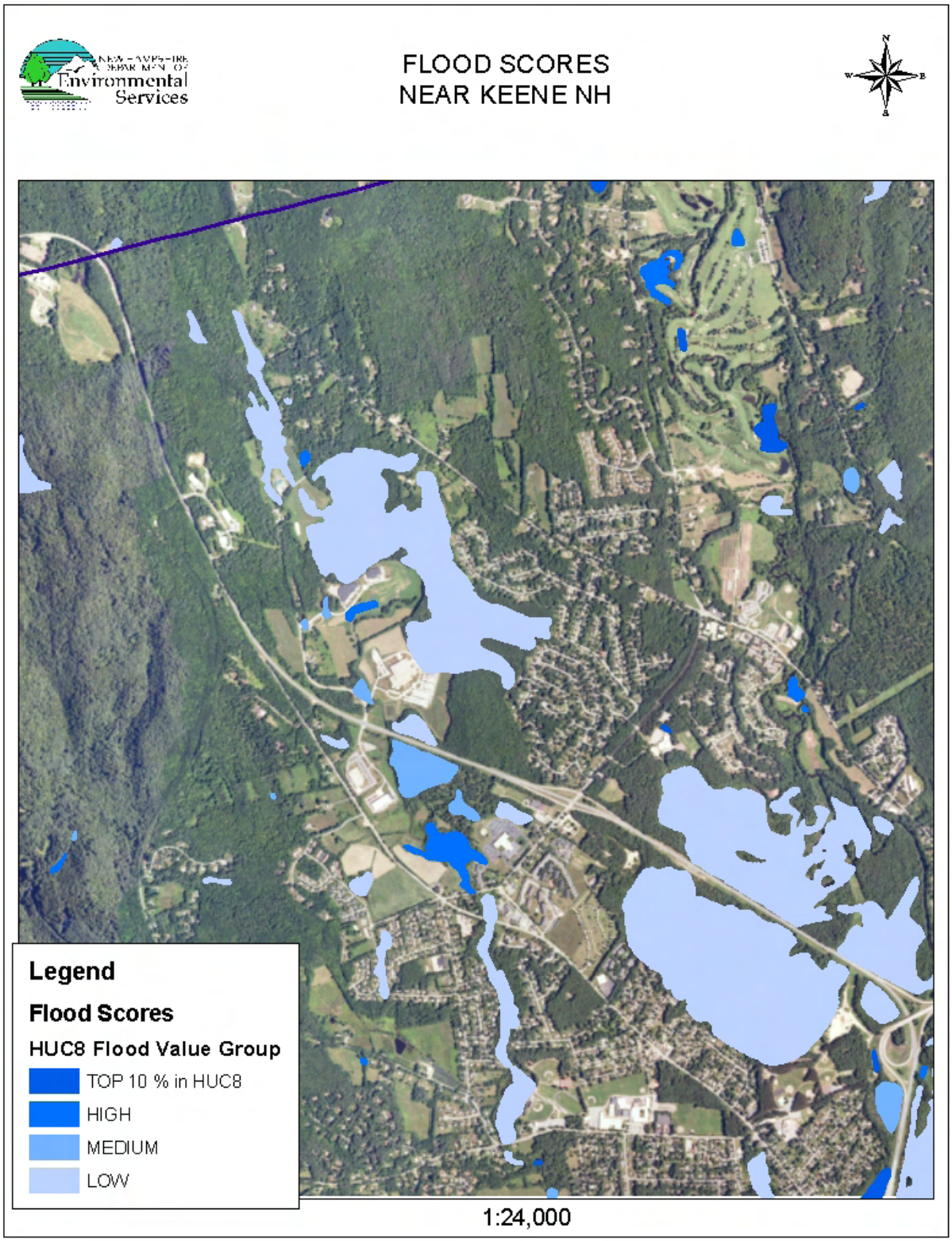


Figure 2. Flood storage scores for wetlands in Keene, NH.



Potential Sources of Analysis Error

One source of analysis error identified was the locations and boundaries of wetlands in the National Wetland Inventory data from which the WAUs were derived. Development of the dataset was initiated in the 1970's and then completed in 1985 and 1986, so the dataset does not necessarily reflect the present-day landscape.

Alignment of the wetland spatially within the DEM and/or inaccuracies within the DEM itself also represents potential sources of error. The actual topography of a WAU may not be accurately represented by the 10-meter resolution DEM (e.g., a leveled area or hummocky relief within the elevation surface) or a leveled area may not be spatially located directly within the boundaries of the wetland.

Realities Not Considered/Included

Because hydraulic simulation is beyond the scope of the method, additional storage related to backwater effects was not considered. These effects would be most pronounced in wetlands fringing impoundments and in larger riverine systems generally. The analysis could be enhanced by considering this effect and implementing it within the GIS.

Also, the analysis does not evaluate the ability to WAUs to desynchronize flood flows across the landscape. Wetlands provide an important function in that they can cumulatively increase runoff transit times and attenuate the hydrograph peak generated by a storm event. The more peak storm flows can be effectively desynchronized, the less flooding and potentially resulting damage to infrastructure will occur in downstream locations.

Lastly, estuarine and permanently submerged wetlands should be excluded from population of WAUs subject to future analyses. The hydrologic processes involved in the analysis of wetlands in these hydrogeomorphic settings are complicated due to the effects of tide (bidirectional flows) and variation in tidal height. Also, there really is no need to analyze a permanently flooded wetland within a larger water body as it provides little in the way of storage capacity or desynchronization of peak flood flows.

Future Directions

Two lines of inquiry have been identified that should be explored to better predict the capacity of wetlands to desynchronize and store flood flows. The first involves creating a more refined index that uses estimated peak flow discharge, such as the 50-percent exceedance flood, in combination with wetland storage volume, as calculated in the current method, to quantify residence time within each wetland. The GIS could then be used to accumulate estimated residence time along each flow path. The two expressions of residence time, representing the local and watershed-wide context, respectively, would provide a more robust characterization of wetland flood attenuation function than either metric alone. The final ranking could integrate both effects, but also allow the component residence time factors to be queried separately. An alternative approach would be to use the wetland storage values in a rainfall-runoff model, similar to TR-20 and TR-55, designed to predict flows at the watershed scale.

WATER QUALITY MODULE

Introduction

For the 2008 305(b) report, the DES Watershed Management Bureau created wetland complexes from the National Wetlands Inventory (NWI) to act as assessment units (AUs). The method for complex creation into AUs was based on criteria established by the New Hampshire Fish and Game Department's Wildlife Action Plan (2005), wherein wetlands within 250 m of one another and separated by a roadway were treated as one large wetland complex.

In the summer/fall of 2008, the DES Watershed Management Bureau and Wetlands Bureau completed a Level 1 Landscape Assessment of the state's wetland resources. The Level 1 assessment was conducted on the 2008 AUs using a GIS model to make preliminary determinations as to which wetlands were likely adequate to support aquatic life and to identify those that were potentially not supporting. (Full details in the attached Sept 16, 2008 memo)

In 2010, the DES Watershed Management Bureau and Wetlands Bureau worked with UNH Cooperative Extension to construct wetland complexes from the individual NWI wetland polygons in accordance with the 2010 NH Method. These new complexes were given Assessment Unit IDs (AUIDs) to replace those of 2008. The new base layer was built as the foundation of a comprehensive wetlands catalog for the state and as a starting point for anyone utilizing the NH Method. While the NH Method applies only to freshwater wetlands, the complex creation methodology was applied to both fresh and marine wetlands independent of one another.

Due to the differences in the methods of complex formation, the direct transfer of the 2008 level 1 assessment scores to the 2010 AUIDs was not valid.

Difference in Complex Methodology

The underlying complex methodology was different between 2008 and 2010 (table 1). This difference resulted in a substantially different number of complexes between the two AUID sets and the later transfer of scores.

Table 1. Comparison of 2008 and 2010 AUID complex methodologies.

Spatial Feature	2008	2010
Distance	Wetland polygons within 250m of one another became one AU unless split as defined below.	Spatially separate wetland polygons coded as independent AUs
Watersheds	Wetland polygons overlapping HUC12 boundaries were split at the HUC12 boundary	No impact.
Rivers	No impact.	Use NHHD and stream order dataset from GRANIT to split contiguous polygons based upon >4th order streams. By this process, a NWI polygon that spans both >4th and ≤4th order stream segments will not be split since the >4th order portion does not bisect the whole polygon.
Roads	Wetland polygons bisected by a road were split at the road.	Wetland is cut by a four-lane (or greater) highway into separate AUIDs.
Lake margins	No impact.	1 - Generate shoreline nodes at preprocessing step 1 to limnetic & riverine polygons intersections. 2 - From those nodes generate lines perpendicular to the shoreline. 3 – Use new perpendicular lines to split the lacustrine-limnetic & riverine polygons. 4 – Use the preprocessing step 2 code to select lacustrine-limnetic & riverine polygons to keep.

Method for Level I Assessment Scores

The overall method used for 2010 mirrors the 2008 approach:

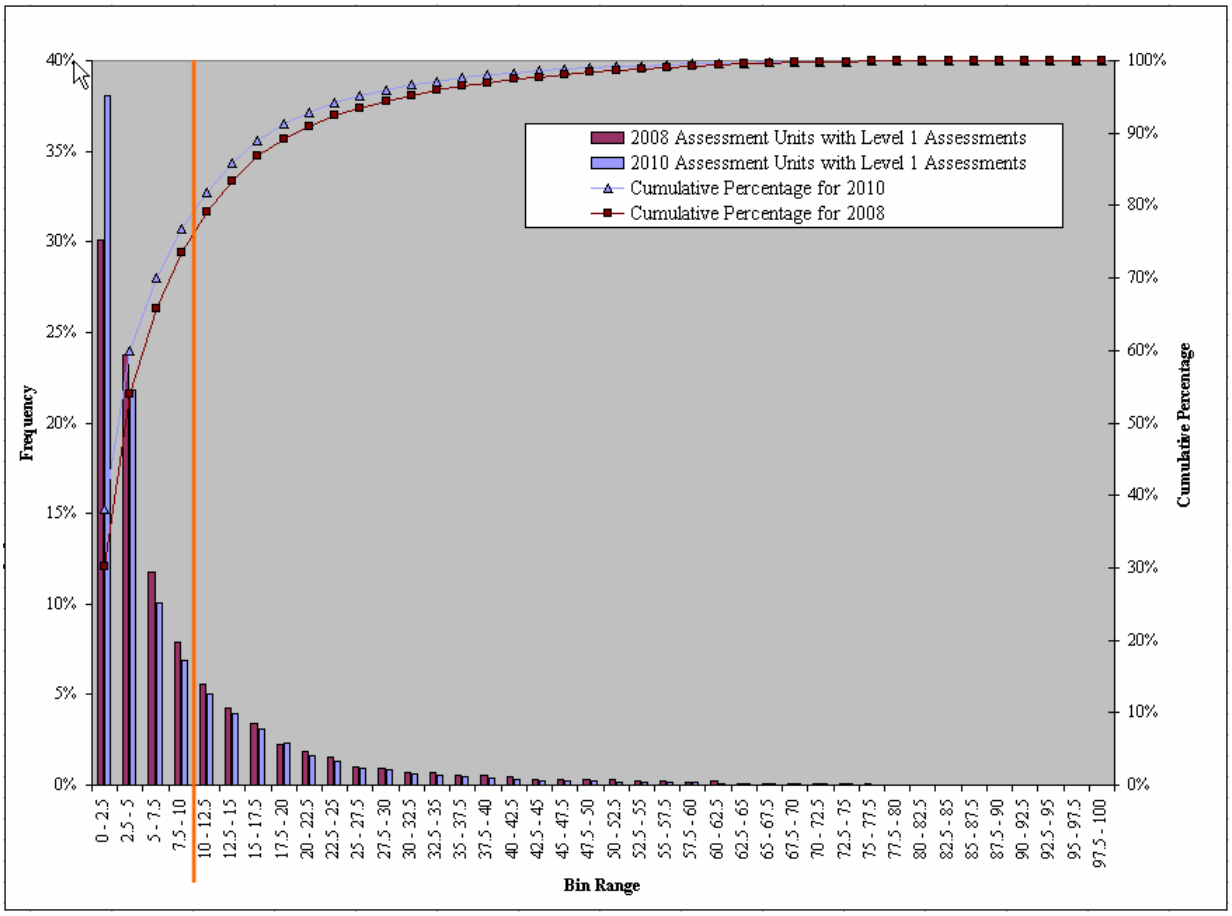
- Wetland buffer land cover condition can be used as a predictor of the ecological heath of a given wetland. Ecological integrity of wetlands will degrade as impervious surface cover increases thereby degrading supporting habitat and increasing pollutant loadings. Buffer rings were built using the 'buffered.ave' & 'buffdnut.ave' (Eugene W. Martin University of Washington - Department of Geography)
- The 2006 National Land Cover Data (NLCD) was used to identify landscape types within each wetland buffer area. The 2006 NLCD is based on Landsat Thematic Mapper Imagery (30 m resolution) collected from June 1999 through October 2003.
- The Center for Watershed Protection's Stormwater Managers Resource Center (SMRC) has developed The Simple Method for estimating stormwater runoff, pollutant loading based upon land cover types.
- The coefficient set used for the 2008 Level 1 assessment was used on the 2010 AUID complexes. (Full details attached in the Sept 16, 2008 memo)

Here the methodology diverges. In 2008, each buffer was independently evaluated and a *.dbf file created with the percent and area of land in each cover class. For 2010 we used the Geospatial Modeling Environment (GEM) (http://www.spatialecology.com/gme/) functions to efficiently evaluate the amount of each land cover class within a given wetland buffer. The coefficient set developed in 2008 were then fed to the percent of each land cover class to compute the Level 1 Assessment score for the 2010 AUID buffers.

Results

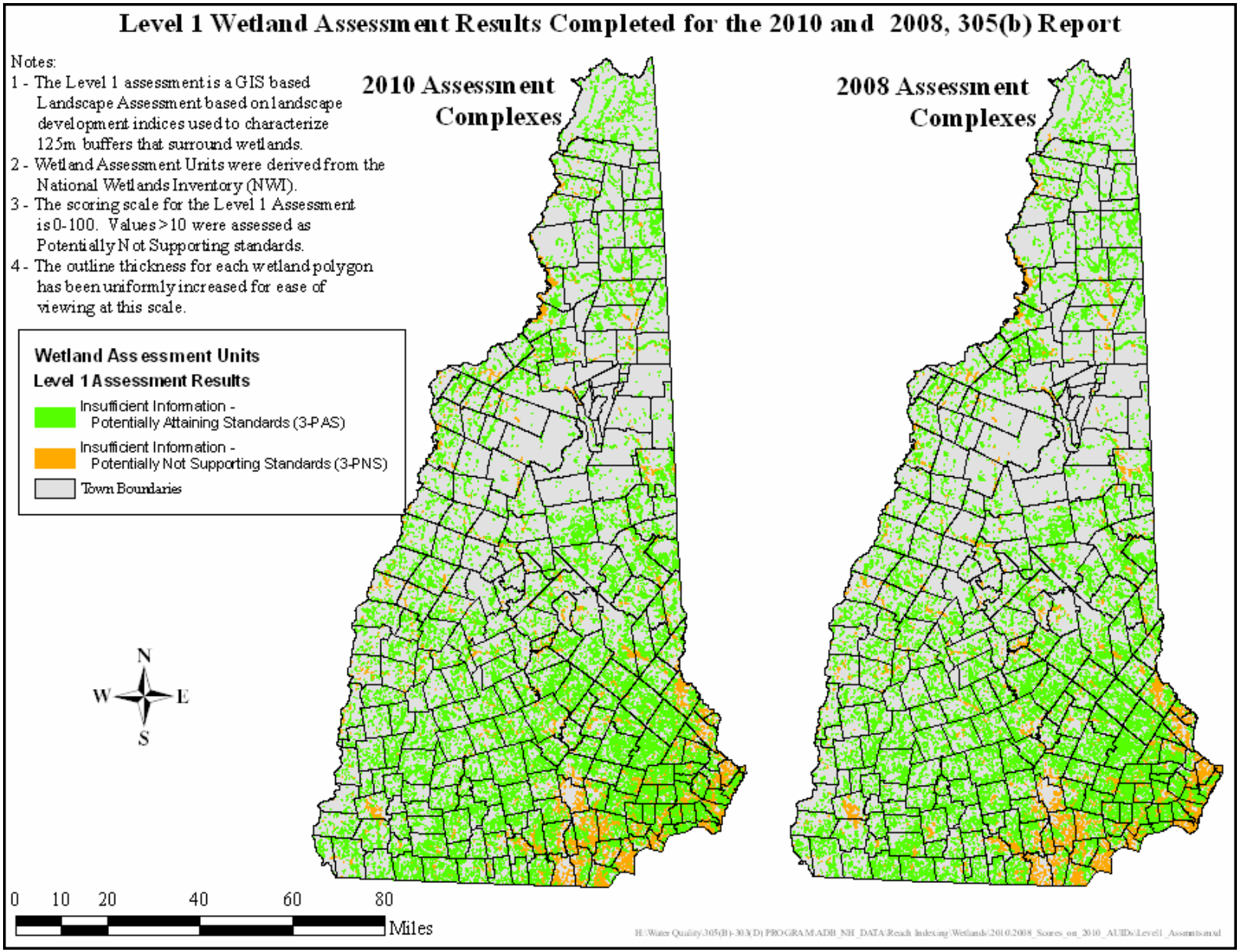
While the assessed condition distribution is comparable to the 2008 Level 1 Assessment the two populations differ (figure 1). In 2008, a total of 18,909 (80.0%) wetland assessment units were assessed as potentially supporting and 4,717 (20.0%) as potentially not supporting aquatic life. In 2010, a total of 42,837 (81.9%) wetland assessment units were assessed as potentially supporting and 9,476 (18.1%) as potentially not supporting aquatic life. This is particularly evident in the frequency of high quality wetlands (0-2.5). This is a logical outcome as a group of disconnected wetlands in an undeveloped area would have been one large AUID in 2008, whereas those same separate wetlands in 2010 would each get a unique AUID.

Figure 3. Frequency distribution of 2008 and 2010 AUID complex Level 1 Assessment Scores.



The spatial distribution of scores for the wetland assessment units potentially attaining and potentially not attaining standards remained consistent between 2008 and 2010 (figure 4).

Figure 4. Distribution of the 2010 and 2008 Level 1 Wetland Assessment Scores



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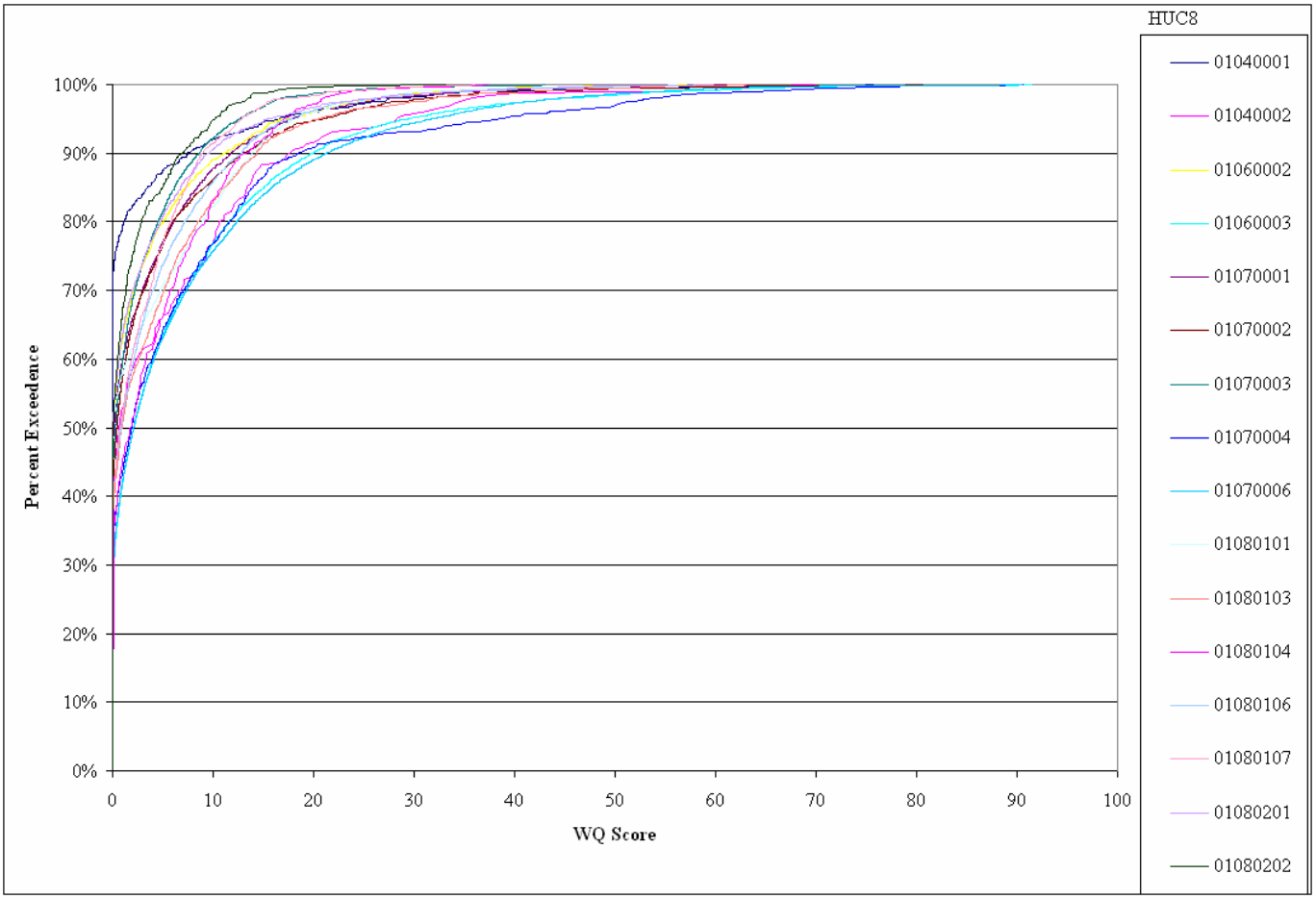
Additionally, there was a need to rank the water quality scores within a HUC 8 so that wetlands permit reviewers could understand how good or bad the water quality score for a wetland is compared to other wetlands within the HUC 8. The initial proposal was to have a HUC 8 percentile rank of the WQ scores for each HUC 8 with the following general bins.

Bin	Bin Description
0-10%	Best in HUC 8
10-25%	Good in HUC 8
25-50%	Poor in HUC 8
50-100%	Worst in HUC 8

However the distribution of water quality scores was such that the 0-10 bin would be filled with only those wetlands with a water quality score of zero which is to say only those wetlands with 100% natural buffers (figure 3, table 2). No HUC 8 would have a single AUID in the 10-25 bin, 12 of the 16 HUC 8s would have values in the 25-50 bin, and four HUC 8s would skip directly from the 0-10 to the 50-100 bin. In those last four HUC 8s the 50-100 bin would start with sites that have a WQ score of 0.5 or less with the 50-100 bin starting at water quality score of 0.008 in the Upper Androscoggin. Although technically correct this method of ranking the water quality scores would be of little use to the permit reviewer.

Figure 5. Percent exceedance of water quality scores by HUC 8.



To give the reviewer an idea of how a particular wetland complex scored from the level 1 water quality assessment as compared to the rest of the wetlands in a given HUC 8 we normalized by the worst AUID water quality score for the HUC 8 as:

HUC 8 Percent of Maximum = [AUID WQ Score]/ [HUC 8 Max WQ score]

While not perfect, this approach gives us a better continuous distribution and a 0-100% value that is relative within a HUC 8.

Table 2. HUC 8 level attributes of AUIDs and water quality scores from the level 1 assessment.

HUC 8	HCU 8 Name	Number of AUIDs	Percent of AUIDs with WQ Scores of Zero	Average WQ Score	Maximum WQ Score
01040001	Upper Androscoggin River	1116	72%	2.5	75.7
01040002	Lower Androscoggin River	266	39%	6.0	69.9
01060002	Saco River	2330	50%	3.3	57.2
01060003	Salmon Falls-Piscataqua Rivers	10420	29%	6.9	91.5
01070001	Pemigewasset River	2383	49%	3.7	62.3
01070002	Winnipesaukee River	2635	43%	4.1	80.7
01070003	Contoocook River	4316	45%	2.6	43.1
01070004	Nashua River	1038	34%	7.3	90.7
01070006	Merrimack River	15787	31%	7.1	90.6
01080101	Upper Connecticut River	2262	51%	4.3	56.3
01080103	Connecticut-Johns River to Waits River	2061	38%	4.8	63.1
01080104	Connecticut River-Waits River to White River	535	36%	4.5	37.4
01080106	Connecticut-White River to Bellows Falls	3024	40%	4.1	58.5
01080107	Connecticut-Bellows Falls To Vernon Dam	1059	40%	3.1	36.1
01080201	Connecticut-Ashuelot River-Vernon Dam to Millers River	2362	52%	3.1	59.9
01080202	Connecticut River-Millers River	719	50%	1.9	33.3

Examples of the water quality scores for wetlands under this model are shown for Walpole and Keene. For the Keene area, the lower value wetland for water quality is lighter in color. These lower value wetlands have less supporting buffers.

Figure 6. Water quality score for wetlands in Walpole, NH

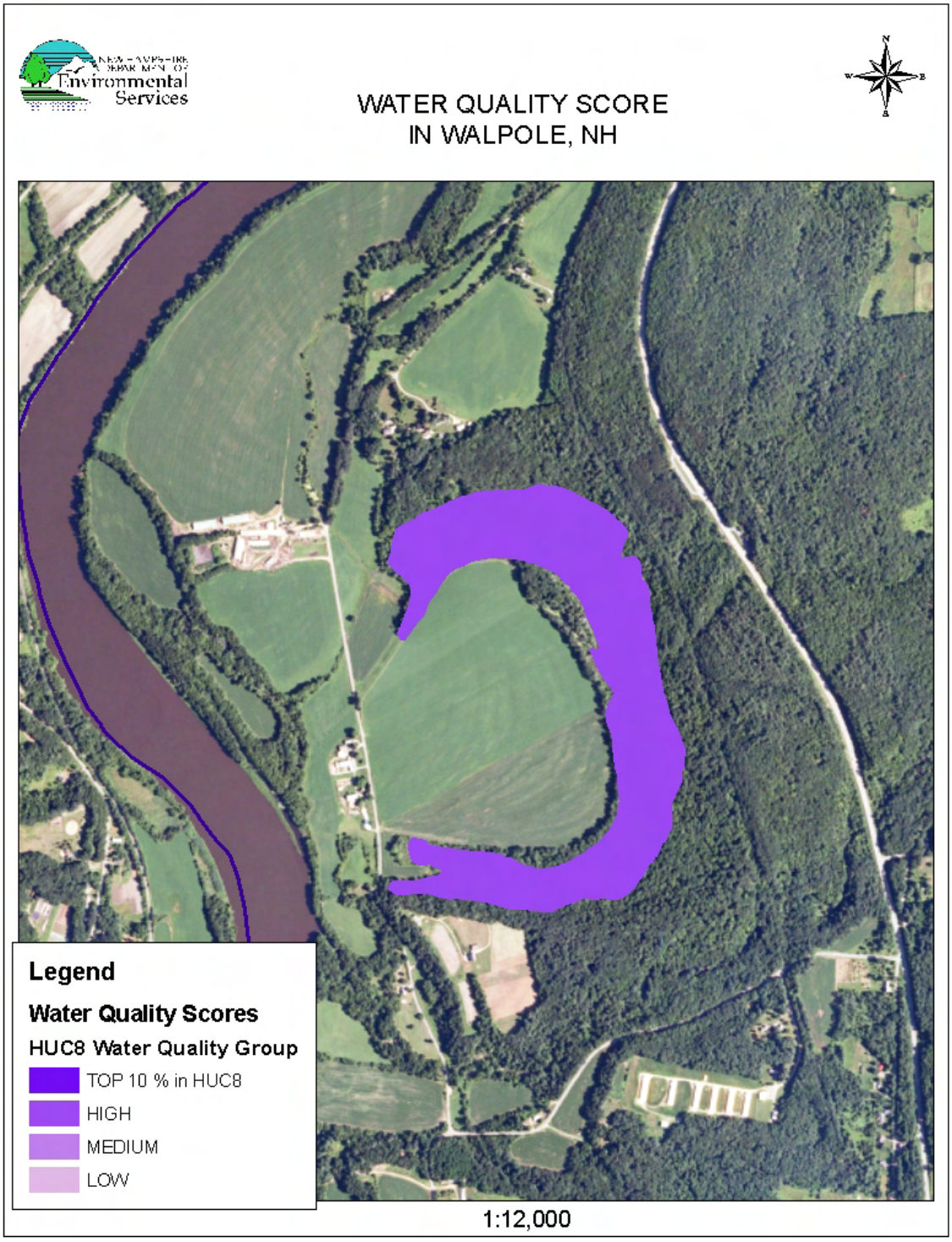
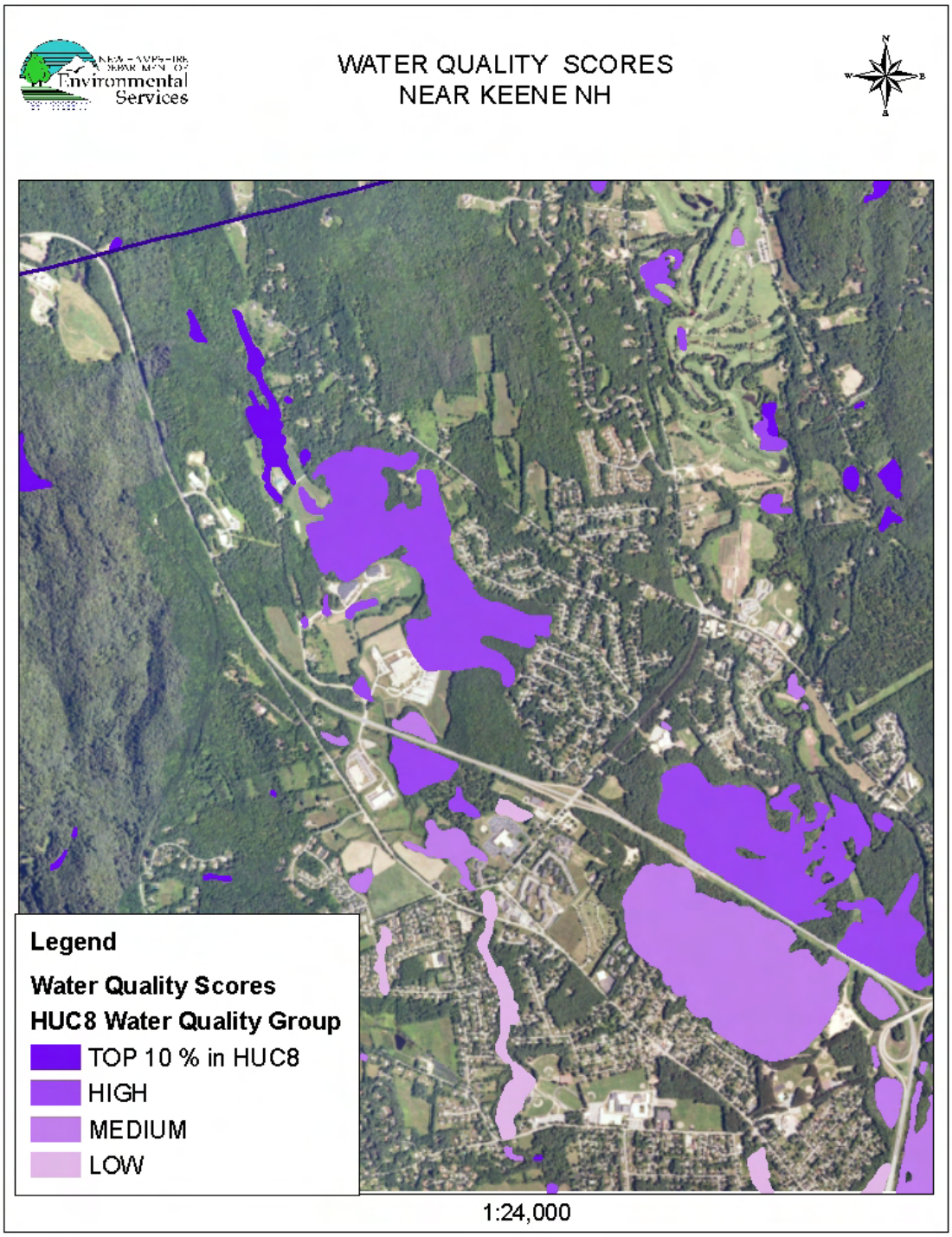


Figure 7. Water quality scores for wetlands in the Keene area. The lower value wetlands, shown in a lighter color, have less supporting buffers.



Background information on how the wetland assessment units were created is described in the following section. This information originated from a September 16, 2008 Watershed Management Bureau memo from Ted Walsh, water quality specialist to Ken Edwardson, Water Quality Assessment Program, Gregg Comstock, Water Quality Planning Section and Paul Currier., Administrator, Watershed Management Bureau.

Methodology and Results of Level 1 Landscape Level Wetlands Assessment

The DES Watershed Management Bureau and Wetlands Bureau completed a Level 1 Landscape Assessment of the state's wetland resources. This effort was conducted to achieve goals outlined in the New Hampshire Water Monitoring Strategy (2005) and the EPA's Elements of a State Water Monitoring and Assessment Program for Wetlands (2006). The goal of this Level 1 Assessment was to conduct a landscape level assessment of the state's wetlands using a GIS model and to make preliminary determinations as to what wetlands were likely adequate to support or potentially not support aquatic life.

Project Goals and Objectives

- Create wetland assessment units
- Create a buffer area around each wetland assessment unit that can be analyzed to determine what landscape types comprise the buffers.
- Create an index to assess the ecological integrity of the buffer areas based on the relative impact of each of the landscape types identified in the buffers.
- Based on the index developed identify a threshold between potentially support and potentially not supporting for aquatic life use support.
- Evaluate the condition of the wetland buffer, apply the index of ecological integrity, and determine potential aquatic life use support status.
- Summarize the results of the analysis and include the results in the 2008 305(b) report.

Methods

1. Create Wetland Assessment units

National Wetlands Inventory (NWI) polygons were used as the base for identifying individual wetlands and aggregating them into assessment units. NWI polygons were aggregated due to the large number of individual units (N = 83,565). NWI polygons identified via Cowardin classification as lacustrine/limnetic, palustrine/open water, marine/subtidal, estuarine/subtidal, and riverine were removed from the population as they are already identified as open water lake, riverine, or estuarine assessment units. The remaining NWI polygons were amalgamated into assessment units based on methods used by the New Hampshire Fish and Game Department's Wildlife Action Plan (2005). A 125 m buffer was created around all NWI polygons. Overlapping buffers were then merged into a single buffer complex. These distances are intended to reflect the distance at which biological communities are likely overlapping and traveling between individual NWI polygons. The buffer complexes and base NWI polygons were then split if bisected by a road or a HUC 12 divide. The split due to roadways ties back to the ability of biological communities to move from wetland to wetland. The HUC12 split was largely an administrative action to allow categorization of the final product to be produced. After the splits, each complex was assigned a unique Assessment Unit ID (AUID) based upon the

HUC 12's within which they resided. Finally the AUIDs were transferred from the buffer complexes to all of the NWI polygons within the complexes. The Cowardin classification information attached to each NWI polygon was retained thus allowing for the identification of each Cowardin type within each assessment unit.

2. Create AUID Buffers for Landscape Level Assessment

A 125 m buffer was created around each wetland assessment unit. This second set of buffers did not include the area for its own wetland AUID but could include the area of a separate wetland AUID. That is, it you had two wetland AUIDs bisected by a roadway but otherwise right next to one another each wetland would be included in the landscape assessment for its neighbor but not for itself. It is these buffers that were evaluated based on land cover types and their corresponding impact on the ecologic communities that reside within the wetland proper. New Hampshire's Consolidated Assessment and Listing Methodology (CALM) (DES 2008) identifies designated uses for New Hampshire's surface waters. This landscape level assessment is based upon the aquatic life designated use and is intended to identify those wetlands that are likely or unlikely to provide suitable conditions for supporting a balanced, integrated and adaptive community of aquatic flora and fauna. The assessment is based on the idea that the condition of a wetlands buffer will be a major driver of the condition of the wetland. Further, we can systematically estimate the condition of the buffer by knowledge of the land cover types within that buffer. Due to the inherent roughness of a landscape level analysis and that no in-wetland measurements were conducted no definitive support categories were made. Based upon the results of the analysis the use support category "potentially supporting" or "potentially not supporting" will be assigned to each assessment unit.

3. Evaluation of Buffer Land Cover Types

The 2006 National Land Cover Data (NLCD) was used to identify landscape types within each wetland buffer area. The 2006 NLCD is based on Landsat Thematic Mapper Imagery (30m resolution) collected from June 1999 through October 2003. The New Hampshire NLCD was imported into ArcView (9.2) and then used to determine what percent of the buffer is comprised of each of the NLCD land cover types. Once the analysis was complete on all 23,626 wetland assessment unit buffers the resulting summary was converted to an Excel format for further analysis.

The Center for Watershed Protection's Stormwater Managers Resource Center (SMRC) has developed The Simple Method for estimating stormwater runoff, pollutant loading, and the resulting impacts to the ecological integrity of 1st through 3rd order streams. Although this model was not designed specifically for wetlands it is reasonable to concur that the ecological integrity of wetlands will also degrade as impervious surface cover degrades supporting habitat and pollutant loadings increase. The SMRC Simple Method was used to estimate the impact of each landscape type and its corresponding impact on the ecologic health of the parent wetland. The Simple Method provides event mean concentration values for numerous pollutants and various land cover types. (Table 3)

Table 3. Event Mean Concentration Value by Land Cover Type (Center for Watershed Protection)

Pollutant	Forest/Rural Open	Water Wetland	Agriculture and Pasture	Commercial	Highway	Industrial	Medium Density Residential	Urban Open
BOD	3.0	3.5	5.5	14	17	15.3	27	7
COD	36.5	11.5	53.0	60.6	103	85	98	43
TSS	77.5	11.5	142.5	67.3	141.5	110.3	85	82.5
TDS	415.0	12.0	415	174	294	202	144	415
TP	0.12	0.055	0.705	0.23	0.39	0.24	0.43	0.205
DP	0.035	0.025	0.09	0.11	0.22	0.43	0.2	0.07
TKN	0.825	0.695	1.64	1.31	1.8	2.08	2.57	1.25
NO2/NO3	0.67	0.595	4.06	0.81	0.83	1.5	1.27	0.775
Pb	0.27	0.009	-	0.068	0.17	0.28	0.84	0.05
Cu	-	0.006	-	0.049	0.04	0.076	0.033	0.027
Zn	0.142	0.05	-	0.18	0.21	0.502	0.158	0.083
Cd	-	0.001	-	0.003	0.003	0.005	0.004	0.001
Fecal Coliform	300	300	3250	4736	600	1022	11954	3250
E. coli	-	-	-	-	-	-	38607	-

The landscape types used in the NLCD and the Simple Method did not correlate exactly so land use types were matched as closely as possible between the two datasets. In some cases land cover types were combined and in all cases land cover types were weighted by estimates of impervious surface cover (Table 4). The overall NLCD land cover type "developed" was correlated to the average of the SMRC land cover types that comprise developed lands; commercial, highway, industrial and medium density residential. A percent impervious surface value was then assigned to each NLCD land cover type based on information provided with the NLCD dataset that assigns a range of impervious surface cover for each land cover type. For purposes of calculating pollutant loads the highest value in each impervious surface cover range was used. Incorporating impervious surface coverage into the pollutant loading calculation will compensate for using the same average of SMRC land cover types for the low, medium, and high NLCD land cover classes.

Table 4. Translation of SMRC Land cover Types to NLCD Land Cover Types

NLCD Land cover Type	SMRC Land cover Types and EMC's Assigned	Assigned % Impervious Surface
High Intensity Developed	AVERAGE (Commercial, Highway, Industrial, Med. Density)	100
Medium Intensity Developed	AVERAGE (Commercial, Highway, Industrial, Med. Density)	79
Low Intensity Developed	AVERAGE (Commercial, Highway, Industrial, Med. Density)	49
Open Space Developed	Urban Open	20
Cultivated	Agriculture and Pasture	15
Pasture/Hay	Agriculture and Pasture	15
Grassland	Agriculture and Pasture	15
Deciduous Forest	Forest/Rural Open	0
Evergreen Forest	Forest/Rural Open	0
Mixed Forest	Forest/Rural Open	0
Scrub/Shrub	Forest/Rural Open	0
Palustrine Forested Wetland	Water/Wetland	0
Palustrine Scrub/Shrub Wetland	Water/Wetland	0
Palustrine Emergent Wetland	Water/Wetland	0
Estuarine Emergent Wetland	Water/Wetland	0
Unconsolidated Shore	Water/Wetland	0
Bare Land	Water/Wetland	0
Water	Water/Wetland	0
Palustrine Aquatic Bed	Water/Wetland	0
Estuarine Aquatic Bed	Water/Wetland	0

For each NLCD land cover type an annual pollutant load was calculated (Formula 1).

Formula 1. Calculation of annual pollutant load using event mean concentrations and % impervious surface

$$L = 0.226 * R * C * A$$

Where:

L = Annual load in lbs (Table 1 values converted from mg/L to lbs)
R = Annual runoff
C = Pollutant Concentration
A = area (acres)
0.226 = unit conversion factor

A more detailed explanation of the Simple Method can be found at http://www.stormwatercenter.net/

Assuming the land use with the highest pollutant loading would correlate to the most degraded surrounding habitat and cause the most impairment an initial scoring system was developed using the landscape type with the highest loading (Developed High Intensity = 100). A load ratio was then calculated by dividing the pollutant load for each NLCD land cover class by the pollutant load for Developed High Intensity and then multiplying by 100. This allows for all pollutant loads to be in relation to the land use with the highest pollutant load ratio and to be on a scale of 0 – 100.

An additional calculation was done to correct the load ratios for "natural" loadings which were assumed to be the pollutant loads associated with forested NLCD landscape types. This adjusts the pollutant load ratio for forested landscape types to zero and subtracts natural loadings for the remaining NLCD landscape types. The resulting adjusted load ratio was then assigned as the "score" for each landscape type (Table 5).

Table 5. Level 1 Assessment Scores

NLCD Land cover Type	Assessment Score	Impervious Cover Fraction	% Buffer Occupied by Land cover Type @ PNS Threshold
High Intensity Developed	100	1	10
Medium Intensity Developed	79.6	0.79	13
Low Intensity Developed	50.5	0.49	20
Open Space Developed	12.0	0.2	84
Cultivated	15.6	0.15	63
Pasture/Hay	15.6	0.15	63
Grassland	15.6	0.15	63
Deciduous Forest	0	0	-
Evergreen Forest	0	0	-
Mixed Forest	0	0	-
Scrub/Shrub	0	0	-
Palustrine Forested Wetland	0	0	-
Palustrine Scrub/Shrub Wetland	0	0	-
Palustrine Emergent Wetland	0	0	-
Estuarine Emergent Wetland	0	0	-
Unconsolidated Shore	0	0	-
Bare Land	0	0	-
Water	0	0	-
Palustrine Aquatic Bed	0	0	-
Estuarine Aquatic Bed	0	0	-

The following formula was used to calculate the overall Level 1 Assessment Score for each wetland AUID buffer area:

Level 1 Assessment Score = Σ %LCi * LCSi
where:

%LC = percent of the total area in a given land cover class

LCS = Assessment score for given land cover class

In order to identify wetland assessment units as potentially supporting or potentially not supporting for the aquatic life designed use a threshold was needed for the Level 1 assessment scores. Both the Center for Watershed Protection and DES have determined that once a watershed area exceeds 10% impervious surface cover, exceedances of water quality criteria are likely. Thus, if a wetland buffer is comprised of 10% or greater of the "high density developed" NLCD land cover class, that wetland assessment unit is very likely to have violation of water quality standards. Based upon the 10% threshold, any wetland assessment unit with a Level 1 score exceeding 10 will be listed as potentially not supporting. Table 3 indicates the percent of a given buffer that would need to be occupied by each NLCD land cover class to exceed the potentially not supporting threshold of 10.

Level 1 Assessment Score <10	**AUID listed as Potentially Supporting**
Level 1 Assessment Score >10	**AUID listed as Potentially Not Supporting**

Results and Discussion

Figure 8 shows the distribution of the resulting scores from the Level 1 assessment. A total of 18,909 (80.0%) wetland assessment units were assessed as potentially supporting and 4,717 (20.0%) as potentially not supporting. Figure 9 shows a distribution of how the potentially supporting and potentially not supporting wetland assessment units are geographically distributed. Results of the Level 1 assessment including both the Level 1 Assessment Score and the relationship to the potential support threshold, will be imported into the DES Supplemental Assessment Database and consequently included in the 2008 305(b) report to EPA.

Figure 8. Distribution of Level 1 Wetland Assessment Score

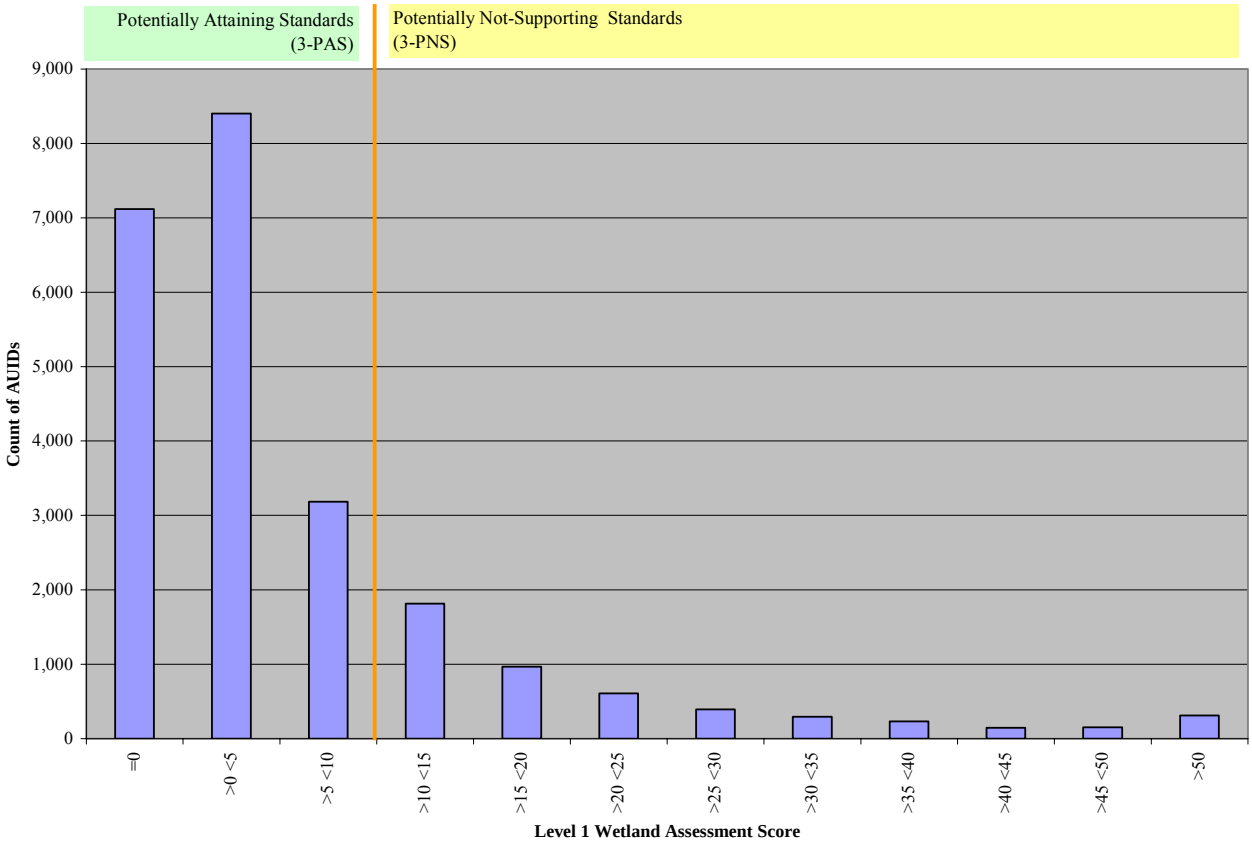
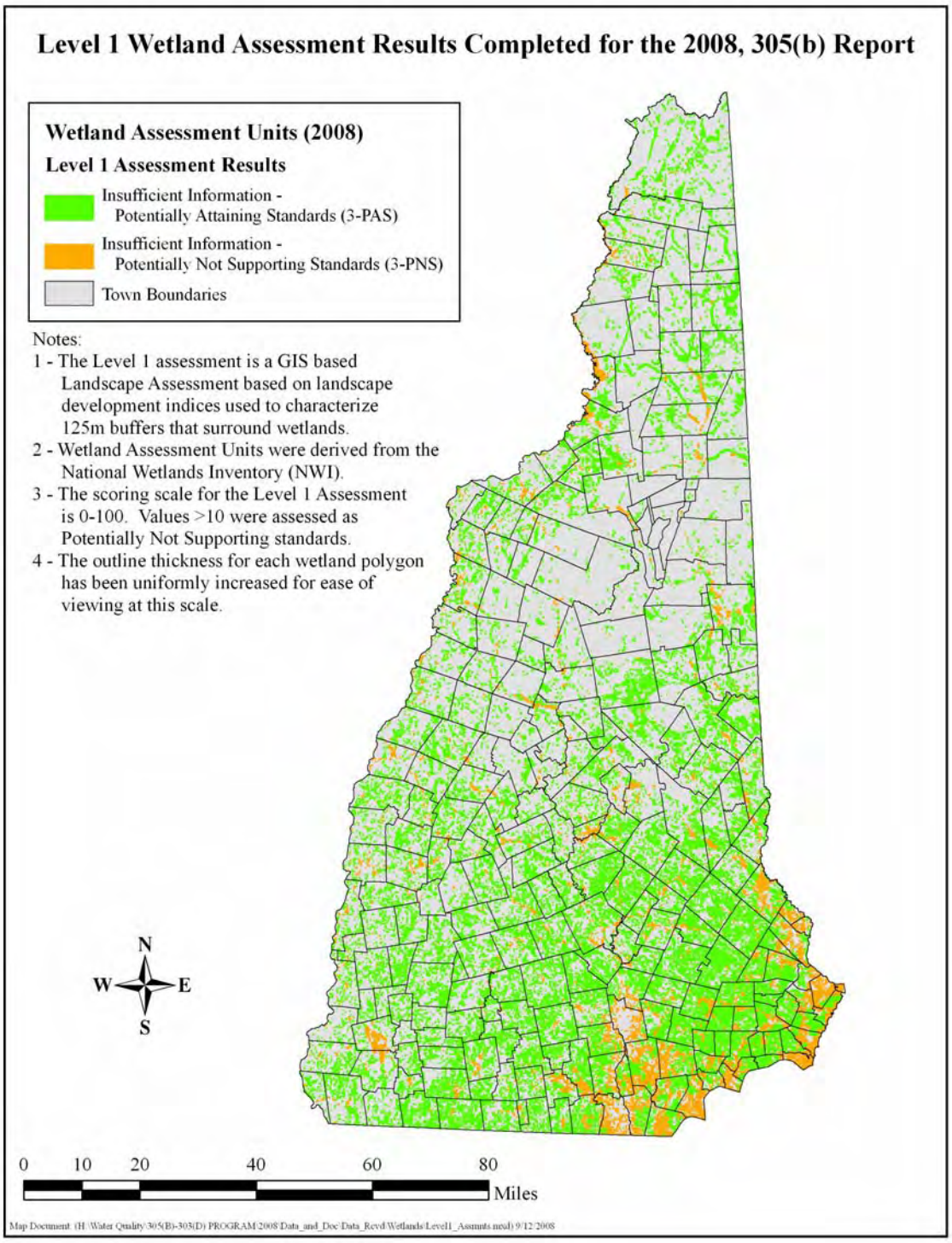


Figure 9. Distribution of Level 1 Wetland Assessment Score 305(b)



C. WILDLIFE MODULE- NH WILDLIFE ACTION PLAN- WETLANDS CONDITION

DETERMINING ECOLOGICAL CONDITION

Habitat condition was analyzed to develop statewide and regional rankings that identify the highest condition habitat relative to all polygons of a given habitat type in the state. The goal is to provide regional planners and conservation professionals with a tool to help identify the most ecologically intact wildlife habitat areas.

Using the 16 habitat types mapped in the NH Wildlife Habitat Land Cover dataset, plus streams and rivers and lakes and ponds, NHFG biologists developed condition filters to analyze which habitat patches are in the best relative ecological condition in the state. These filters are composed of GIS data that indicate to what degree a particular patch of habitat has good biological diversity (particularly in terms of rare species), is connected to other similar patches in the landscape, and is negatively impacted by humans. There is a different filter for each habitat, but each filter includes biological, landscape, and human impact factors. These three types of data are combined into BIO, LAND and HUMAN scores and are shown in the attribute fields.

Each habitat type has different factors that may affect its condition, but there are some commonalities in each of the groupings. Biological factors included data such as rare species richness for animals, plants and exemplary natural communities, as well as vertebrate species richness and other biological factors. Landscape factors include area of habitat patch, proximity to the nearest similar habitat patch, diversity of ecological land units (TNC data on ecological potential which is similar to potential natural community diversity) within the patch, and other factors depending on the habitat type. Human impacts include data such as road density, wetlands permits, population density, pollution indices, dams and other similar factors.

A set of available statewide data was collected for each of these three groups, with each individual score being on a 1-100 scale. Within each group, the scores for each data set were evenly weighted (expect for the aquatic features). This condition score (COND) is a relative score, based on all polygons of a given habitat type that occur in NH. Habitat patches were assessed as full polygons except the five matrix forest types, which were assessed in raster format (see below).

Surface waters were assessed a little differently than terrestrial habitats. Streams and rivers were assessed in watershed units developed by the US Geological Survey, using the HUC 12 level. The condition filter developed had some factors unevenly weighted, but otherwise the process was the same as the other habitats. See the metadata for details.

In 2010, a significant improvement in the accuracy of scoring the relative condition of forest habitats was accomplished by evaluating all forests as a seamless matrix instead of by individual polygons. In the NH WAP, a matrix forest is a large contiguous area having the geo-physical conditions favorable to a particular suite of forest land cover classes. The matrix forest polygons in the WAP data represent a heterogeneous mix of landscape features. They are embedded with other small habitats (early succession/disturbance patches, forested wetland, cliffs, etc…). In consideration of the matrix forest as the most extensive and interconnected habitat type, in 2010 its relative condition assessment was determined by evaluating the entire matrix as a seamless

raster. This assigns a condition score to each 30 meter pixel (0.22 acre) in the forest habitat data. Using the same thresholds as the 2005 analysis, but a new set of condition attributes, pixels scoring Highest Ranked Habitat by Ecological Condition are selected for each of the forest matrix types. Pixels must be clustered into a patch of at least 100 acres to rank as highest in the state or biological region. In this method, only the portion of a forest patch meeting the condition threshold is assigned the highest rank rather than the entire polygon. Small clusters of highest-ranked pixels (less than 100 acres) were assigned Tier 3 Supporting landscapes. Clusters of lower-ranked pixels less than 100 acres but completely surrounded by highest-ranked pixels were elevated to the surrounding Tier.

RANKING HABITATS

Within each habitat type, the patches were ranked into one of four categories based on percentage of that habitat by area. The four priority rankings are; **Highest Ranked in the State by Ecological Condition**, **Highest Ranked in the Biological Region by Ecological Condition, and Supporting Landscapes.** The percentages are listed in the table on page 8. The top ranked habitats were assigned **Highest Ranked in the State by Ecological Condition**. Coastal and alpine habitats are so rare that all patches are included in this ranking.

Since NH is so ecologically diverse, the habitats were then ranked within their ecoregional subsection. Ecoregional subsections reflect broad regional patterns of geomorphology, stratigraphy, geologic origin, topography, regional climate, and dominant associations of potential natural vegetation. The Nature Conservancy has identified 9 ecoregions in New Hampshire. These were used to rank habitats as **Highest Ranked in the Biological Region by Ecological Condition**. The Nature Conservancy also developed watershed groupings, Developed like the ecoregional subsections but with abiotic features that influence aquatic biology and were used for wetland habitats and watersheds.

The condition of a habitat patch will deteriorate if the surrounding landscape is degraded. A third ranking, **Supporting Landscapes**, consists of the upland part of the watershed for surface waters, some very intact forest blocks, some known locations of exemplary natural communities, and additional forest areas as scored through the condition analysis.

In order to capture occurrences of specialist species with imperiled populations, a select set of wildlife Element Occurrences (areas known to support populations of rare species) from the Natural Heritage Bureau database was used either to elevate underlying habitat polygons to the highest rank in NH or to buffer locations within an already high ranked matrix forest. The same was done for significant ecological features identified by NH Natural Heritage Bureau but, elevating them to Supporting Landscape level. Both additions are incorporated in the WAPTIERS data layer. A description of the species, plants and natural communities add-ins begins on page 9.

For more details on this work, see the metadata for each habitat layer and the WAPTIERS layer.

The following factors were quantified and combined to create a single score for each habitat polygon.

Floodplain Forest

Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Area of buffer in hectares
% of 1-km buffer around complex that is wetland
Mean IFES score (Integrated Fragmentation Effects Surface; The Nature Conservancy; Zankel, 2005) – effect of fragmentation on the landscape
Percent of floodplain forest drainage area that is impounded
Distance to nearest dam (meters)

Marsh and Shrub Wetland Complexes

Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Number of marsh polygons in the complex
Area of largest marsh in the complex (hectares)
Number of dominant NWI vegetation classes in the complex
Road density within 250 m of the complex
Distance to nearest road (meters)
Mean IFES score (defined above)

Peatland Complexes

Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Area of buffer in hectares
Percent of 250 m buffer of complex that is forest, water or wetland
Distance to nearest human impact
Mean IFES score (defined above)

Matrix Forests

Predicted matrix forest (%) consistent with validated current forest cover types (Miller et al., 2005).
Vertebrate species richness (VT/NH GAP Analysis), maximum in 1 km radius
Richness of rare animal occurrences in 1 km radius, buffered by species dispersal distances
Richness of rare plant occurrences in predicted matrix forest polygons
Richness of rare and exemplary natural communities in 1 km radius
Richness of ecological land units (substrate, landform) in 1 km radius

Density of matrix (by forest type) in a 5 km circle
Size of contiguous forest block within which forest habitat patch is located
NH Wildlife Connectivity Model, average landscape permeability for 16 terrestrial species
Road density in the (km road/km2)

Population density in 2000 (people per square mile)
Housing units density in 2000 (houses per square mile)
Average total deposition of mercury (wet + dry) by land cover type (Miller et al, 2005)
Average deposition index, rate of cation depletion per ha/per year (Miller et al, 2005)

RANKING LEVELS AND ADDED PRIORITY FEATURES

Tier 1 = Habitats of Highest Relative Rank by Ecological Condition in New Hampshire
Tier 2 = Habitats of Highest Relative Rank by Ecological Condition in Biological Region
Tier 3 = Supporting Landscapes

Note that these designations are mutually exclusive. Habitat already ranked as Tier 1 counts towards the percentages for Tier 2, but only those not already Tier 1 will be designated as Tier 2. This is also the same for Tier 3.

HABITAT	TIER	% USED FOR EACH RANK
Wet Meadow/Shrub Wetland	1	Top 10% in NH by area
	2	Top 50% in Watershed Group by area
Peatland	1	Top 10% in NH by area
	2	Top 50% in Watershed Group by area
Floodplain Forest	1	Top 10% in NH by area
	2	100% in Watershed Group

OCCURRENCES USED TO ELEVATE HABITAT RANK

Data for rare species and exemplary natural communities used in these analyses:

- For animals: restricted to endangered, threatened, special concern and S1-S2 species with precise location information (precision = "seconds") that were observed within the last 20 years
- For plants: restricted to populations with precise location information (precision = "seconds") that were observed within the last 20 years
- For natural communities: restricted to those observed within the last 40 years

For important background information on NH Natural Heritage Bureau data, see *Important Background Information for Interpreting Species Richness Counts based on NH Natural Heritage Bureau Data.*

Selected Rare Wildlife

Animal occurrence records were extracted from the NH Natural Heritage Bureau database and overlaid on the WAP habitat polygons. Only geographically precise data recorded within the last

20 years were used. For some species, known core populations, population models or reproductive data were used to refine locations to core populations. Except where noted, the presence of these species elevated the habitat patch to Tier 1: Highest Ranking by Ecological Condition in New Hampshire. Species whose populations were already well covered by the basic condition rankings were not included.

Criteria used to select species:

- Endangered or threatened in NH
- Limited populations known or likely to occur
- Isolated or restricted in NH
- Point specific sensitive information
- Provides critical habitat for state's population which his not already highly ranked

Selected Element Occurrences (EO) (1988 to 2009 and excluding "general" precision) and core populations included:

Birds:

Peregrine nest EOs (natural sites), Bald eagle nesting and wintering habitat (buffered), common nighthawk (non-urban EOs), pied-billed grebe, sedge wren, and American three-toed woodpecker elevated pertinent habitats.
Common loon productive nests (productivity 0.48 or greater) elevated Lakes and Ponds.
Northern harrier, upland sandpiper, grasshopper sparrow EOs elevated Grasslands habitat.
Piping plover, roseate tern, common tern, least tern occur on tier 1 dunes or coastal islands.
(There are no breeding records of golden eagle in NH.)

Mammals:

New England cottontail: used a refined model delineating core population areas.
Known bat hibernacula with portions of forest block, and small-footed bat EOs, buffered.
American marten occur on high-elevation spruce-fir (already ranked minimum tier 2).
(There are no breeding records of Canada lynx or Eastern wolf in NH).

Reptiles and Amphibians:

Supporting habitat of sensitive snake EOs.
Eastern hognose snake and black racer (with 1 km buffer).
Marbled salamander (with 0.3 km buffer)
Blanding's turtle core areas elevated to Tier 3, wetlands within core areas ranked tier 1.
Spotted turtle EOs elevated marsh and peatland complexes.

Invertebrates:

Karner blue butterfly, Persius duskywing skipper, pine pinion moth, frosted elfin were used to elevate PINE BARREN habitat.
Special concern pine barrens Lepidoptera elevated selected PINE BARRENS to tier 3
Ringed boghaunter (500 m buffer)
(All White Mountain fritillary and White Mountain arctic EOs are within tier 1 Alpine habitat.)

Aquatic Species:

Cobblestone tiger beetle, American brook lamprey and bridle shiner EOs were used to elevate AQUATIC habitat. Listed fish and mussels elevated stream and 100m buffer to 1 km up and downstream, stopping at dams for mussels. Shortnose sturgeon EOs >20 years old and not used.

The EO features listed above were used to elevate the underlying non-matrix forest habitat polygons to Tier 1 or are added as separate polygons encompassing multiple habitat types to Tier 1. If the EO only overlapped a matrix forest habitat, then a buffer was applied to the EO and elevated to Tier 1.

Selected Rare Plants and Natural Communities

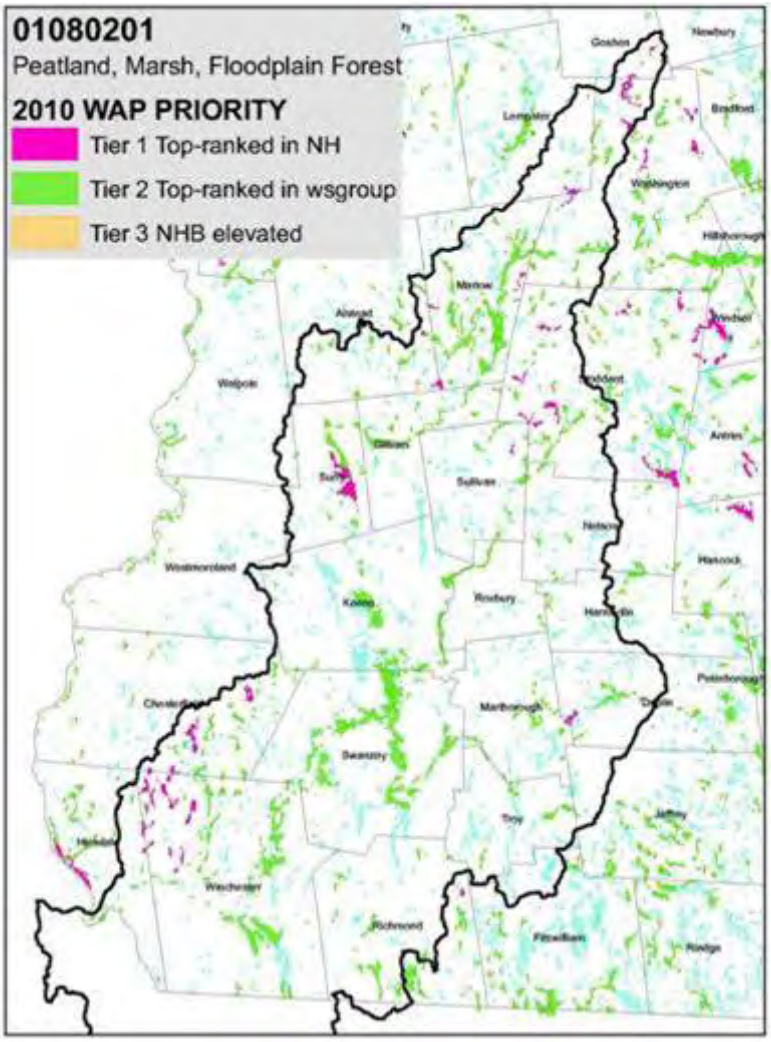
Natural communities are recurring assemblages of plants and animals found in particular physical environments. Three characteristics distinguish natural communities: 1) plant species composition, 2) vegetation structure (e.g., forest, shrubland, or grassland), and 3) a specific combination of physical conditions (e.g., water, light, nutrient levels, and climate).

Exemplary natural communities are the best remaining examples of New Hampshire's natural community types. Exemplary status is assigned based on a combination of the rarity of the natural community type and the quality rank of a given occurrence. Quality ranks are a measure of the ecological integrity of a community relative to other examples of that particular type based on size, ecological condition, and landscape context. The NH Natural Heritage Bureau (NHNHB) provided spatial data identifying NHNHB-priority sites not covered by habitat polygons meeting "highest quality" tiers based on condition filters. NHNHB developed a simple method to identify high priority natural communities based on element rarity and occurrence condition. All natural community and natural community system EOs that met the following criteria were considered "high" priority for conservation (see NHNHB for details):

1) High quality: Any "A" ranked element occurrence, regardless of rarity.
2) Rare elements: Any "B" ranked element occurrence for rare (S1 or S2) community types.

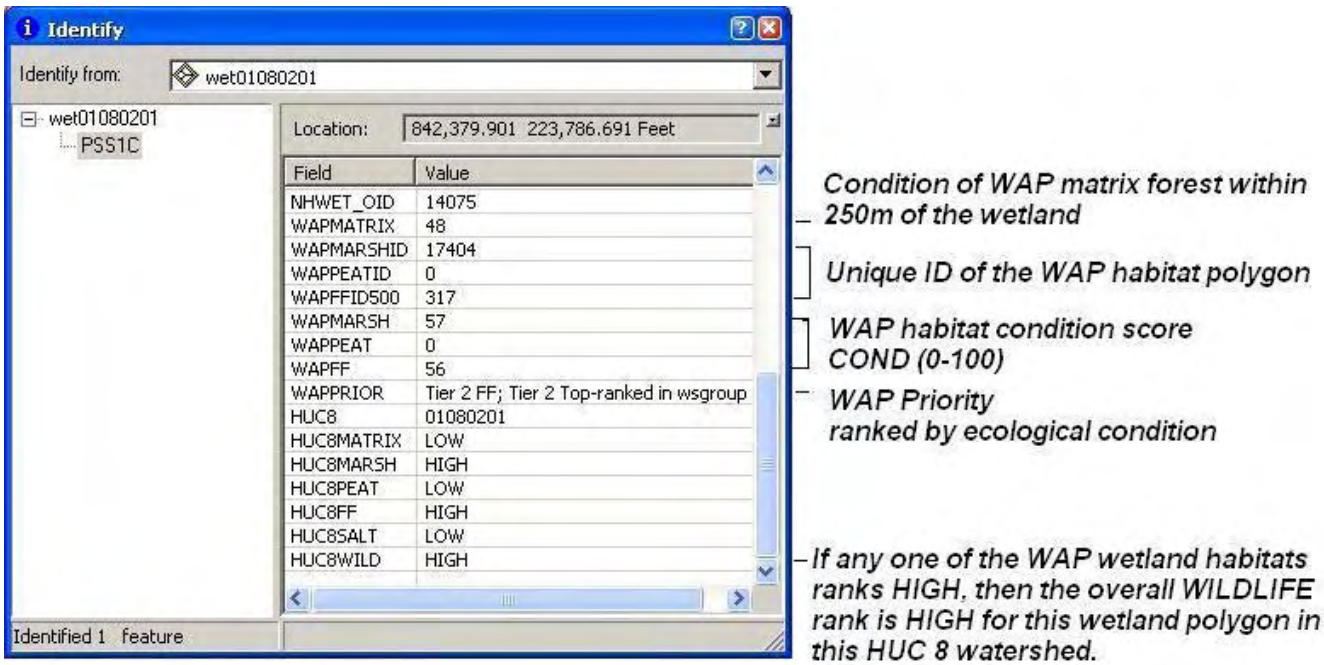
Natural Communities were restricted to those documented during the last 20 years. All identified Natural Communities and systems were then intersected with associated WAP habitat polygons and used to elevate the rank of a previously unranked polygon from "no rank" to "Tier 3", regardless of its condition score. Where these overlapped a matrix forest, the feature was buffered before scoring it and adding it to the WAPTIERS data layer. Certain areas were identified by NHB as of exceptional ecological value based on an assemblage of EOs, and these were elevated to Tier 1. Natural community-WAP habitat associations were based on Appendix C of the Wildlife Action Plan.

Figure 10. Wildlife Habitat Condition in the statewide wetland base map for New Hampshire.



Unique identifiers in the NH Wildlife Action Plan wetland habitats were assigned to polygons in the NH Wetland Base Map using the IDENTITY tool in ArcGIS 9.3. The unique IDs were then used to join some of the wildlife habitat condition scores to the Wetland Base Map attribute table:

WAPMATRIX = the average condition score of the matrix forest in a 250 meter buffer of the wetland
WAPMARSH = the condition score of the co-occurring WAP wet meadow/shrub wetland complex
WAPPEAT = the condition score of the co-occurring WAP peatland complex
WAPFF = the condition score of the co-occurring WAP floodplain forest
WAPPRIOR = the priority ranking of the co-occurring WAP wetland habitat polygon(s)



Each feature in the Wetlands Base Map, within each HUC 8 watershed, was then assigned a relative rank based on decile breaks in the condition score of each WAP habitat type (matrix forest for forested wetlands, marsh complexes, peatland complexes, floodplain forest, and salt marsh):

TOP 10 = 90th percentile
HIGH = 75th percentile
MEDIUM = 50th percentile
LOW = below 50th percentile

An overall wildlife habitat condition rank (HUC 8WILD) reflects the best rank overall. Note, all salt marsh is considered "Top 10" consistent with all salt marsh being Tier 1 Top-ranked in NH in the NH Wildlife Action Plan.

Examples of this wildlife GIS module for Walpole and Keene are provided.

Any feature in the NH wetland base map co-occurring with a Tier 1 priority wetland polygon was assigned a rank of "Top 10" in the HUC 8 watershed regardless of relative condition scores, because these features may have been elevated to WAP Tier 1 due to a documented rare species occurrence or exemplary natural community.

Figure 11. Wildlife scores for wetlands in Walpole, NH.

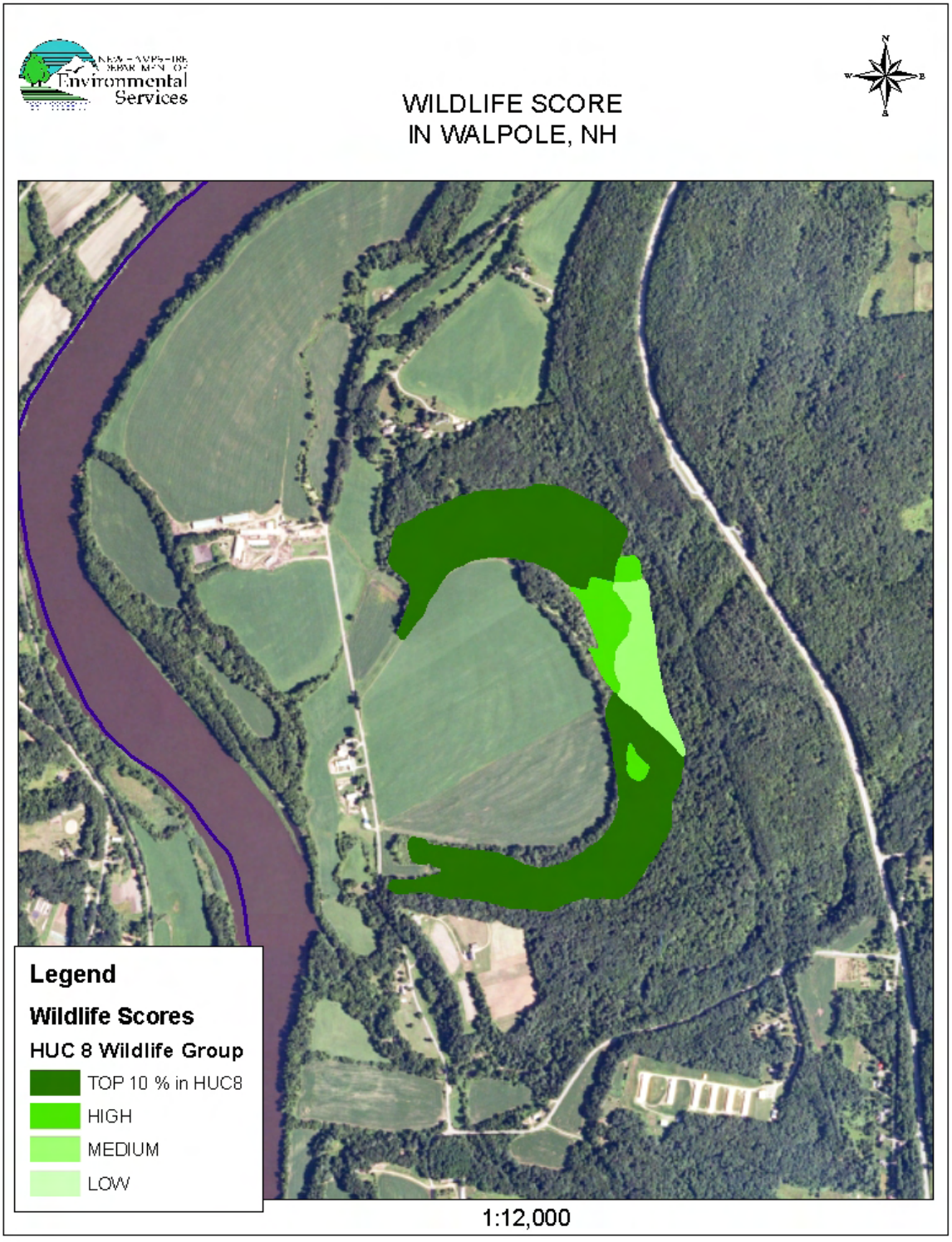


Figure 11. Wildlife scores for wetlands in Walpole, NH.

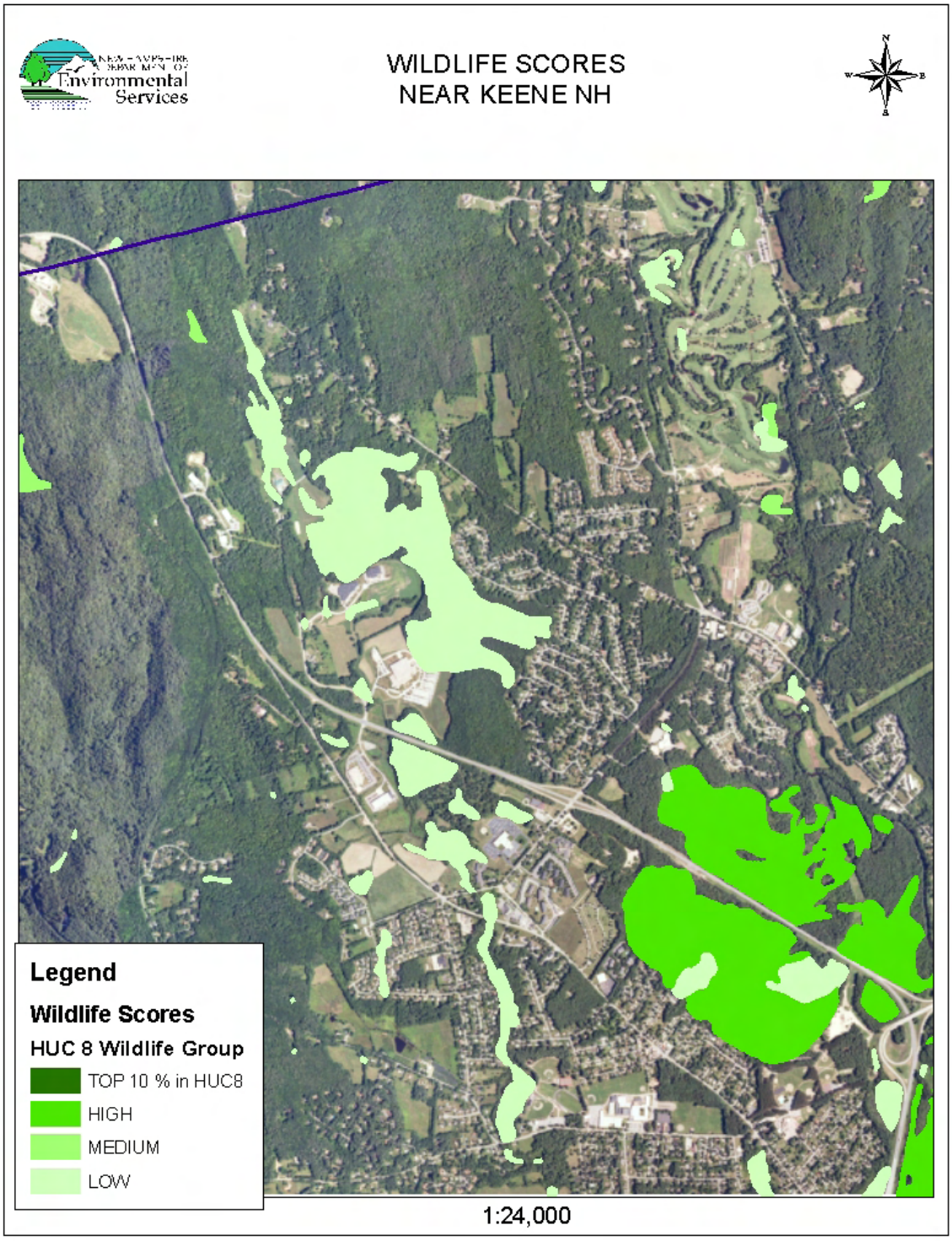


Figure 12. Wildlife scores for wetlands in Walpole, NH, showing conservation lands and unfragmented forest blocks.

Figure 13. Valuable wetlands, Unfragmented Forest Blocks and Conservation Lands in Keene, NH.

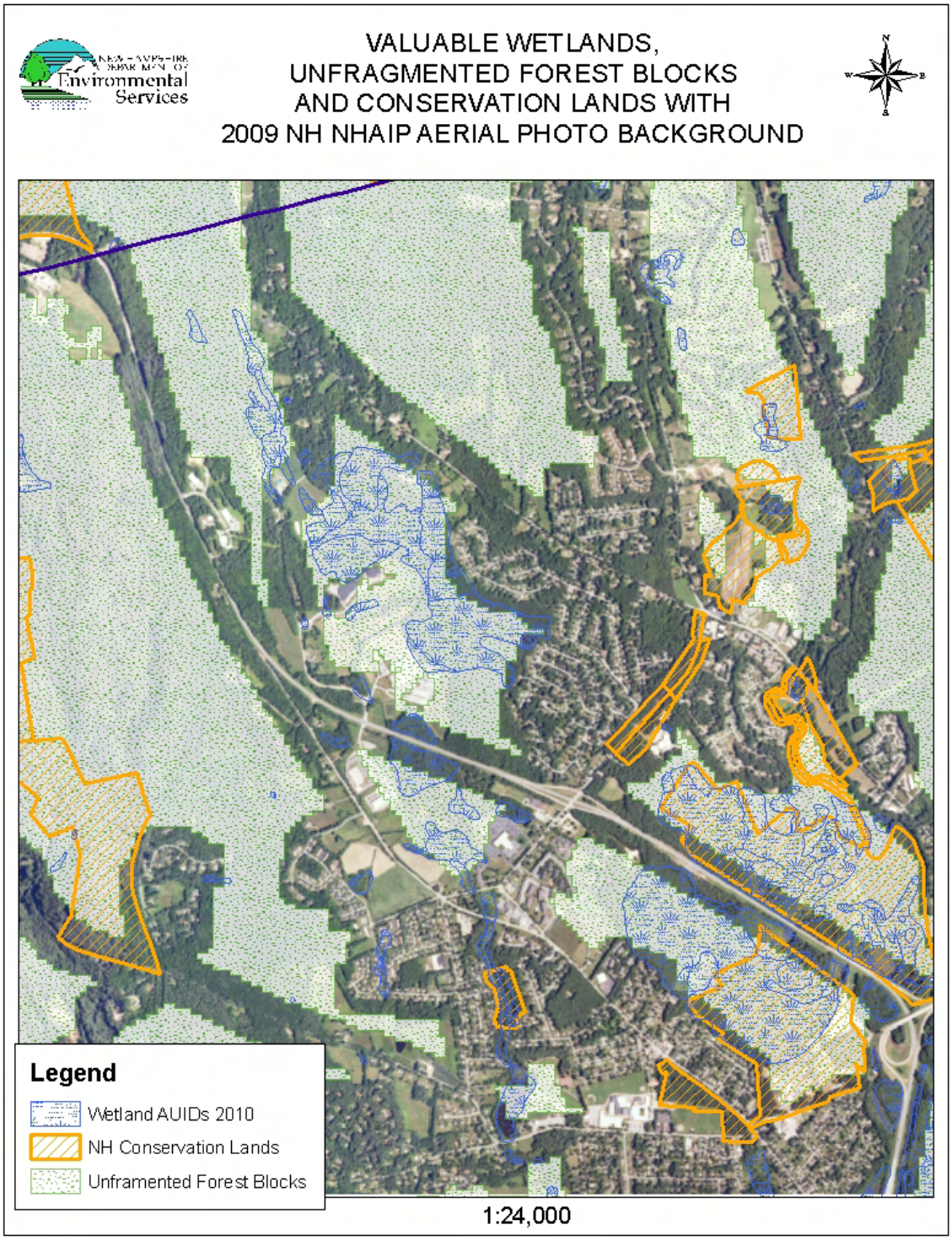
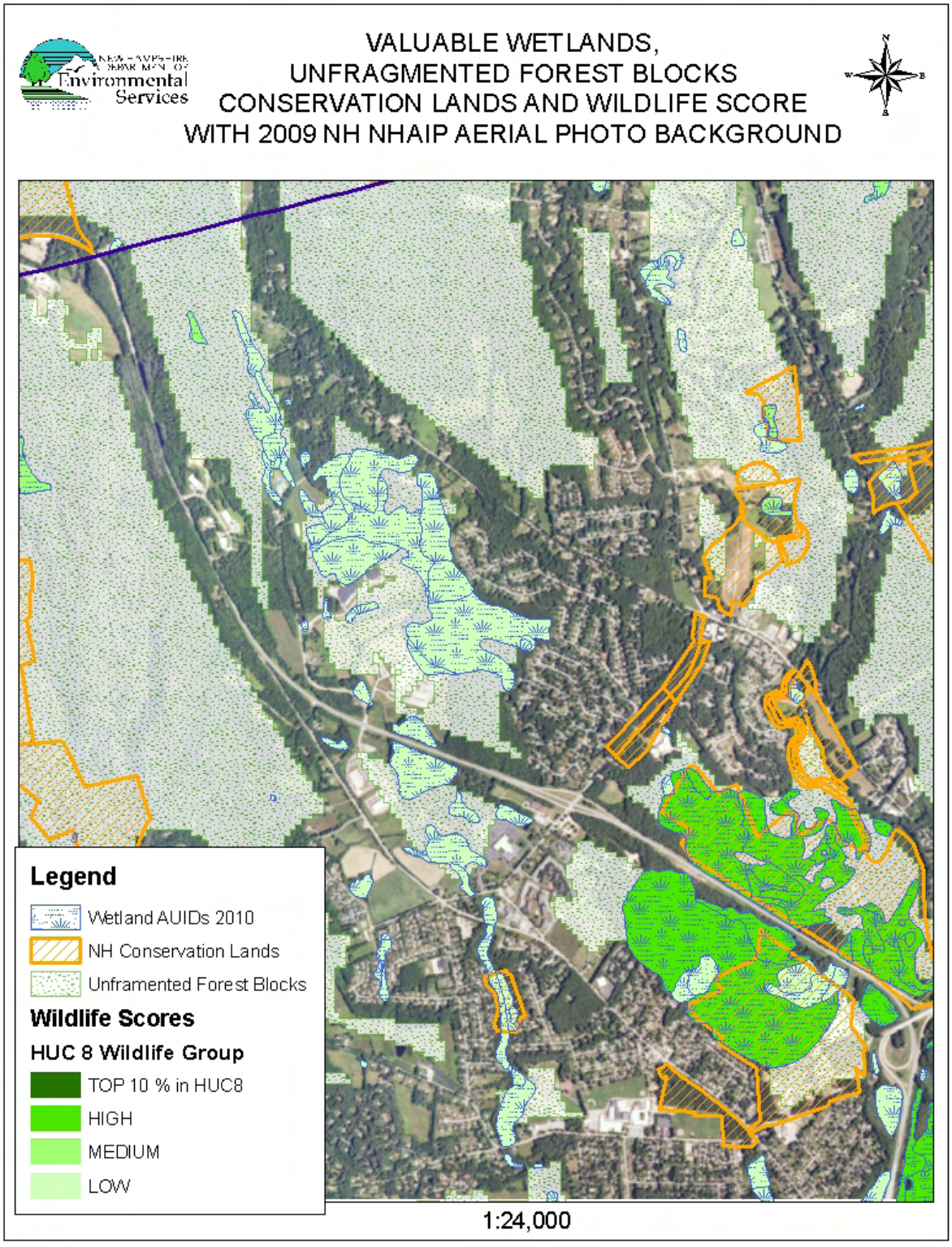


Figure 14. Wildlife scores for wetlands Keene, NH showing conservation lands and unfragmented forest blocks..



III. DEVELOP AND DISTRIBUTE MITIGATION REPORTS

The DES Wetlands Bureau has been approving upland preservation as a form of wetland mitigation since the mid 1990's. The legal mechanisms for this protection have been recordation of conservation easements and to a limited extent, warranty deeds with conservation restrictions to protect resources from future development. In August 2004, DES adopted rules that recognize conservation easements as the only acceptable means of satisfying the mitigation requirements for land preservation.

The DES rules stipulate either a municipality, state agency or an established land trust shall be the grantee of mitigation easements so there is long-term oversight of the protected parcel. As a grantee, it is incumbent upon the easement holder to monitor the property and routinely determine if there is compliance with the terms of the easement. A conservation easement no matter how carefully crafted depends on the easement holder's commitment to stewardship. Since there are other responsibilities associated with this oversight, some towns are unwilling to accept easements and some may accept them without adequate support to carry out the stewardship role.

In an effort to facilitate the towns compliance with these wetland mitigation easements, under this grant DES proposed to provide the local communities with tracking reports and GIS maps illustrating conservation lands and mitigation sites within their town so they can assist in the monitoring of these resources and become proactive in land use decisions. The mitigation tracking and assessment program assists with the exchange of information to municipalities, land trusts, and others and elevate the important resource areas in the minds of decision makers.

Method

Under this grant, a new process was developed to provide local decision makers with GIS maps locating wetland mitigation parcels in order to track these important resources and integrate wetland protection into their town, region, or watershed conservation plan. DES issued letters to conservation easement holders as a reminder of their responsibilities in stewardship of the easements in their town or service area which will assist with compliance and protection of the conservation areas and improve the knowledge of these important resource areas.

DES also developed yearly monitoring report forms for towns to use in the assessment of mitigation sites and conservation easements (See Mitigation Attachment A). DES developed this process into a yearly reminder on the status of protected parcels to include the following: the location of the parcel on the landscape relative to National Wetland Inventory wetlands (NWI) and conservation lands.

Results

The information and assistance provided to towns that hold DES-related conservation easements was well received. DES contacted 74 towns through an informative letter to improve compliance and protection of the conservation areas (See example in Attachment A). The location of the wetland easements held by a Town was illustrated on a map that was correlated to NHDES database and UNH Complex Systems GRANIT program (See Mitigation Attachment B). In addition, at the annual 2009 conference for the New Hampshire Association of Conservation Commissions, this information was included in a mitigation program presentation.

Many of the Commissions present had found the information useful in their record keeping of the mitigation lands.

As an added benefit, one aspect of conservation planning is finding ways to locate these important protected resource areas relative to other natural resources in the town. Through this grant, awareness of land conservation and how towns shape their open space plans to achieve town resource goals, was accomplished.

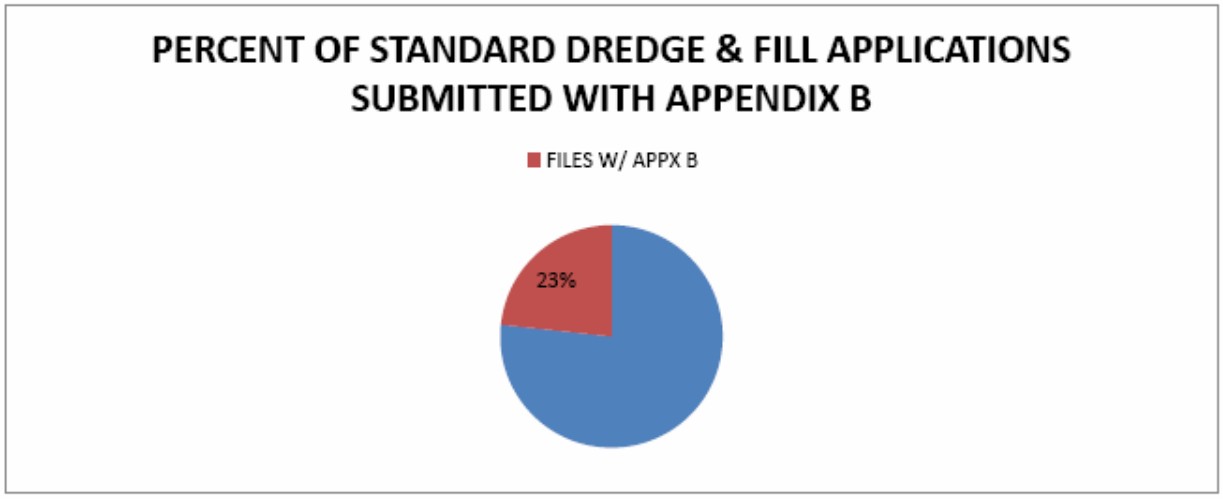
Summary

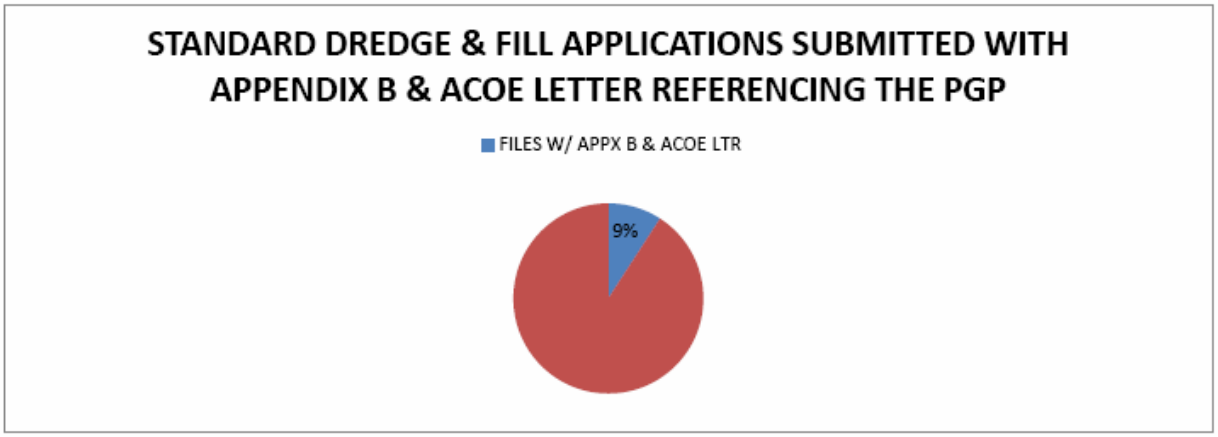
The information provided to the 74 towns at a critical time in the development of the DES mitigation program and for town involvement in the process for several reasons. First, this effort informed towns of valuable resources and reminded them of the need to perform stewardship activities. Second, it facilitated conversations at the local level about what type of parcels would be accepted in the future and how their Commission could improve decision-making in natural resource planning. Lastly, it occurred at a time when the DES in-lieu fee program was gaining momentum, so if a town chooses to not accept a wetland easement there is an alternative to developers. As a result, towns accept marginal parcels less often as they understand the commitment of resources necessary for stewarding easements and, as the in-lieu fee program now can provide a valuable mitigation alternative.

IV. Secondary Impacts and Wetlands

Effective July 1, 2007 the US Army Corps of Engineers issued a State Programmatic General Permit for New Hampshire (PGP). The General Permit Conditions of the PGP require that projects authorized under the PGP "shall have no more than minimal individual, secondary and cumulative adverse environmental impact to water of the U.S. as a result of construction and operation of the project." PGP Appendix A, Endnote 3 defines secondary impacts. The PGP states that "in order for the Corps to determine whether independent Corps review of a project with possible secondary and cumulative impacts is required, applicants must complete the Corps Secondary Impacts Checklist at Appendix B. For convenience, Appendix B is also provided as an attachment to the DES Wetlands Bureau application and Permit By Notification forms."

As part of this grant, DES reviewed all wetland Standard Dredge and Fill application files from August 1, 2007 – July 31, 2008 to evaluate the compliance rate for submission of the Appendix B checklist. The results are shown below. Of the total 554 application files reviewed, only 29 percent had submitted the Appendix B checklist.





FILES WITH APPX B & ACOE LETTER REFERENCING PGP

CATEGORY	Data Count of APPX B RCVD	Count of ACOE LTR RCVD	Count of ACOE LTR REF PGP
30	1	1	1
EXP MIN	1		
MAJOR	48	29	26
MIN	47	1	1
MINOR	72	23	23
Grand Total	169	54	51

FILES REVIEWED

Count of FILES CATEGORY	Total
	1
30	9
EXP MIN	3
MAJOR	125
MIN	149
MINOR	267
(blank)	2
Grand Total	556

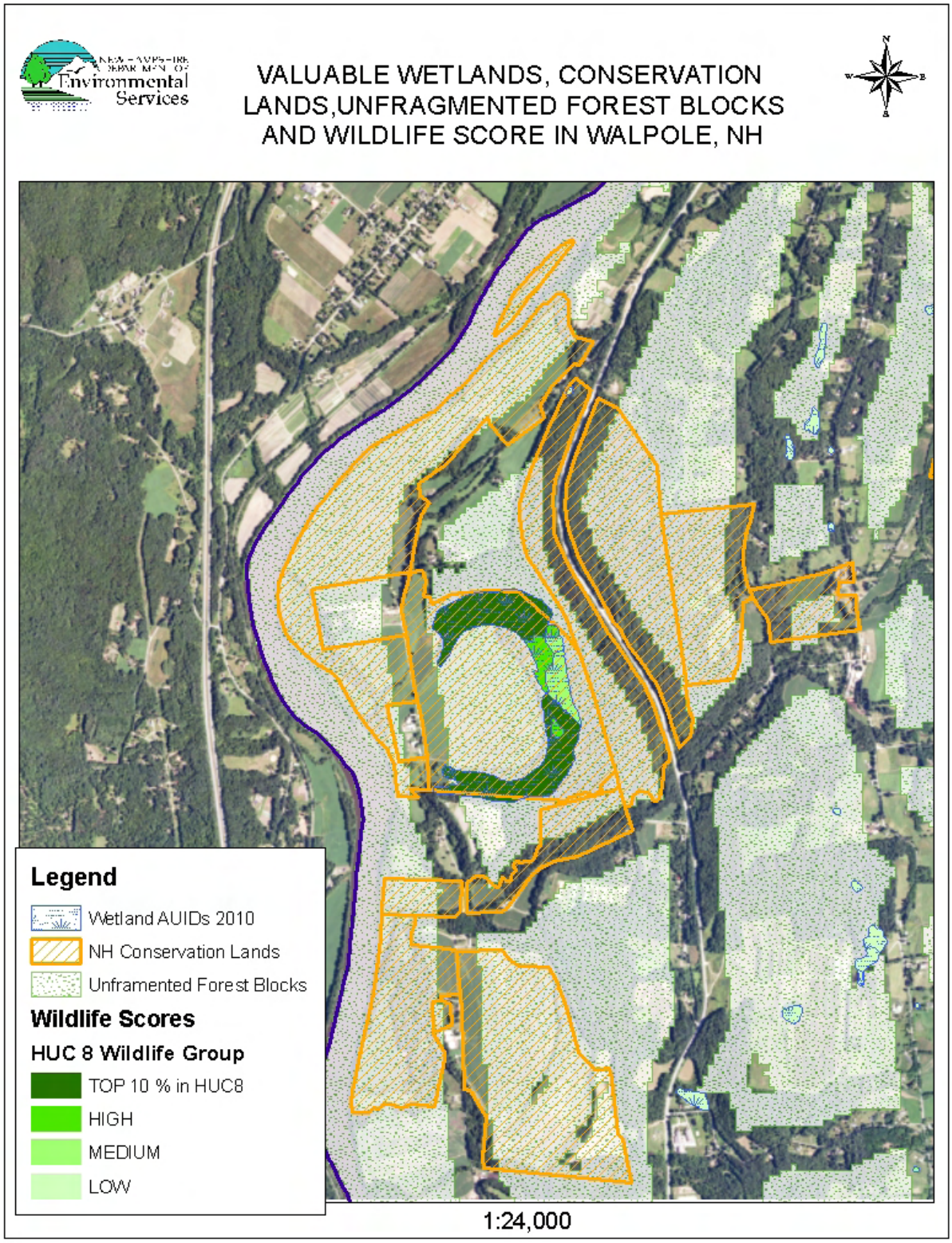
Further application of GIS tool

Through the PGP, DES has provided a screening process for federal agencies to flag projects with potential secondary impacts. DES currently prints GIS maps with "impaired waters" locations noted for permit application files. These maps could be used to address secondary impacts.

Based on the work products and GIS tool developed through this grant, DES is proposing that a new screening process be developed to assist federal agencies in addressing potential secondary impacts. Habitat fragmentation is a significant secondary impact that could be addressed.

"Fragmentation of wetlands interferes with wetland values previously described, particularly wildlife habitat." Fragmentation results in some loss of the wetland itself and disrupts migratory and breeding patterns of many wetland-dependent species." NH Water Resources Primer (WRP), 5-7. The development of adjacent uplands is also a concern because many wildlife species need both wetlands and uplands for survival (WRP).

Several example GIS maps showing the Fish and Game Department Large Unfragmented Block layer could be screened with other significant wetland functions. For example, high wildlife habitat areas and unfragmented block areas would identify potential future impacts to important wildlife corridors. Additionally, combining conservation lands, unfragmented blocks with other important wetland-function areas provides excellent information for mitigation planning. The new modules now run and ranked based on each HUC 8 watershed could provide important information in assessing grants for funding through the Aquatic Resource Mitigation Fund (ARM) Fund.


Environmental Services
VALUABLE WETLANDS, CONSERVATION LANDS,UNFRAGMENTED FOREST BLOCKS AND WILDLIFE SCORE IN WALPOLE, NH
Legend
Wetland AUIDs 2010
NH Conservation Lands
Unframented Forest Blocks
Wildlife Scores
HUC 8 Wildlife Group
TOP 10 % in HUC8
HIGH
MEDIUM
LOW
1:24,000

V. PERMIT INSPECTION PROGRAM

Permit Inspection Program for Permits, Mitigation and Secondary Impacts

In 2008, DES began to conduct cross-program staff training within the Land Resources Management (LRM) program, consisting of the Wetlands Bureau, Subsurface Systems Bureau, and Alteration of Terrain (AOT) Bureau. In addition to conducting in-house training on the statutes, regulations, and enforcement strategies of each program, staff formed multi-media "teams" to train in the field in their respective programs. In addition, DES created a Land Resources Management Inspection Report, a comprehensive field inspection report for use by the LRM program in the field by staff. The purpose of the LRM inspection report was to provide immediate feedback to the violator and identified less significant, on-going violations. The inspection report summarized outstanding compliance issues and, depending on the degree of cooperation and knowledge of the violator, included deadlines for restoration. In 2008, the LRM program issued 65 field inspection reports.

After completion of the initial cross-training, in May 2009 compliance regions for the AOT and Wetlands programs were combined and restructured, thereby dividing the state into nine regions from six (See May 2009 map in Appendix). The decrease in the size of the regions allowed staff, for the first time, the opportunity to conduct permit compliance inspections in addition to responding to violations based on citizen complaints. Due to budget issues, a compliance staff person was reassigned outside the bureau and there are now eight compliance regions (see March 2010 map in Appendix).

In addition, the AOT database was modified to accept inspection information. When an AOT permit is issued for a project, the permitting inspector indicates an inspection priority based on a variety of factors, including location of the project, size of the permitted impacts, proximity to sensitive or prime wetlands, steepness of slopes, erodibility of a soil type, and type of mitigation proposed. The regional compliance inspector can then identify sites to inspect based on the permitting inspector's knowledge of the project and site.

The following is a summary of the accomplishments for state fiscal year 2010 (7/1/09 – 6/30/10):

	Wetlands	Alteration of Terrain
Permit Compliance Inspections	**109**	**242**
Complaint Inspections	**458**	**92**

Quarter of SFY 2010	Inspections Conducted and Enforcement Documents Generated				
	Permit Compliance Inspections		Complaint Inspections		Enforcement Docs Generated
	Wetlands	AOT	Wetlands	AOT	
July-Sept	40	81	149	31	198
Oct - Dec	35	70	135	23	156
Jan-Mar	11	25	42	14	95
Apr - Jun	23	66	132	24	114
Totals	**109**	**242**	**458**	**92**	**563**

This is an example of a violation which was successfully resolved using an LRM inspection report:

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

LAND RESOURCES MANAGEMENT COMPLIANCE INSPECTION REPORT
NH Department of Environmental Services
PO Box 95
Concord NH 03302-0095
www.des.nh.gov (603) 271-3503

Date: 8/27 Time: 2:30 NHDES Inspector: EPL AFH Phone: 271-4086 Page 1 of ____

Owner: Al Le Blanc Town: Clarksville 03592 Map: ____ Lot: ____
Contractor: ____ Site Address: 171 NH Route 145
Project Representative: ____ Waterbody: ~~[illegible]~~ Pond ~~ed~~ Brook & wetland

A site inspection has been conducted for compliance with the following program(s) and permit(s):

- **Alteration of Terrain: RSA 485-A:17** ☐ File Number: ____
- **Wetlands Bureau: RSA 482-A** ☐ File Number: ____
- **Shoreland Protection: RSA 483-B** ☐ File Number: ____
- **Subsurface Systems Bureau: RSA 485-A:32** ☐ Work/Approval Number: ____

During the inspection the following deficiencies were documented:

- ☐ Failure to obtain permit(s)
- ☑ Failure to follow appropriate Best Management Practices
- ☐ Activities within waterfront buffer or woodland buffer exceeds allowable limits
- ☐ Project exceeds approved permit limits and/or conditions
- ☐ Water quality degradation is evident
- ☐ Failure to maintain a minimum of 50 points within waterfront buffer grid
- ☐ Failure to follow approved construction sequencing
- ☐ Failure to properly install and/or maintain erosion, sediment, and/or turbidity controls
- ☐ Failure to leave stump and root system intact within 50 feet of reference line
- ☐ Failure to follow approved design
- ☐ Water quality exceeds 10 NTUs (Class B surface waters)
- ☐ Failure to maintain proper setback distances
- ☒ Other fill and exposed soils encroaching on perenial brook and adjacent wetland

NH DES strongly recommends that you take the following action:

- ☒ Install erosion controls by: 9/30/08
- ☐ Obtain environmental consultant by: ____
- ☐ Submit restoration plan by: ____
- ☐ ____ by: ____

Other comments/recommendations: 1) install silt fence or staked haybales above edge of water to prevent sedimentation of stream 2) pull sediment/fill material back @ slope no greater than ~~3~~2:1 to area discussed 3) apply seed mix to exposed areas 4) straw or mulch after seeded 5) call DES to schedule followup inspection

→ follow original grade + vegetate

Turbidity measurements taken ☐
Photographs taken ☑ GPS points taken ☑ Weather conditions: Sunny 70°

[signature]
Inspector Signature

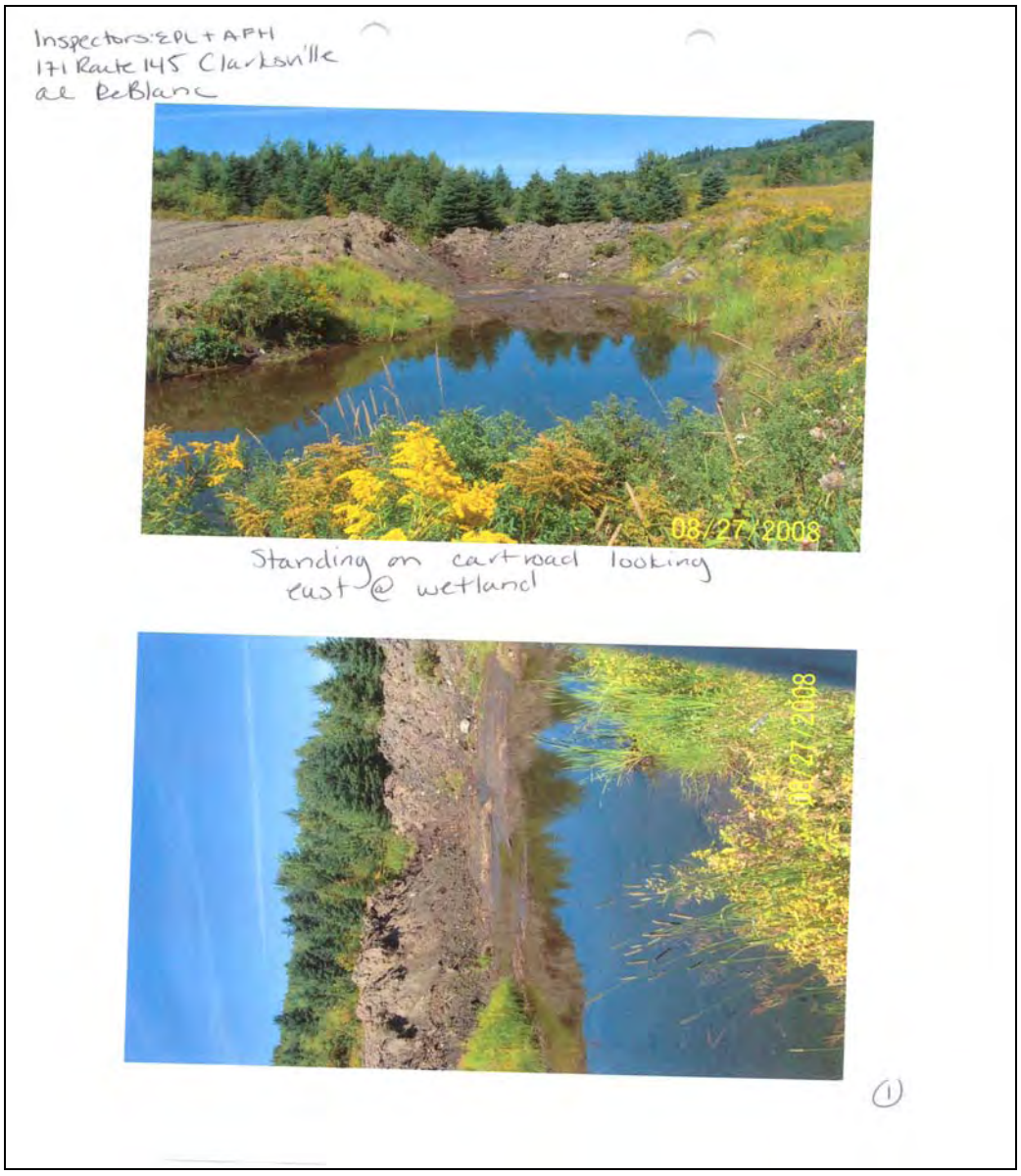
[signature]
Project Representative Signature

CC:

Distribution: White copy to file Yellow copy to project representative Pink copy to owner/contractor

DES reserves the right, within statutory and administrative authority, to conduct further inspections of this property and to take appropriate enforcement action, should such action be deemed necessary.

* DES will send information on Best Management Practices for agriculture



Photos from inspection report. Note unstable, eroding soils.

Restored site, approximately one year later.

The most common permit violation was that the site did not meet the construction sequence and erosion control conditions of permit. Each compliance staff inspector is now trained to perform wetlands, Alteration of Terrain and Shoreland investigations as needed.

During this integration process, DES initiated a LEAN analysis to address organizational structure and to improve consistency. The result was the development of a Compliance Review Team (CRT) composed of bureau administrators and the Land Resources Director. The CRT now meets each week and has developed protocols and policies to handle all program violations from inspection to resolution.

Mitigation Inspections

DES created a mitigation inspection checklist (attached) and instructed staff on its use. Three compliance inspectors conducted ten mitigation inspections in 2010 in the Merrimack and Ashuelot watersheds. Work on three of the ten mitigation sites had not begun, nor had the boundaries been marked. Five of the mitigation sites were in compliance; and two mitigation sites had minor compliance issues (e.g., personal property located within the easement.)

Conclusions

The grant request and resources budgeted for this project exceeded the budget proposed for this grant. DES retained the services of a consulting firm, Vanasse Hangen Brustlin, Inc (VHB) to meet the commitment to adapt the VHB model to three additional ARM fund watersheds (the VHB report has already been submitted to EPA under separate cover). Much staff resources were donated by the DES Watershed Management Program and the Geology Unit to develop the wetland basemap and to develop the separate modules. DES Wetlands program donated time for the grant beyond match for inspections and coordination.

Relative ranking scores were developed for each function module. The top ten percent wetlands of high wildlife, flood storage and water quality function, high function, medium and low function rankings were developed. Example maps have been provided. This tool has been developed for state-wide application and each relative ranking was done for each HUC 8 watershed. High and top ten percent wildlife wetland maps linked with unfragmented blocks serves as a useful screening tool for assessing secondary impacts – such as habitat fragmentation. DES is proposing that these linked maps be generated for federal resource agencies reviewing DES files as a new screening protocol. DES will initiate further discussion with EPA, Fish and Game to brainstorm on this new process. DES will be providing training to the DES wetlands bureau staff on the tools developed and how these tools can be used in review of wetland applications and in mitigation planning.

Integration of Land Resources compliance has helped to improve the efficiency of the Compliance Section. Additionally, all compliance staff are now trained in Alteration of Terrain and Subsurface System program issues. This integration should serve as a model for more program integration in the future. LEAN processes were also implemented beyond the scope of this grant to develop a Compliance Resource Team to ensure consistency across watershed boundaries and among and between staff from the various programs.

ACKNOWLEDGEMENTS

This project was possible only through the funds granted by the Environmental Protection Agency. Special recognition goes to Ken Edwardson, Greg Barker, Catherine Callahan, Rick Chormann, Mike Stanley, Erin Huot, Mike Marchand, Linda Magoon, Lori Sommer, Karla McManus, Emily Lucas, Stacey Herbold, and Sandra Mattfeldt for their efforts in the development of this project. Thanks to Collis Adams for invaluable editing comments.

The State of New Hampshire

DEPARTMENT OF ENVIRONMENTAL SERVICES

Thomas S. Burack, Commissioner

Town of Hooksett
16 Main Street
Hooksett, NH 03268

October 27, 2009

Re: Conservation Land related to NHDES Wetlands Bureau Permits: #2000-0203, #2001-1512, #2001-2205, #2002-2449, #2005-519, #2005-00083, and #2005-00317

Dear Town of Hooksett:

The New Hampshire Department of Environmental Services, Wetlands Bureau ("DES") is developing a strategy for monitoring easements and open space, which result as a condition of a wetlands permit, requiring the permittee to perform mitigation by preserving open space or placing a conservation easement on a piece of land. Mitigation is typically required as a permit condition for large projects that affect the functions and values of wetlands.

DES records indicate that seven wetland permits were granted in your Town in 2000 through 2005, which contained conditions relating to wetland mitigation. In accordance with these permit conditions, a certain amount of land was agreed to be protected by the Town. The following is a summary of the wetlands permit number, number of acres, type of protection, and location of the protected site (a map with the approximate location is enclosed):

#2000-0203: Conservation easement on 78.74 acres, Lot 99 Glencrest Estates
#2001-1512: Conservation easement on 2.83 acres, Map 38, Lot 43-A
#2001-2205: Conservation easement on 1.54 acres, Map 26, Lot 5; 3.84 acres, Map 26, Lot 39
#2002-2449: Conservation easement on 192 acres, Parcels 14-1-6, 14-1-10, 14-1-12, 14-1-13
#2005-00083: Conservation easement on 69 acres, Parcels 14-1-8, 14-1-18, 14-1-20, 14-1-21
#2005-00317: Conservation easement on 10.1 acres, Tax Map 25, Blocks 69-71 and 73-76
#2005-0519: Conservation easement on 69 acres, Map 14, Lot 14-1.

As the conservation easement holder, the Town of Hooksett is now ultimately responsible for monitoring these and any future parcels in which the Town is the easement holder to ensure that there is no breach of the conservation land protections placed on the property.

It is suggested that the Town monitor each easement once a year. I have attached a sample monitoring report for your convenience. If there are any enforcement issues with regard to the easement boundaries or terms, please contact me by e-mail at *Karla.McManus@des.nh.gov* or by telephone at 271-7514.

Thank you,

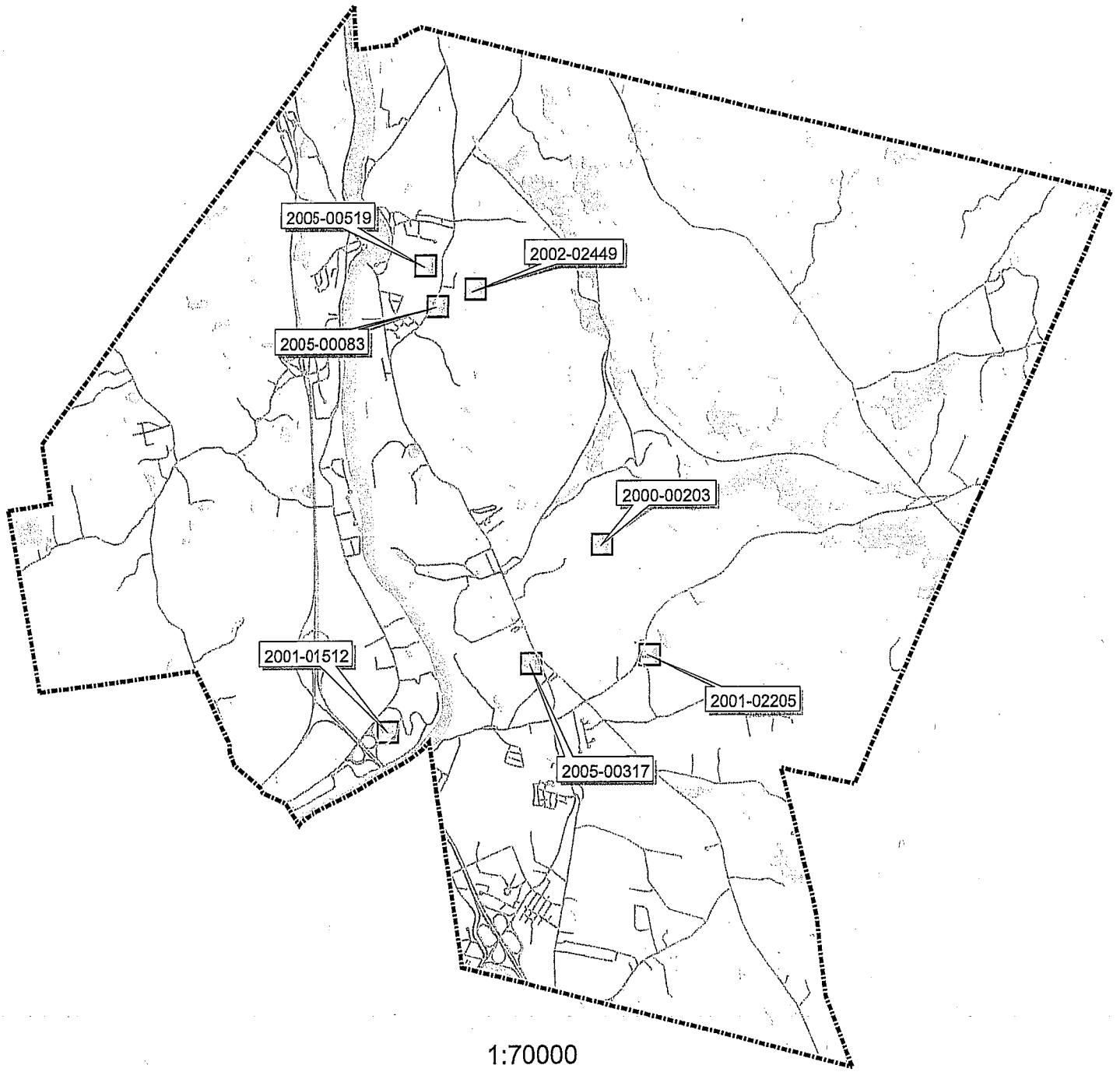
Karla S. McManus
Wetlands Bureau

Enclosures

NEW HAMPSHIRE DEPARTMENT OF
Environmental Services
WETLANDS BUREAU

LOCATION OF WETLAND FILES WITH EASEMENTS IN HOOKSETT

N
W E
S



1:70000

☐ = PROJECT LOCATION

Mitigation Monitoring Report

1. **File Number:** **Inspection Date:**

   Location: **Acreage:**

   Name of Easement:

   Current Owner:

   Date of Report:

2. **Background:** The property was visited for mitigation and easement monitoring purposes pursuant to permit conditions. No complaints or problems prompted the visit.

3. **Summary of Easement:**

   Purpose: (Preservation of open space; scenic enjoyment of the general public.)
   Use Limitations:
   Reserved Rights:

4. **Monitoring Activities:**

5. **Past & Current Land Use:**

6. **Future Land Use/Management Plans:**

7. **Boundary clarity, issues & posting:**

8. **Other Comments (natural features & disturbances, landowner info, ownership changes, etc.):**

9. **Potential Easement Violation Issues:**

10. **Are the restrictions in the easement being complied with, to the best of your knowledge and observation? Describe:** (The restrictions are being complied with to the best of my knowledge.)

11. **Follow-up:**

12. **Visit Attendees:**

13. **Monitor's Name:** **Signature: _____ Date:**

14. **Materials included with this report:**

    Aerial Photos: **Maps:**

    Ground Photos: _____ **Illustrations:**

DEPARTMENT OF ENVIRONMENTAL SERVICES
WETLANDS BUREAU
29 Hazen Drive PO Box 95
Concord, NH 03302-0095
Phone: (603) 271-2147 Fax: (603) 271-6588
web site: www.des.nh.gov email: wetmail@des.nh.gov

Compensatory Mitigation Information and Checklist

For permanent impacts that will remain after avoidance and minimization measures have been addressed, the applicant shall submit a compensatory mitigation proposal in accordance with Chapter Env-Wt 800, unless exempted by Env-Wt 302.03(c). Criteria in Env-Wt 501.02(a) provide details about information to be submitted with your application.

In general, an applicant is required to provide compensatory mitigation if the project meets any of the following criteria:

- The project will result in 10,000 square feet or greater of permanent wetland impact.
- The project will alter the course of or disturb 200 or more linear feet of an intermittent or perennial nontidal stream or river channel or its banks. For intermittent streams, the distance shall be measured along the thread of the channel. For perennial streams or rivers, the total disturbance shall be calculated by summing the lengths of disturbance to the channel and each of the banks.
- The project involves construction of a pond with more than 20,000 square feet of impact in a wetland or surface water.
- The project involves only the installation of accessory docking structures or the construction of new shoreline structures and breakwaters, or includes such work in combination with other qualifying criteria, provided the resulting dock surface area of all new shoreline structures on the frontage is less than 2,000 square feet.

Compensatory mitigation is required to replace or protect wetland functions and values that are impacted by the project. Please demonstrate how you have reviewed all of the following four options:

1) **Upland Buffer Preservation** means an area of land that is contiguous to an aquatic resource and contributes to the functions and values of that resource. For this to be acceptable by DES, the land must be protected through a conservation easement or transfer of fee simple ownership to an acceptable agency or organization. Please demonstrate that the following organizations have been consulted that include state natural resource agencies, land trusts, watershed associations, and regional planning commissions.
2) **Wetland Restoration** means the re-establishment of a filled, dredged, or drained wetland to its historic condition, so as to restore lost functions to the greatest extent practicable, by removal of fill, restoration of hydrology to the area, or by such other means necessary.
3) **Wetland Creation** means the transformation of upland to wetland at a site where upland was not created by human activity such as by filling or water diversion.
4) **Payment** in-lieu of the three options above after they have been considered and determined not feasible. Payment is provided to the Aquatic Resource Mitigation Fund if the project will fill less than one acre of wetlands or will impact up to 3 acres if it is a public roadway or public utility project.

Mitigation Checklist

For projects that require mitigation, the Standard Dredge and Fill application shall be considered <u>administratively complete</u> when a Preliminary Mitigation Package is submitted with the following items:

_____ An **explanation** of which of the mitigation options is/are being proposed for compensatory mitigation.

____ Wetland creation **____ Wetland restoration**

____ Upland buffer preservation **____ Payment to Aquatic Resource Mitigation Fund**

_____ A plan showing the general location of the proposed mitigation site.

_____ A functional assessment of the impacted jurisdictional area(s).

_____ A functional assessment of the proposed mitigation site.

_____ A completed agreement form signed by the applicant and noting the date when a complete mitigation proposal will be submitted to DES. The agreement form is attached to this checklist.

Where **upland buffer preservation** is proposed:

_____ A draft report that documents the current property conditions.

_____ A summary of the conservation values and goals.

Where **wetland restoration or creation** is proposed:

_____ A summary of the proposed measures.

For a compensatory mitigation <u>proposal</u> to be deemed complete, the applicant shall consult DES rules, Env-Wt 800 which requires additional information to be submitted such as the following items:

For projects that involve **upland buffer preservation:**

_____ Final baseline documentation report of the land proposed for protection, which describes current property conditions and includes photographs.

_____ A copy of the proposed conservation easement language or language noting conveyance of fee simple ownership.

_____ A surveyed plan showing the location of the proposed conservation area boundaries.

_____ A statement from the proposed grantee indicating that the proposed grantee will accept the easement or fee simple deed.

For projects that involve **wetland restoration or creation**:

_____ Explain how the proposal creates hydrologic conditions or land connections that will produce the desired wetland functions or values to be restored or created.

_____ Detailed plans with existing and proposed grades, predicted water fluctuations, and proposed wetland cover types.

_____ Construction procedures and timing of the work to take place.

_____ A planting proposal, source of soils to be used, erosion controls to be installed, and an invasive species control plan if applicable.

For projects that will provide **payment into the Aquatic Resource Mitigation Fund:**

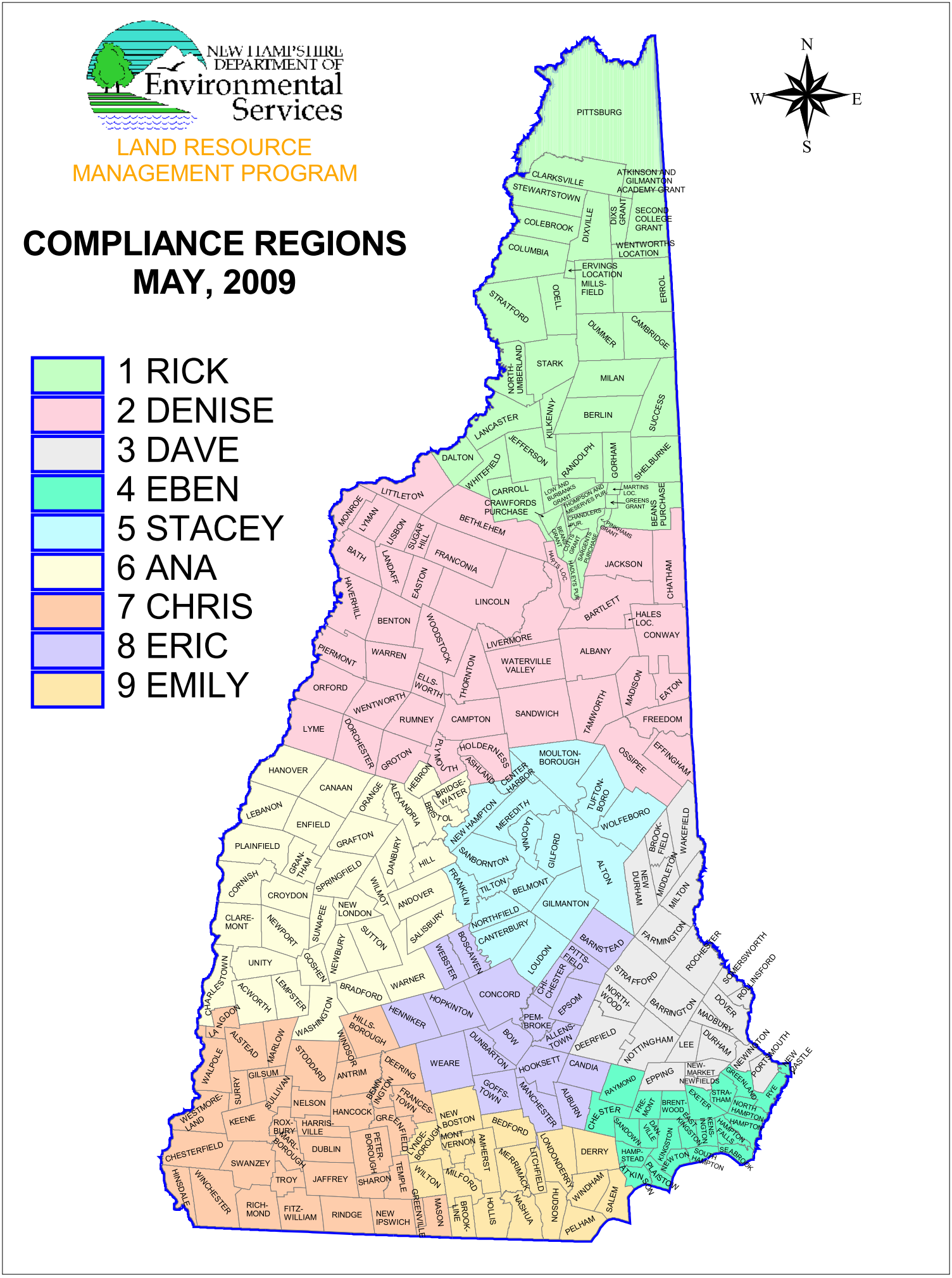
- ❑ Describe what other forms of mitigation were considered and why they are not feasible.
- ❑ Request DES to calculate a payment amount.

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

LAND RESOURCE MANAGEMENT PROGRAM

COMPLIANCE REGIONS MAY, 2009

- 1 RICK
- 2 DENISE
- 3 DAVE
- 4 EBEN
- 5 STACEY
- 6 ANA
- 7 CHRIS
- 8 ERIC
- 9 EMILY



NEW HAMPSHIRE DEPARTMENT OF Environmental Services

LAND RESOURCE MANAGEMENT PROGRAM

COMPLIANCE REGIONS MARCH, 2010

- 1 RICK - FHT
- 2 DENISE - DMF
- 3 DAVE - DAP
- 4 EBEN - EML
- 5 STACEY - SPH
- 6 ANA - AKF
- 7 CHRIS - CTB
- 8 EMILY - EPL