Mapping Regional Development for Smart Growth Planning to Minimize Degradation of Water Quality and Enhance Green Infrastructure

ANNUAL PROGRESS REPORT
July 1, 2009 – June 30, 2010

1. Overview

Work Status/Progress—The contract with Sanborn Mapping Co. (Ann Arbor, MI) to assist with mapping development (roads and buildings) for this project expires June 30, 2010. Sanborn has completed capturing data for their assigned portions of the state (Maine was divided into 475 Production Areas with 229 assigned to Sanborn Mapping Co. and 246 assigned to Maine staff). Sanborn has assembled (mosaiced) the completed Production Areas into 3 data sets (Time 1 = 2004, Time 2 = 2007, and Time 1-Time 2 Change). Imagery for a third time period (2009) became available this year. A "T3" data set was not part of the subcontract with Sanborn Mapping Co., but Maine staff have been mapping T3 development in Production Areas they have worked on since that imagery became available. An unexpected vacancy among the Maine staff has delayed completion of the project. As a result, we requested for and received a 1-year, no-cost extension to complete the project.

Preliminary Data—Sanborn has completed all 229 Production Areas assigned to them. Maine staff have completed 181 of the 246 Production Areas assigned to Maine. The assembled data sets for the completed Production Areas need final QC, then they will be incorporated into Beginning with Habitat planning maps.

Results—The modified methodology for capturing development (i.e., hand-digitizing from aerial imagery with a set of customized tools) has worked well. The delay for Maine staff in completing their assigned Production Areas was due to an unexpected position vacancy, not the revised methodology.

Evaluations Made During Reporting Period—Sanborn did preliminary QC on their completed Production Areas prior to combining them with the Production Areas completed by Maine staff. A more rigorous QC of this combined data set data will be completed before it is distributed via Beginning with Habitat planning maps.

Comparison of Actual Accomplishments With Goals and Objectives

Date	Benchmark	Status
June 2007	Combine existing road data and existing 5-m impervious data to identify urban areas and large subdivisions for "Baseline" (2004) map	COMPLETED
Nov 2007	Digitize buildings in rural areas and small subdivisions from 2004 imagery	COMPLETED, but modified from original goal of digitizing buildings for the entire project area to digitizing a sample of buildings to create a training data set for impervious surface analysis
Dec 2007	Compile existing road data and digitized buildings to create 2004 "Baseline" map	COMPLETED creating a training data set for impervious surface analysis. ONGOING as part of QC of impervious data set for T1 (2004). Scheduled completion is Dec 2009.
Mar 2008	Conduct change-detection analysis with coarse-resolution (LANDSAT) imagery to identify areas in which development most likely occurred between the "Baseline" (2004) and "Current" (2007) maps	NOT NEEDED because the high-resolution 2007 NAIP imagery now available for the "Current" map is statewide
Oct 2008	Acquire new, high-resolution imagery for areas in which development most likely occurred between the "Baseline" (2004) and "Current" (2007) maps	NOT NEEDED because the high-resolution 2007 NAIP imagery now available for the "Current" map is statewide
Mar 2009	Create and QC impervious surface data for "Current" (2004) map	ON-GOING; 86% complete. Scheduled completion date is Dec 2010.
June 2009	Incorporate development maps into *Beginning with Habitat* data package	NOT STARTED. Completion of impervious data creation and QC was delayed due to an unexpected vacancy among Maine staff. This step will begin July 2010 and should be complete by Sep 2010.
Oct 2009	Create supporting materials for *Beginning with Habitat* development maps	NOT STARTED. This step will be completed along with incorporating the development maps into the *Beginning with Habitat* data

		package
Dec 2009	Assess use of development data by towns and land trusts	NOT STARTED. This step will be initiated after the data has been incorporated into the *Beginning with Habitat* data package in.
Dec 2010	Create and QC development for "baseline" (2004) and "current" (2007) maps for remaining 14% of Production Areas.	ONGOING
Mar 2011	Combine data from remaining 14% of Production Areas with the already completed 86%.	NOT STARTED
June 2011	Prepare final report for project.	NOT STARTED

Difficulties Encountered

An unexpected vacancy among Maine staff delayed completion of the 246 Production Areas assigned to Maine. Sanborn delayed assembling the final data sets until June 2010 to allow the Maine team as much time as possible to complete more Production Areas. To date, 86% are now complete and Sanborn has assembled those into semi-final data sets. Maine has requested and received a 1-year, no-cost extension to complete the remaining 14% of the Production Areas, which will then be combined with the semi-final data sets to create the final data sets.

Changes in Project Goals—Imagery has become available for 2009, allowing creation of a Time 3 data set. Although not specified as a product of this project, capturing additional development as new imagery becomes available has always been part of the project concept. Maine staff have been capturing 2007-2009 development (T3) for the Production Areas they have been working on since the new imagery became available. Panning and zooming through each Production Area is a significant part of the time of data capture and there is relatively little development for T3, perhaps due to the global economic slow-down. Therefore, it is much more efficient to capture this minimal T3 development at the same time as T1 and T2 rather than returning to each area at another time.

2. Changes in Key Personnel

Tara King resigned her position as GIS Analyst at Maine Department of Inland Fisheries and Wildlife in October 2009. That position remains vacant due to reductions in state budgets.

Dugan Murphy, Ryan Williams, and Steven Dobrinich have assisted the project as GIS Technicians hired under temporary contracts.

3. Budget

Expenditures to Date

	U.S. EPA	State of Maine
A. Personnel	$ 62,600.14	$ 21,234.64
B. Benefits	$ 9,796.14	$ 8,493.86
C. Travel	$ 3,724.08	
D. Equipment		
E. Supplies	$ 557.83	$ 6,000.00
F. Contracts	$ 120,462.47	$ 1,000.50
TOTAL	$ 197,140.66	$ 36,729.00

Percent of Project Completed Compared to Project Schedule

Step	% Completed
Combine existing road data and existing 5-m impervious data to identify urban areas and large subdivisions for "Baseline" (2004) map	100%
Digitize buildings in rural areas and small subdivisions from 2004 imagery (modified from original goal of digitizing buildings for the entire project area to digitizing a sample of buildings to create a training data set for impervious surface analysis)	100%
Compile existing road data and digitized buildings to create 2004 "Baseline" map	100%
Conduct change-detection analysis with coarse-resolution (LANDSAT) imagery to identify areas in which development most likely occurred between the "Baseline" (2004) and "Current" (2007) maps. NOT NEEDED because the high-resolution 2007 NAIP imagery now available for the "Current" map is statewide	N/A
Acquire new, high-resolution imagery for areas in which development most likely occurred between the "Baseline" (2004) and "Current" (2007) maps. NOT NEEDED because the high-resolution 2007 NAIP imagery now available for the "Current" map is statewide	N/A
Create and QC impervious surface data for "Current" (2004) map	86%
Incorporate development maps into *Beginning with Habitat* data package	0%
Create supporting materials for *Beginning with Habitat* development maps	0%
Assess use of development data by towns and land trusts	0%

Create and QC development for "baseline" (2004) and "current"   0%
(2007) maps for remaining 14% of Production Areas.

Combine data from remaining 14% of Production Areas with the   0%
already completed 86%.

Prepare final report for project.   0%

Cost Overruns—There have been no cost overruns. We are on-track with expending funds on the steps described above.

4. Quality Assurance

The quality assurance requirements of 40 C.F.R. 30.54 and the agreement are being met by following the protocols outlined in the Quality Assurance Project Plan (QAPP) for this project. Specifically, we used the Standard Operating Procedure (SOP) "Digitizing Buildings in Organized Towns in Maine" (QAPP Appendix 1). We have developed another protocol for cleaning impervious data and hand-digitizing roads, driveways, and structures. We created a set of tools to assist with and to standardize this data capture. We are holding regular teleconference meetings with the contractor to coordinate efforts. The contractor is collecting all cleaned and digitized data into a single database and will ultimately be responsible for ensuring conformity. We also have developed a protocol for conducting QC of the final database (Appendix A).

5. Results – We have mapped development for the "Baseline" (2004) and "Current" (2007) data sets for 86% (410 / 476) Production Areas.

6. Planned Activity for July 1, 2010-June 30, 2011

MDIFW staff will continue to digitize roads and buildings for both time periods (2004, 2007) for the remaining 14% of the Production Areas. The contract with Sanborn Mapping Co. will be completed once QC of the data for the 86% of the Production Areas that are already completed. MDIFW staff will incorporate the maps into the "Beginning with Habitat" package and develop informational materials to accompany them. The maps also will be incorporated into the new "Beginning with Habitat" interactive webservice. The final report will be prepared and the project completed by June 30, 2011.

7. Publications

The State of Maine gave a presentation on this project at the September 2009 annual meeting of the Organization of Fish & Wildlife Information Managers.

8. NCER Assistance Agreement Annual Report Summary

Date of Report— July 1, 2009 – June 30, 2010

EPA Agreement Number—RD-83334501-0

Title— Mapping Regional Development for Smart Growth Planning to Minimize Degradation of Water Quality and Enhance Green Infrastructure

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Research Category—Communities and the Built Environment

Project Period—07/01/2007 – 06/30/2011

Objective of Research— Unplanned development threatens water quality and degrades ecosystems. *Beginning with Habitat*, a public-private partnership, provides local planners with maps of riparian habitats, water resources, high value plant and animal habitats, and undeveloped blocks to guide smart growth and enhance green infrastructure. Tracking development is critical for the success of this program. Unfortunately, local planners and land trusts lack the regional, long-term perspective that a map of cumulative development could provide. Further, this information could be used to assess whether communities have used *Beginning with Habitat* information to successfully guide growth away from important habitats and to protect water resources. This objective of this project is to use geospatial data to map development and provide that information to towns and land trusts to assist with smart-growth planning.

Progress Summary/Accomplishments—We contracted with The Sanborn Mapping Co. to assist with creating a "Baseline" (2004) and "Current" (2007) data set depicting roads and buildings in each time period. We have completed 86% of the project area. Data capture was slowed by an unexpected vacancy in the Maine staff working on the development mapping, so we applied for and received a 1-year, no-cost extension to complete the project.

Publications/Presentations—"Mapping Development – the Yang of Habitat," Organization of Fish and Wildlife Information Managers, Seattle, WA. Sep 2009.

Future Activities—QC data for the 86% completed part of the project area, continue capturing data for the remaining 14%. Incorporate final data sets into the *Beginning with Habitat* natural resource maps.

Supplemental Keywords— animal, aquatic, community-based, decision making, ecological effects, ecology, environmental assets, indicators, integrated assessment, Landsat, ME, modeling, monitoring, northeast, public good, sensitive populations, scaling, sustainable development, terrestrial, watersheds.

Relevant Web Sites—www.beginningwithhabitat.com, "Beginning with Habitat" interactive web mapping service (under development).

Appendix A: Development Mapping QC Process, 2010-06-24

QC process will assess:
1. Omission Error Rate for T1 (2004): proportion of true 2004 development (buildings & roads as identified in mapping protocol) that was not mapped (contractual goal was <10%; i.e., ≥90% of all true development was captured).
2. Omission Error Rate for T2 (2007): proportion of true 2007 development (buildings & roads as identified in mapping protocol) that was not mapped (contractual goal was <10%; i.e., ≥90% of all true development was captured).
3. Commission Error Rate for T1: proportion of non-development (landscape features that are not buildings and roads as identified in the mapping protocol) that was incorrectly mapped as 2004 development (contractual goal was <10%).
4. Commission Error Rate for T2: proportion of non-development (landscape features that are not buildings and roads as identified in the mapping protocol) that was incorrectly mapped as 2007 development (contractual goal was <10%).

QC sampling strategy will cover the entire project area and a variety of development densities, which will require a stratified random procedure. 1,000 QC points will be selected for each assessment as described below:
   o The project area is divided into 418 political townships that have been at least partially completed. Townships capture the variability in past, current, and future development patterns based on local economies and zoning ordinances. A QC point will be randomly selected within each township.
   o The project area is divided into 476 "production areas" based on the extent of the various imagery tiles that were used to map development. Production Areas were divided among staff in the Maine Team and Sanborn Mapping Co., so they capture the variability among image tiles (quality, resolution, etc.), between the two teams, and among all observers. A QC point will be randomly selected within each Production Area.
   o Not all townships and production areas have been mapped yet, so additional QC points will be selected at random from across the project area to bring the total sample size to 1,000 for each assessment.

Each sample point will be the center of a 2.0 km² area that will be evaluated at 1:5,000 scale for each QC assessment (this scale maximizes the view extent while still allowing reliable identification of features). We will calculate the percent error rate by the number of buildings (omission) or other features misidentified as buildings (commission) and segments of roads (omission) or other features misidentified as road segments (commission). The QC assessor will occularly estimate the combined percentages to "pass" or "fail" the sample point extent for the assessment. For example, approximately 95% of the total number of T1 buildings and total T1 road length in the sample point extent were correctly mapped as development = PASS for Assessment 1. Alternatively, approximately 20% of the T2 buildings and T2 road length in the sample point extent were other features that were misidentified as roads/buildings = FAIL for Assessment 4.

Not all sample point extents will be usable for all 4 QC assessments (e.g., an extent with no T1 development cannot be used to determine the T1 Omission Rate, but could be used to determine the T1 Commission Rate); therefore there will be more than 1,000 sample points needed to

generate 1,000 valid QC tests for all 4 assessments. Additional random points will be selected until all 4 assessments have been made within each township and each production area (which could require up to 4 different random points within the township or production area). It also is possible that an entire township may have no T1 or T2 development. In that case, extra sample points distributed randomly across the project area will be assessed to raise the total number of QC samples to 1,000 for each assessment.

QC Procedure:
1. Use the GIS tool "Hawth's Tools" to randomly locate 5 sample points within the stratification unit being tested.
    a. If the stratification unit is a township and only part of the township is within the project area, clip the township boundary to the project area
2. Center the view extent on the first sample point and zoom to 1:3,000 scale
3. Conduct Assessments:
    a. Assessment 1, T1 Omission – estimate the approximate number of T1 buildings and road length that were NOT mapped:
        i. >10%, "T1_Omission" = 'Fail'
        ii. ≤10%, "T1_Omission" = 'Pass'
        iii. No T1 development, "T1_Omission" = 'Not Tested'
    b. Assessment 2, T2 Omission – estimate the approximate number of T2 buildings and road length that were NOT mapped:
        i. >10%, "T2_Omission" = 'Fail'
        ii. ≤10%, "T2_Omission" = 'Pass'
        iii. No T2 development, "T1_Omission" = 'Not Tested'
    c. Assessment 3, T1 Commission – estimate the approximate number of T1 buildings and road length that were other features misidentified as T1 roads/buildings:
        i. >10%, "T1_Commission" = 'Fail'
        ii. ≤10%, "T1_Commission" = 'Pass'
        iii. No T1 mapping, "T1_Commission" = 'Not Tested'
    d. Assessment 4, T2 Commission – estimate the approximate number of T2 buildings and road length that were other features misidentified as T2 roads/buildings:
        i. >10%, "T2_Commission" = 'Fail'
        ii. ≤10%, "T2_Commission" = 'Pass'
        iii. No T2 mapping, "T2_Commission" = 'Not Tested'

    For each assessment that Passed or Failed, copy the sample point into "RandomPoints" feature class and attribute with the appropriate assessment.

    For each assessment that was Not Tested, go to Step 4

4. Repeat steps 2 for the next random sample point, then Step 3 for any 'Not Tested' assessments. Continue through the 5 random points as needed to complete all the assessments. If some assessments could not be completed because the random point

extent did not include any actual development (omission assessments) or any mapped development (commission assessments), then:

   a. If there is any actual (or mapped) development in the stratification unit being tested, subjectively locate a sample point near it and complete the needed assessment.
   b. If there is no actual (or mapped) development in the stratification unit, set that assessment value to 'Not Applicable.'

5. Repeat steps 1-4 for all townships and production areas. Tally the number of completed samples for each assessment, then repeat steps 1-4 by locating points randomly throughout the project area until there are 1,000 completed QC sample points for each assessment.

6. Tabulate the proportion of 'Pass' samples for each assessment. If ≥900, the assessment passes.