A Progress Report

Quantification of Spatial Change of the Natural Areas in NPCA Watershed from 1934 to 2010

AML Solutions

Project Manager: Hailey Gullett

GIS Analyst: Andrew Lipinski

Niagara Peninsula Conservation Authority

Client Representative: Tara Metzger

NIAGARA PENINSULA CONSERVATION AUTHORITY

AML SPATIAL SOLUTIONS

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Project # GISC 201212-04
March 19TH, 2014

MS. Tara Metzger
Niagara Peninsula Conservation Authority
250 Thorold Road
Welland, ON
L3C 3W2

Dear Ms. Metzger

RE: Project #GISC 201212-04 – Progress Report: Quantification of Spatial Change of the Natural Areas in the NPCA Watershed from 1934 to 2010

Please accept this progress report for the Quantification of Spatial Change of the Natural Areas in the NPCA watershed from 1934 to 2010. Outlined within this progress report is a summation of the key accomplishments to date, and any variations in the schedule and budget, and finally any risks and constraints AML Spatial Solutions encountered.

AML Spatial Solutions is eager to update you on the progress made for the given opportunity. We are enthusiastic to remain ahead of schedule and below budget to date, and looking forward to the successful completion of the project in June, 2014.

The overall goal of the Quantification of Spatial Change of the Natural Areas in the NPCA Watershed from 1934 to 2010 project remains estimated be completed in June 2014 and have a revised estimated budget of $33,282.42

Should have any further questions or concerns do not hesitate to contact AML Spatial Solutions at gullett.h@gmail.com or (905) 933 9551.

Sincerely,

Hailey Gullett-Project Manager
GIS-GM Candidate

HG/al
Cc: Andrew Lipinski, Xinxia Jiang

Enclosures: 1) Project Progress Report- Quantification of Spatial Change of the Natural Areas in the NPCA Watershed from 1934 to 2010

Executive Summary

Geographical Information Systems are very useful in determining spatial change, and quantifying spatial analysis (Johnston, Ver Hoef, Krivoruchko, & Lucas, 2001). With the use of Esri's ArcMap as an investigation platform, AML Spatial Solutions has begun to create a spatial inventory for 1934 of the changes that have taken place within the Niagara Peninsula Conservation Authority (NPCA) Watershed until 2010. This project will be completed by June 13, 2014, as requested by the Niagara Peninsula Conservation Authority. The project study will take place within the NPCA jurisdiction which includes all of the Niagara Region, part of the City of Hamilton and part of Haldimand County.

AML Solutions consultants are Hailey Gullett and Andrew Lipinski, with Dr. James Jiang being the project advisor. This report outlines the project management achievements, and current status of all aspects of the project. The project management phase began in October 2013 and will continue to be carried out for the remainder of the project. All of the data that has been obtained until this point in the project, and a proposal has been presented and accepted. AML Spatial Solutions is proud to update the client that 32% of the project has been completed at this point.

The success of this project is reliant upon the completion of remaining phases and objectives defined within the report. AML Spatial Solutions will continue quality project management, continue to update a spatial inventory and perform analysis, and summarize the project in June 2014. There has been an updated schedule and budget for the project, as of the submission date of this report, AML Spatial Solutions is $600.00 below budget and approximately 18% ahead of schedule.

The anticipation challenges for the remainder of the project are any georeferencing inaccuracies in the 1934 orthoimagery, there are certain areas within the NPCA's jurisdiction that 1934 orthoimagery contain gaps between tiles. AML Spatial Solutions will use their best judgment to determine if there are any natural areas where these gaps exist. One last challenge AML Spatial Solutions encountered is missing 1934 imagery for parts of Haldimand County and the City of Hamilton, this will be managed by altering the scope of the project. AML Solutions will continue to create the spatial inventory excluding the parts that are missing. These watershed planning areas will not contain complete statistics.

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1.0 Introduction

AML Spatial Solutions has been given the opportunity to update the progress within a project involving the quantification of spatial change concerning natural areas within the Niagara Peninsula Conservation Authority's (NPCA) watershed. This study will identify and quantify the spatial change of natural areas between 1934 and 2010 within the NPCA's jurisdiction. This study has involved the use of Esri's ArcGIS software with all data and previously created inventories supplied by the NPCA. AML Spatial Solutions continues to exhibit determination to complete a project that will greatly benefit the NPCA by providing scientifically defensible data for use in planning and policy development, identifying areas of habitat loss, gain and fragmentation as well as, allow for the development of greater environmental awareness within the community.

1.1 Niagara Peninsula Conservation Authority (NPCA)

The Niagara Peninsula Conservation Authority (NPCA) was established on April 30th 1959 under the Conservation Authorities Act. The NPCA serves roughly half a million people in a jurisdiction known as the Niagara Peninsula Watershed (NPCA, 2013) (Figure 1, pg.2). When established the driving force behind the conservation movement was the organizations grassroots programs surrounding land stewardship and water quality and protection (NPCA, 2013). Now, the Niagara Peninsula Conservation Authority's commitment to these grassroots programs is vital as it strives to manage the impacts of human activities, urban sprawl, habitat destruction and rural activities within its jurisdiction (NPCA, 2013).

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Figure 1: Niagara Peninsula Conservation Authority Jurisdiction

1.2 Project Background

AML Spatial Solutions is eager to update the client on the progress made thus far in identifying changes in natural areas using 1934 and 2010 orthoimagery for the entire jurisdiction. Ultimately, quantifying the level of natural area habitat change and fragmentation in the NPCA Watershed will lead to numerous benefits that support the organizations mandate.

1.2.1 Study Area

As mentioned above the Niagara Peninsula Conservation authority oversees a jurisdiction that serves roughly half a million people. This jurisdiction, known as the NPCA watershed is the location of AML Spatial Solutions' study area. The Study area encompasses all of the Niagara Region, the southeast corner of the city of Hamilton and the Northeast portion of Haldimand County. The jurisdiction is broken up into sub watersheds which are based on the region's major bodies of water. The NPCA watershed and its subwatershed can be seen in Figure 2 on page 3. Unfortunately, the study area has been minimized as a result of certain 1934 orthoimagery. This challenge forces an outcome of the western subwatersheds within the

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Upper Welland River Watershed and Lake Ontario South Shore to be removed from the scope of the project.

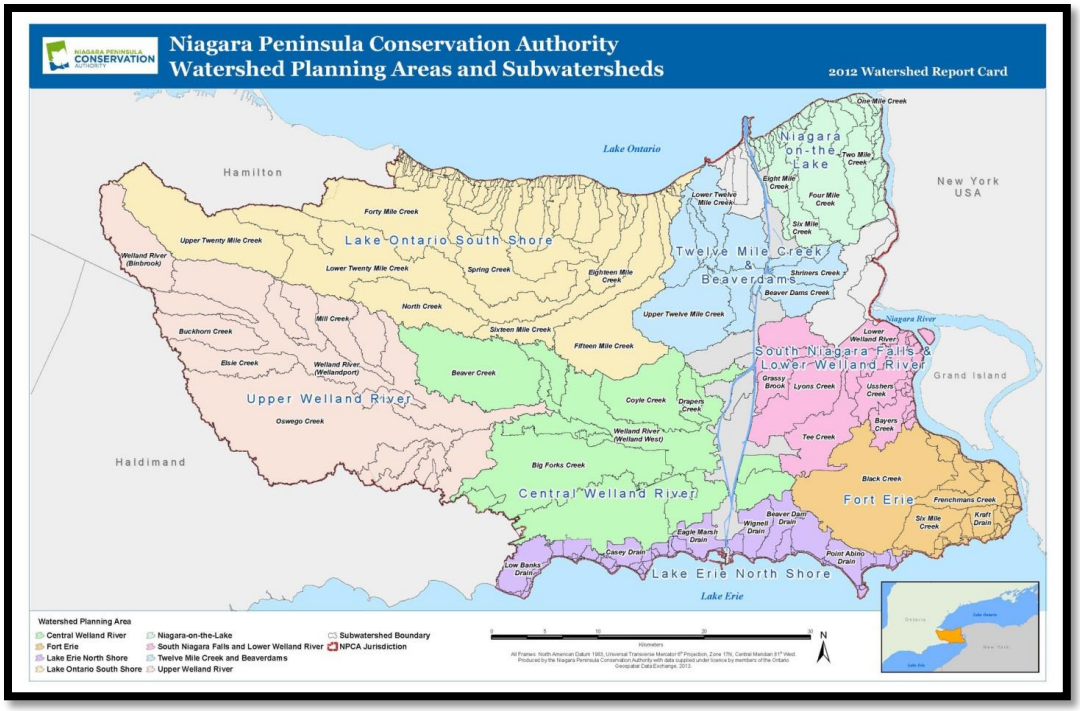

Figure 2: Niagara Peninsula Conservation Authority's Subwatersheds and Study Area

1.3 Client Requirements

The Niagara Peninsula Conservation Authority now requires a geodatabase that will contain layers of feature classes that display the spatial change and fragmentation of these natural areas between 1934 and 2010, the year the NAI was completed. This geodatabase will serve to help the NPCA quantify and better understand the changes that have occurred in their jurisdiction. Staff at the NPCA will be able to easily identify areas and the degree of natural areas change, actual and potential locations of old growth forest and finally habitat associated with at risk species.

AML Spatial Solutions will report identified areas and degrees of change based on the NPCA's designated watershed planning areas, as well as provide cartographic products and statistics that outline the level of change.

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1.4 Project Benefits

The leading benefits from performing this project include:

- An updated spatial inventory of natural areas
- Quantification of changes of natural areas from 1934 to 2010
- Identification of areas containing old growth forests within the NPCA jurisdiction
- Visual comparison of natural area changes from 1934 to 2010
- Identification of potential rare species habitat
- Assistance in planning and policy decision making
- Assistance in NPCA forestry department in guiding logging practices
- Supporting sustainable forestry practices
- Identification of potential areas for reconnaissance surveys

2.0 Key Accomplishments

AML Spatial Solutions is eager to present the details of what has been accomplished to date, which phases are completed or have begun. Within this section are the specifics of baseline time and budget during proposal, and then actual time and budget required for completion of phases and tasks within these phases. Figure 3 on page 5 illustrates the tasks AML Spatial Solutions has completed as those highlighted in red. The tasks that are green are those that are ongoing, or yet to be completed.

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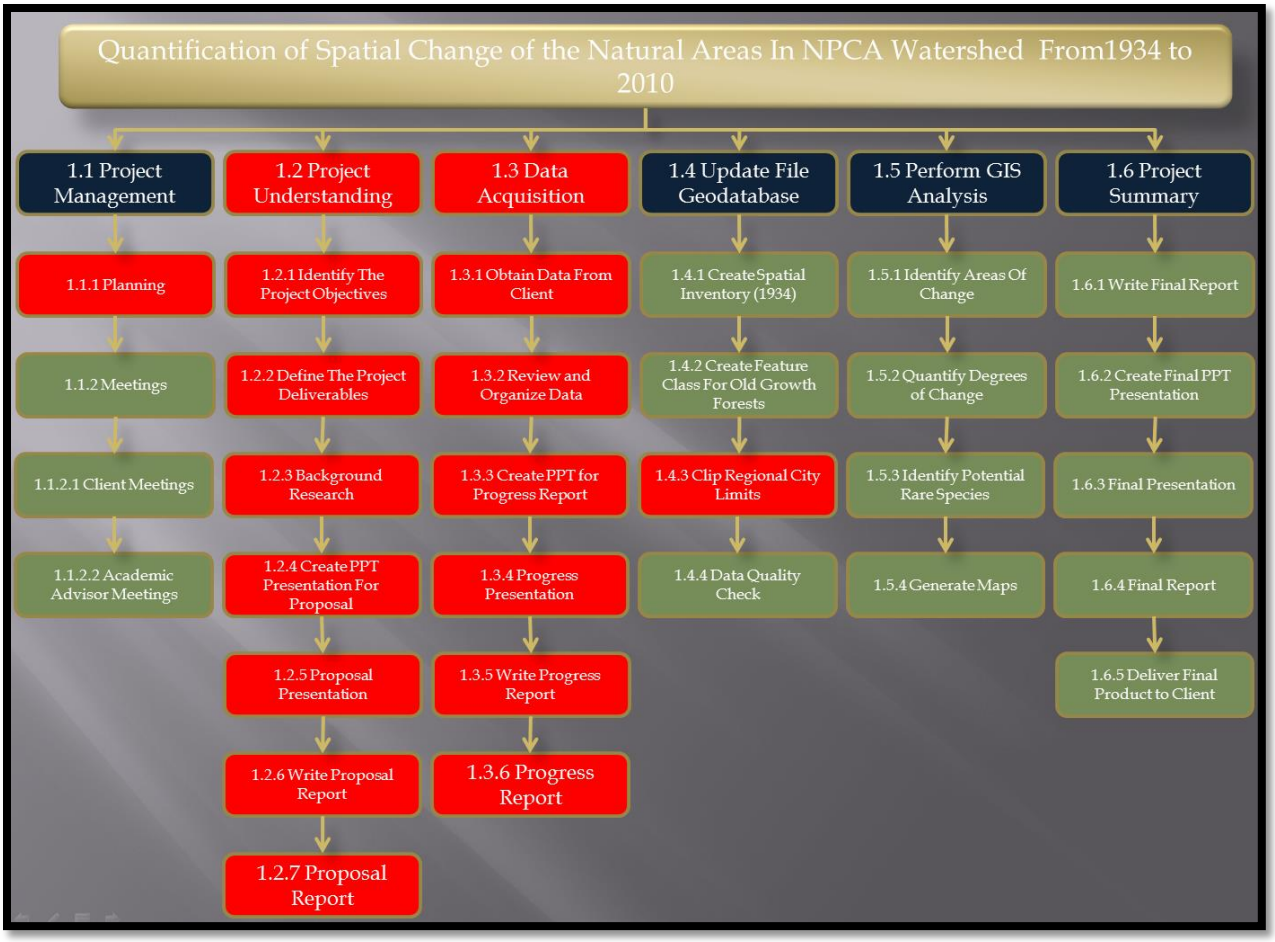

Figure 3: Work Breakdown Schedule with Completed Tasks Highlighted

2.1 Goal

The primary goal of this project will focus on creating a database containing a spatial inventory surrounding natural habitats within the NPCA Jurisdiction. The NPCA will possess statistics that quantify the levels of natural habitat change and fragmentation within the watershed using historical and current orthoimagery along with an updated natural areas inventory.

2.2 Primary Objectives

In order to satisfy the requirements of this project, critical objectives must be met. AML Spatial Solutions will take the time to create a spatial inventory of natural area habitat change from 1934 to 2010, report identifying areas of and degrees of change by municipality including

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nature of change (+,-, change in density), and create maps and statistics that identify the levels of change.

2.3 Project Management

Project management is the first or initial phase of the project and will be ongoing throughout the duration of the study. This phase began on October 4th of 2013 shortly after the team's initial meeting with the client and is expected to be completed at the close of the project. Project management consists of two main subtasks, planning and meetings. 59 percent of this phase has been completed thus far totaling twenty three and half person hours and costing $1,950.00. Table 1 below outlines the key dates, person hours and costs of this phase.

Table 1: Project Management Phase Progress Breakdown

Start Date	Friday October 4th, 2013
Proposed End Date	Monday June 9th , 2014
Proposed Time (Person Hours)	44 Hours
Work to Date (Person Hours)	23.5 Hours
Work Remaining (Person Hours)	16.5 Hours
Proposed Cost	$3,750.00
Actual Cost	$1,950.00

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2.3.1 Planning

The planning subtask has already been completed and entailed AML Spatial Solution determining a basic understanding of the project and identification of broad methods required for its completion. This subtask was completed during the early stages of the project shortly after the services of AML Spatial Solutions were retained by the Niagara Peninsula Conservation Authority.

2.3.2 Meetings

The second subtask of this phase involves meetings that will run the entire length of the project. Client meetings were scheduled to occur monthly however, with bi-weekly updates and contact with the client only one meeting was required to discuss project progress to date. The time allotted for these meetings remained the same as AML Spatial Solutions utilized these slots to complete the bi-weekly progress reports. Academic advisor meetings occur bi-weekly and utilized the resources of James Jiang in order to discuss reports on project progress.

2.4 Project Understanding

Project Understanding was the second phase of the project and consisted of seven main subtasks. These included, identifying the project objectives, defining the project deliverables, background research, creating a proposal presentation, writing the proposal report and finally, submission of the proposal report. This phase of the project has been completed as of the proposed end date of December 13th, 2013. This phase of the project took slightly longer for AML Spatial Solutions to complete and cost $150 dollars more than expected. Table 2 below outlines the key dates, person hours and costs of this phase.

Table 2: Project Understanding Phase Progress Breakdown

Start Date	Monday November 4th , 2013
End Date	Friday December 13th , 2013
Proposed Time (Person Hours)	44 Hours
Actual Time (Person Hours)	42Hours
Proposed Cost	$3,150.00
Actual Cost	$3,300.00

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2.4.1 Identifying Objectives

The initial task of this phase was to identify the project objectives. These objectives were outlined in the original Project Overview Statement (POS) provided to us by Tara Metzger and the NPCA. A copy of this POS can be found in Appendix D.

2.4.2 Defining Deliverables

The next major task of this phase was to identify the key deliverables and milestones of the project. These milestones can be seen in table 3 below. The Three milestones comprise of the project proposal which has been completed as of the proposed completion date of Friday December 13th, 2013, project progress report which has also been completed as of the proposed completion date of March 19th, 2014 and the final report and presentation which is proposed to be completed on June 13th, 2014. Table 3 below outlines the major milestones and deliverables associated with each of these milestones.

Table 3: Outline of Key Objectives & Deliverables

Milestone 1: Project Proposal
• **Deliverable 1.1: Gantt chart.**
• **Deliverable 1.2: Project proposal.**
• **Deliverable 1.3: Proposal presentation.**
Milestone 2: Project Progress Report
• **Deliverable 2.1: Progress report.**
• **Deliverable 2.2: Progress report presentation.**
• **Deliverable 2.3: Maps of processed data.**
Milestone 3: Final Report and Presentation
• **Deliverable 3.1: Prepare maps of clipped area by city within the NPCA jurisdiction.**
• **Deliverable 3.2: Prepare maps which quantify spatial change and variations in natural areas within the NPCA jurisdiction.**
• **Deliverable 3.3: Geodatabase with feature layer indicating areas of change.**
• **Deliverable 3.4: Final report and presentation.**

2.4.3 Conducting Background Research

Background research is an essential part of any project and is required in order to understand the project. AML Spatial Solutions has completed this phase of the project by thoroughly

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researching various academic journals surrounding spatial analysis as well as, investigating the Natural Heritage Areas Inventory report provided to the company by Tara Metzger and the NPCA. This task required slightly more person hours and budget than previously expected. It is important to note that although initial research is 100 percent complete, the research process is ongoing throughout the project as new challenges arise and mitigation strategies are developed.

2.4.4 Proposal Presentation

The project proposal presentation consisted of the delivery of primary objectives, methodologies and proposed milestones to the Niagara Peninsula Conversation authority and their representative Tara Metzger. AML Spatial Solution has completed this task as of the prescribed completion date of December 12th, 2014.

2.4.5 Proposal Report

Similar to the proposal presentation the proposal report outlined in further detail the primary objectives, deliverables, methodologies and challenges that may be face by AML Spatial Solutions while executing the remaining phases of the project. The proposal report was delivered to the client on the prescribed date of completion, December 13th, 2013.

2.5 Data Acquisition

The data acquisition phase of the project began on Friday October 4th and coincident with AML Spatial Solutions initial meeting with the client. This phase ran into the first few months of the New Year and as of March 19th, 2014 can be considered 100 percent complete. This phase was completed 2 days before the proposed completion date of March 21st, 2014 and was an hour and 75 dollars under the predicted cost and time values. Table 4 on page 10 outlines the key dates, person hours and costs of this phase.

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Table 4: Data Acquisition Phase Progress Breakdown

Proposed Start Date	October 4th , 2013
Proposed End Date	March 21st , 2014
Actual End Date	March 19th, 2014
Proposed Time (Person Hours)	32 Hours
Actual Time (Person Hours)	31 Hours
Proposed Cost	$2,400.00
Actual Cost	$2,325.00

2.5.1 Obtaining, Reviewing, Mosaic & Organizing Data

The first subtask of this phase was the acquiring of data required for the execution of the project. This primary data was provided to the team by Tara Metzger of the NPCA at the initial client team meeting on October 4th 2013 and consisted of 122 1934 orthoimagery tiles and reference material. Additional orthoimagery data was required in order to complete the goals and this was provided to the team after their proposal presentation from the client. Data such as watershed planning areas and the 2010 Natural Areas Inventory was acquired by AML Spatial Solutions through an NPCA FTP set up to facilitate the project. AML Spatial Solutions then mosaicked the 122 tiles provided by the NPCA. This was an essential task as it will facilitate the updating of the spatial inventory. Figure 4 on page 11 illustrates the results from the mosaicking of 1934 orthoimagery. Once data all data was obtained from the client and the FTP site AML Spatial Solutions proceeded to review all of the data needed for the project.

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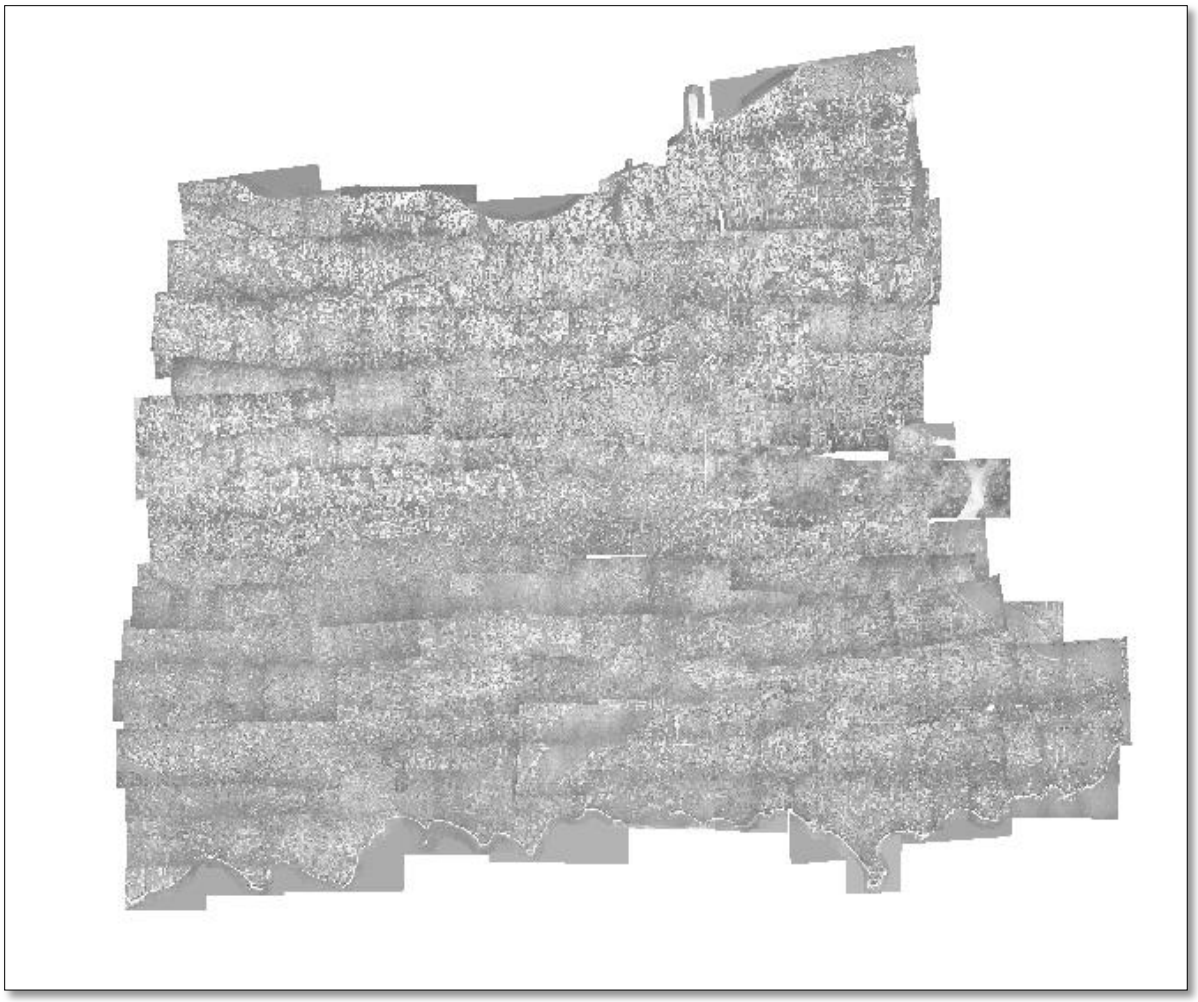

Figure 4: Mosaicked 1934 Orthoimagery

2.5.2 Create & Deliver Progress Presentation and Report

The last task of this phase was the creation and presentation of project progress to date. This was completed on March 15th, 2014 and outlined the major task completed, budget, work remaining and challenges faced by AML Spatial Solutions while performing the first phases of the project. Subsequently, the progress report was written summarizing in more the progress of the project. This was completed on the prescribe date of March 19th, 2014 and will be submitted to the client representative Tara Metzger for review.

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2.6 Updating Spatial Inventory

Phase four, updating the spatial inventory and its subtasks are essential in order to successfully accomplish the goals of the project. This phase is not only the most labor intensive but also the most costly. AML Spatial Solutions was able to begin this phase of the project prior to the prescribe commencement date of March 17th, 2014. This phase is 8 percent complete with 164 person hours still remaining. The cost incurred to this date performing this phase is $1,125.00. Table 5 below outlines the proposed start and end times of this phase along with the proposed man hours and cost.

Table 5: Updating Spatial Inventory Phase Progress Breakdown

Proposed Start Date	March 17th, 2014
Actual Start Date	April 12th, 2014
Proposed End Date	April 30th 2014
Proposed Time (Person Hours)	184 Hours
Work To Date (Person Hours)	15 Hours
Work Remaining (Person Hours)	164 Hours
Proposed Cost (Labor and Materials)	$13.800.00
Cost To Date	$1,125.00

2.6.1 Creating Feature Classes for Watershed Planning Areas

The next major task of this phase completed by AML Spatial Solutions was the creation of feature classes for each of the sixteen NPCA watershed planning areas. This was completed using Esri's ArcMap as a study platform. Each one of the planning areas was selected from the provided watershed planning area shapefile. From this selection a new feature class was created for each of the watershed planning areas respectively. AML Spatial Solution technicians then exported each newly created watershed feature class to the study geodatabase. This was an essential task as these feature class will not only allow for the even distribution of workloads but more importantly, will be the basis for which AML Spatial Solutions performs their analysis. Natural Areas inventories will be updated by watershed planning area and maps and statistics

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will be derived from these feature classes. Figure 5 below illustrates the creation of a new feature class from the watershed planning area shapefile.

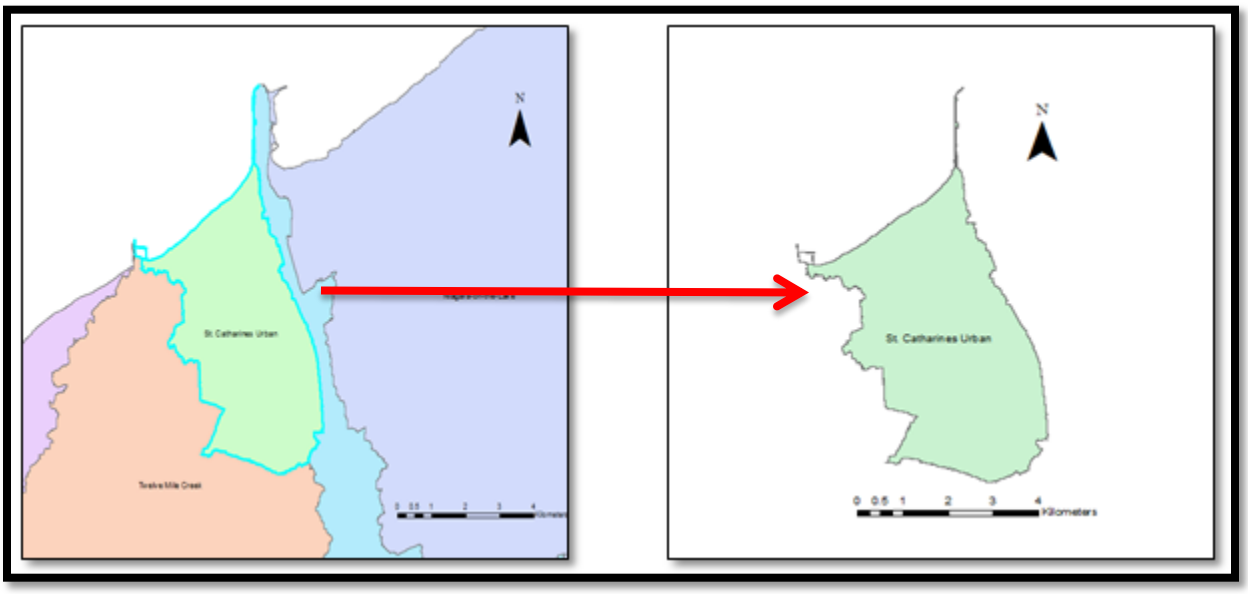

Figure 5: New Feature Class Clip

2.6.2 Clipping NPCA Designated Watershed Planning Areas

The last major task of this phase was the clipping of the 2010 natural areas inventory to each of the watershed planning area feature classes. This was completed using ArcMaps clip geoprocessing tool and was a crucial task to the progression of the project. The spatial distribution of natural areas in 1934 will be identified through the use of the 2010 NAI and 2010 orthoimagery. If an area exist on both the 2010 NAI and the 1934 orthoimagery technicians will update the polygon to match the spatial distribution of the habitat in 1934. Similar to creating a new feature class for each of the watershed planning areas, clipping the NAI to these boundaries will be essential when illustrating and quantifying the spatial change of natural habitats for each watershed planning area. Sample cartographic products can be found in of this report.

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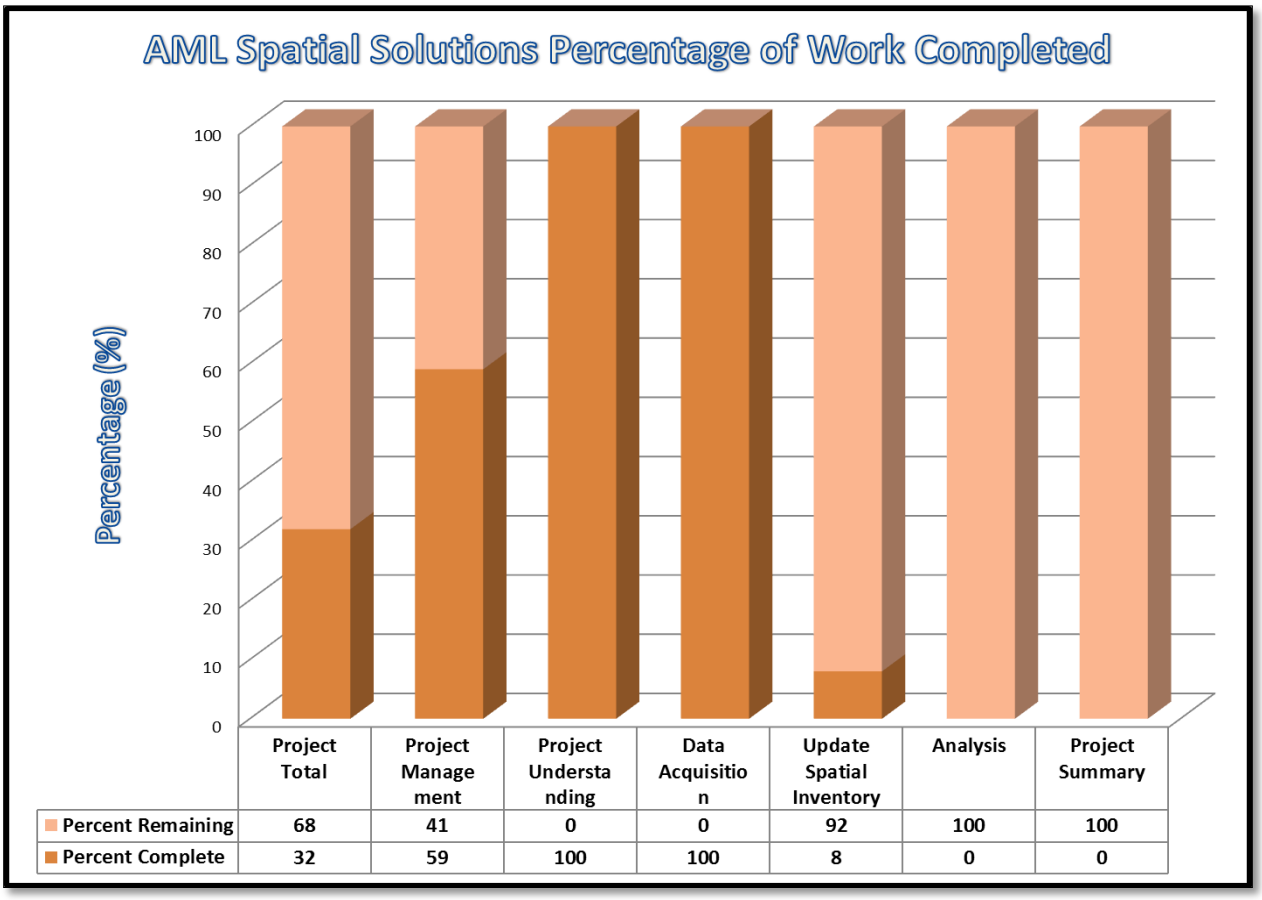
3.0 Future Work

After completing the initial phases of the project AML Spatial Solutions is preparing to execute the entire remaining task effectively in order to complete the project on time, on budget and provide the NPCA with a high quality product. The following subsections will examine in detail the work that is remaining in order to accomplish the project. Figure 6 below illustrates the work that has been completed by AML Spatial Solution and the percentage of work remaining in each phase of the project.



	Project Total	Project Management	Project Understanding	Data Acquisition	Update Spatial Inventory	Analysis	Project Summary
Percent Remaining	68	41	0	0	92	100	100
Percent Complete	32	59	100	100	8	0	0

Figure 6: Percentage of Work Completed and Remaining

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3.1 Project Management

As mentioned in section 2.3 of this report the project management phase is ongoing throughout the duration of project. The remaining 41 percent of this phase can be attributed to upcoming client and advisor meetings as well as the completion of bi-weekly progress reports.

3.2 Update Spatial Inventory

With only 8 percent of this phase complete AML Spatial Solutions will place their time and resources in the execution of the remaining 92 percent of this phase. Perhaps the most important portion of the project, this phase still has 164 person hours remaining and will incur further costs of $12,300.00. The following subsections will review the tasks required to complete this phase of the project.

3.2.1 Create 1934 Natural Areas Inventory

This task necessitates the creation of a natural areas inventory that illustrates the spatial distribution of natural areas in 1934. This will be accomplished by using 1934 and 2010 orthoimagery along with the 2010 natural areas inventory. AML Spatial Solutions will examine the distribution of natural habitats between the two respective years and identify the habitats that exist in both 1934 and 2010. This is not only the most expensive and labor intensive undertaking of the project, but more importantly the basis from which all statistics and recommendation will be derived.

3.2.2 Identify Potential Old Growth Areas

After the creation of the spatial inventory AML Spatial Solutions will attempt to identify potential old growth forest locations within the entire NPCA jurisdiction. The basic definition for what categorizes old growth forest varies widely from a hundred years to a few hundred years. The scope of the project only spans 76 years, however, organizations such as the NPCA and the Bert Miller Foundation will be able to identify potential areas to investigate the presence of old growth forest within the jurisdiction.

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3.2.3 Data Quality Check

The final task of this phase of the project will be to perform a data quality check. This requires AML Spatial Solution technicians to review the updated 1934 spatial distribution of natural areas in order to ascertain whether any crucial errors or misclassifications have occurred when creating the natural areas inventory for each of the watershed planning areas. Spatial data absent of any errors will be essential before continuing to the following phases of the project.

3.3 Perform Analyses

Phase five of the project, like phase four which it complements, is a vital stage of the project in order to provide the client with the goals and objectives required to successfully complete the project. This stage involves the analysis of the updated spatial inventory created in the previous phase. Table 6 below outlines the start and end date of Phase 5 and the proposed cost and man hours required for the completion of this stage.

Table 6: Perform Analysis Phase Progress Breakdown

Proposed Start Date	May 5th, 2014
Proposed End Date	Thursday May 20th, 2014
Proposed Time (Person Hours)	36 Hours
Proposed Cost	$2,700.00

3.3.1 Identify Areas of Change

The first task of this phase will be to identify the spatial change and fragmentation of natural habitats in the NPCA jurisdiction between 1934 and 2010. This will be accomplished by creating maps that illustrate the natural areas in 1934 and in 2010.

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3.3.2 Quantify Degrees of Change

The second subtask of this phase will be to quantify the amount of change within each watershed planning area. This will be accomplished by extracting statistical totals of each spatial inventory for both the 1934 and 2010 layers. The difference between the statistical totals of both the 1934 and 2010 layers respectively, will easily demonstrate whether there existed a positive or negative change between the natural areas. AML Spatial Solutions hypothesizes that most watershed planning areas within the jurisdiction, despite efforts by the NPCA and grassroots organizations, will exhibit a net decrease in natural habitat areas from 1934 to 2010. This can be attributed predominantly to urban growth of major centers and land use changes within the jurisdiction.

3.3.3 Generate Maps

The final task of this phase will be the creation of numerous cartographic products that illustrate the results of the project. The spatial distribution of natural areas for each year will be explained through the use of cartographic products. These maps will be high quality products that exhibit all elements of cartographically sound maps.

3.4 Project Summary

The project summary is the last phase of the project and involves AML Spatial Solution preparing a final product that will be delivered to the client. The first subtask of this phase will be to create a formally written final report that will provide all of the required deliverables and objectives to the Niagara Peninsula Conservation Authority. The second task will be to create a final presentation. This will be formally presented to the client on the specific date give. Table 7 on page 18 outlines the start and end dates of phase six, along with the proposed man hours and cost.

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Table 7: Project Summary Phase Progress Breakdown

Proposed Start Date	May 21st , 2014
Proposed End Date	June 13th , 2014
Proposed Time (Person Hours)	29 Hours
Proposed Cost	$2,175.00

3.4.1 Final Report

A final report is the final product to be delivered to the client, AML Spatial Solutions is eager to provide the NPCA with an accurately detailed final report containing all required statistics and cartographic products.

3.4.2 Create & Deliver Final Presentation

Creating a final presentation is a crucial part of this project. AML Spatial Solutions looks forward to creating a presentation that describes the project at completion. The presentation will be given to colleagues, instructors, clients, and any general public who are interested in the project opportunity.

3.4.3 Deliver Final Product to Client

Finally, AML Spatial Solutions will present the client with the final report consisting of all requirements. The NPCA will be able to use the final product in many different aspects of the organizations mandate.

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4.0 Schedule Status

Below is a table outlining the schedule created for project completion during the initial planning phase, the columns within the table compare the proposed start and finish dates for each phase with the actual dates until the submission of the progress report. The variance column in the table supports the statement that AML Spatial Solutions is roughly 18% ahead of schedule.

Table 8: Progress Schedule Breakdown

Major Task	Proposed Start Date	Proposed End Date	Proposed Person Hours	Actual Start Date	Actual End Date	Actual Person Hours	Variance
Project Management	10/4/2013	6/9/2014	44	10/4/2013	6/9/2014	23.5	-16.5
Understand the Project	11/4/2013	3/10/2014	42	11/4/2013	12/13/2013	44	2
Data Acquisition	1/6/2014	3/21/2014	32	1/6/2014	3/19/2014	31	-1
Update Spatial Inventory	3/17/2013	4/30/2014	184	3/17/2014	4/30/2014	15	n/a
Perform GIS Analysis	5/5/2014	5/20/2014	36	5/5/2014	5/20/2014	n/a	n/a
Project Summary	5/21/2013	6/13/2013	29	5/21/2014	6/13/2014	n/a	n/a

5.0 Financial Details

Table 9 on page 20 displays the details of the project budget alterations that have taken place during the progress AML Spatial Solutions has made. The table is divided based on major tasks defined for successful completion.

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Table 9: Progress Financial Status Outline

Major Task								
Task								
	Planned Value	**Earned Value**	**Actual Cost**	**Schedule Variance**	**Cost Variance**	**Estimated Cost at Completion**	**Baseline Cost at Completion**	**Variance in Actual Cost**
Project Management	$2,400.00	$2,250.00	$1,950.00	$150.00	$300.00	$3,250.00	$3,750.00	$500.00
Understand the Project	$3,150.00	$3,150.00	$3,300.00	$0.00	$150.00	$3,300.00	$3,150.00	$150.00
Data Acquisition	$1,969.23	$2,104.52	$2,044.24	$135.29	$60.28	$2,331.26	$2,400.00	$68.74
Update File Geodatabase	$175.64	$1,500.00	$1,125.00	$1,324.36	$375.00	$10,350.00	$13,800.00	$3,450.00
Perform GIS Analysis	$0.00	$0.00	$0.00	$0.00	$0.00	$2,700.00	$2,700.00	$0.00
Project Summary	$0.00	$0.00	$0.00	$0.00	$0.00	$2,175.00	$2,175.00	$0.00
Project Totals	**$7,694.87**	**$9,004.52**	**$8,419.24**	**$1,309.64**	**$585.28**	**$26,156.67**	**$27.98**	**$1,818.33**

AML Solutions would like to briefly describe each of the variables outlines in the table.

Planned Value: budgeted cost of work scheduled.

Earned Value: budgeted cost of work performed.

Actual Cost: actual cost of work performed.

Schedule Variance: the difference in cost of terms between the current progress and the baseline plan of a task.

Cost Variance: the difference between how much it should have cost and how much it actually cost to achieve the current level of completion to date.

Estimated Cost at Completion: the expected total cost of a task based on performance to date.

Baseline Cost at Completion: the total planned cost.

Variance in Actual Cost: the difference between baseline cost at completion and estimated cost at completion.

(Office, 2010).

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5.1 Earned Value Assessment

AML Spatial Solutions decided that an Earned Value Assessment would be the most effective method of understanding the progress of the project to date. An earned value assessment measures the completed work of the project against the predicted cost and schedule. The three variables required for this assessment method are cumulative planned value, cumulative actual value, and cumulative actual cost until this point in the project. Figure 7 on the following page allows for a visualization of this assessment.

The vertical axis below describes the monetary value of the project variables, while the horizontal axis describes the timeline for each specific variable. It can be seen that the earned value variable is currently at the highest cost amount. This is indicative that AML Spatial Solutions has not only completed more work than projected, but also for less of an expense than planned. This facilitates the project remaining ahead of schedule and under budget.

The pattern shown below indicates that the project has remained consistent since progress started being completed. The only variation in the assessment is the most recent progress that has been made; this is most likely a result of AML Spatial Solutions completing significant objectives.

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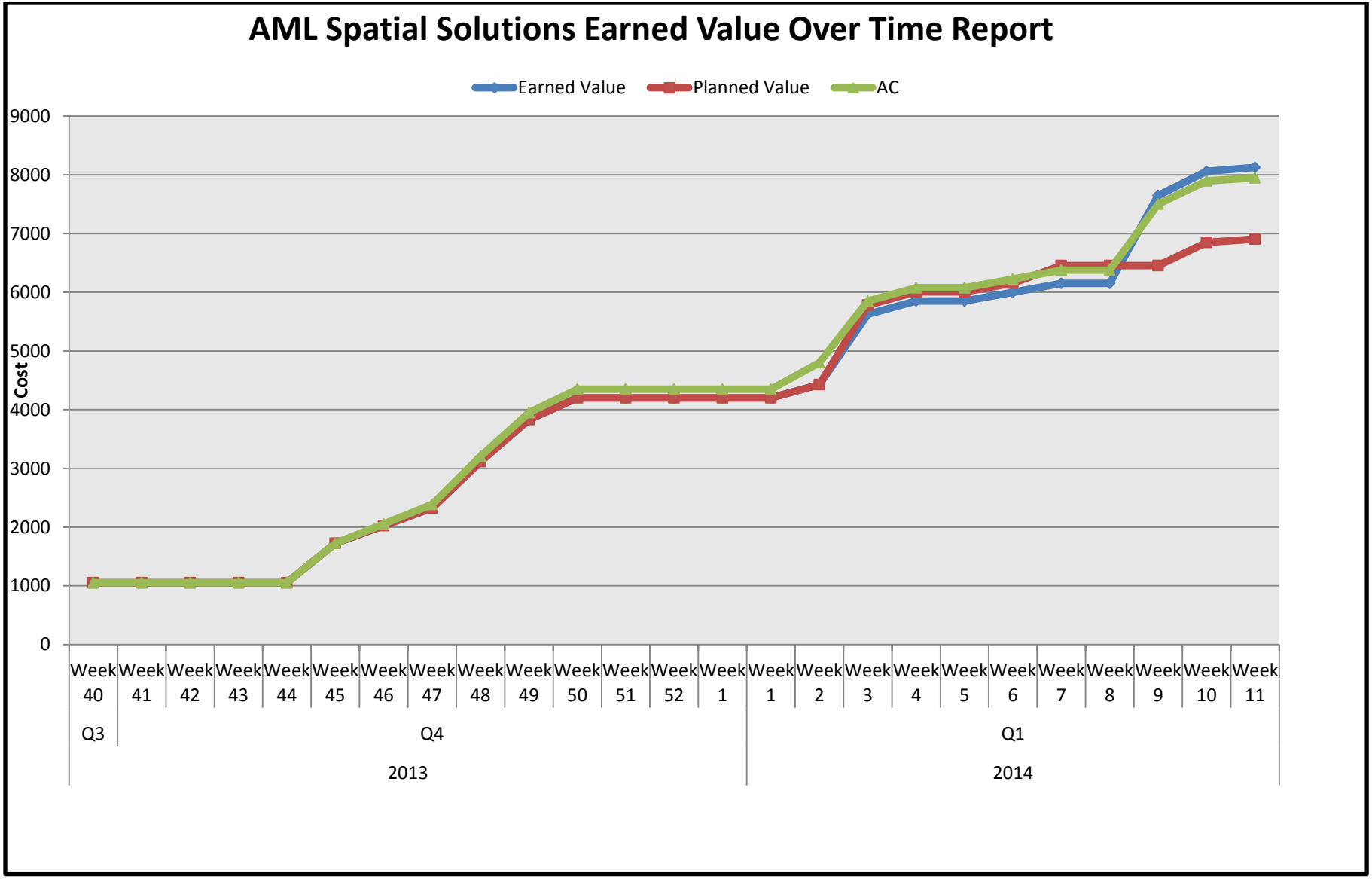

Figure 7: Earned Value over Time Report

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6.0 Challenges & Management

At this point in the report, AML Spatial Solutions would like to provide a framework of the challenges faced during progress, as well as any foreseen challenges. With further investigation, AML Spatial Solutions provides management strategies for each challenge faced and each challenge expected.

6.1 Challenges Encountered

AML Spatial Solutions significant progress since October did not occur without any challenges. These challenges include navigating throughout the 2010 orthoimagery, creating a mosaic of the 1934 orthoimagery, and a lack of 1934 orthoimagery tiles within the Haldimand County and City of Hamilton watershed planning areas.

6.1.1 Navigating throughout the 2010 Orthoimagery

The first key accomplishment since the proposal of this project is building pyramids for 2010 orthoimagery. This task became necessary while navigating throughout the 2010 orthoimagery, loading the tiles while steering through them consumed a large amount of time. This required AML Spatial Solutions to conduct research on the issue, the result was sacrificing storage space on the hard drive for better navigation by building pyramids. Through trial and error, a pyramid level of 9 was chosen as this level required the least amount of storage space while allowing for simple and rapid navigation. As suggested by Esri's ArcGIS resources, a resampling technique of bilinear interpolation was chosen for building pyramids within aerial imagery (Esri, 2014).

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6.1.2 Creating a Mosaic of the 1934 Orthoimagery

The second challenge encountered throughout the progress is the mosaicking of the 1934 orthoimagery. AML Spatial Solutions attempted to mosaic the 122 tiles at once and had an unsuccessful result after a significant amount of waiting time. The solution to this was to mosaic the tiles together by municipality; this was successful and then had just 13 mosaicked tiles to work with rather than 122. AML Spatial Solutions again researched the most effective method to mosaic these 13 images and concluded that creating a mosaic dataset before mosaicking the images was the recommended approach. This method was successful and as a result the mosaicked 1934 orthoimagery could be added to the key accomplishments.

6.1.3 Missing Tiles in 1934 Orthoimagery

The final major challenge faced during the progress phase of the project was missing tiles in the Haldimand County and City of Hamilton watershed planning areas. Although this was disappointing to AML Spatial Solutions, there was a management plan generated. AML Solutions contacted the client and an agreement was made to slightly alter the scope of the project and omit these parts of the watershed planning areas where there are not tiles.

6.2 Anticipated Challenges

As with any project, risks and challenges are inevitable. AML Spatial Solutions has anticipated numerous challenges that may be faced while executing the remaining phases of the project. It becomes essential that these challenges are identified and potential mitigation strategies determined prior to the commencement of future work. The following sections will examine in detail the anticipated challenges and the associated mitigation strategies that will be employed by AML Spatial Solutions.

6.2.1 Georeferencing Inaccuracies

While conducting the initial phases of the project it was quickly discovered by technicians that georeferencing inaccuracies existed with a number of the 1934 Niagara region orthoimagery tiles. Although minor, these inaccuracies merited further investigation by the team. Upon

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examination it was determined that some tiles did not match the 2010 imagery and natural areas inventory. In order to create the updated 1934 spatial inventory it is essential that technicians are able to identify and match natural areas in 1934 to those in 2010. Thus, it became essential that a strategy was determined to allow for the identification of corresponding natural areas.

It was quickly determined by AML Spatial Solutions that this challenge was easily mitigated. Since the georeferencing errors were not extreme it was easy to identify the slight differences in the spatial distribution of natural areas between the 1934 orthoimagery and the 2010 natural inventory. The first mitigation strategy consisted of simply moving the 2010 natural areas polygon to match the topology of the inaccurately georeferenced 1934 orthoimagery tile. In some circumstances however, this method may not be suitable. In these cases AML Spatial Solutions have determined that the polygons may be edited to match the 1934 orthoimagery topology. Figure 8 below illustrates an example of the georeferencing inaccuracies while placing the 2010 Natural Areas Inventory over the same area on 1934 orthoimagery.

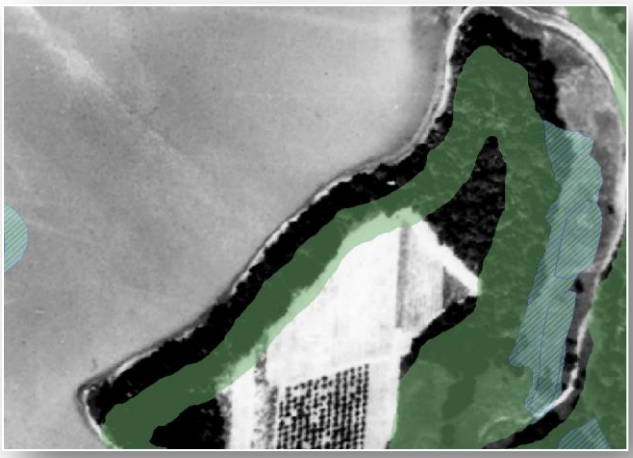

Figure 8: Georeferencing Inaccuracies

5.2 1934 Orthoimagery Quality

Another potential challenge that was identified throughout the initial phases of the project was the quality of the 1934 orthoimagery. At the advent of the emergency of aerial photography, the quality of sensors and platforms were not as good as they are in 2010; this may prevent AML Spatial Solutions from identifying certain natural areas. Another obstacle in identifying natural areas is the gaps between tiles of the 1934 orthoimagery. Figure 9 on page 21 displays

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an example of the 1934 orthoimagery quality including the gaps between tiles. These tiles are within the Niagara Region, around the Niagara Falls area.

Figure 9: 1934 Orthoimagery Quality

AML Spatial Solutions intends on managing this issue by estimating the extent of the natural area if there is one in the surrounding tiles of the gap. Judgment and analysis will allow for natural areas to be identified where these gaps exist to the best potential. AML Solutions is continuing to work on developing a methodology to manage the poor quality of 1934 orthoimagery.

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7.0 Conclusion

AML Solutions continues to play a critical role in determining the levels of change of natural areas within the NPCA watershed, which will be beneficial in determining natural habitat changes, identification of potential rare species habitat, as well as the ability to identify areas containing old growth forests within the NPCA jurisdiction. This project will be completed by June 13, 2014 as requested by the Niagara Peninsula Conservation Authority. The project study will take place throughout the Niagara Region, and partially the City of Hamilton and Haldimand County as well.

The Quantification of Spatial Changes within the NPCA Watershed from 1934 to 2010 will aid in planning and policy decision making at the Conservation Authority as well as assist their forestry department in guiding logging practices as well as supporting sustainable forestry practices. The adjusted total cost of the project, including mileage, a contingency estimate, and HST is $33,282.42. It is important to mention that there are challenges associated with every project; however AML Solutions will do their best to continue to diminish these risks.

AML Solutions is passionate about GIS, and has extensive experience with project work where the implementation of GIS is involved. The team is also familiar with the NPCA, their goals and their values. These assets paired with their up-to-date knowledge of GIS techniques and methods will continue to ensure this project is carried out successfully on time and on budget. AML Solutions is looking forward to completing this project, and satisfying all of the client's requirements.

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Appendix A – Terms of Reference

Niagara Peninsula Conservation Authority

42 Montgomery Road, Welland ON, L3C 2Y3

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Project ID: **201213-04** (for our office use only)

Contact Person & Organization Details

Contact Person	Name:	Tara Metzger
	Title:	GIS Technician
	Telephone:	905-788-3135 x 226
	Fax:	905-788-1121
	Email:	tmetzger@npca.ca
Organization	Name:	Niagara Peninsula Conservation Authority
	Address:	250 Thorold Road, 3rd Floor, Welland
	Website:	www.npca.ca
Date:		

Quantification of Spatial Change of the Natural Areas in NPCA Watershed from 1934 to 2010

Project Details

Project Background

Project Problem/Opportunity: Identify changes in natural areas using 1934 and 2010 orthoimagery for the entire NPCA jurisdiction.

Business Goal: Quantify the level of natural area habitat change and fragmentation in the Niagara Peninsula Watershed by using historical and current orthoimagery along with NPCA's updated natural areas inventory.

Primary Project Objectives [Provide a list of the project objectives.]

- Spatial inventory of natural area habitat change from 1934 to 2010
- Report identifying areas of and degrees of change by municipality including nature of change (+, -, change in density etc.)
- Maps and statistic's identifying level of change

Primary Project Deliverables [Provide a list of the project objectives.]

- Report discussing methodology and findings
- Geodatabase with feature layer indicating areas of change
- Other items as client determines (statistics, maps, graphs, charts)

Requirements

Number of students required to complete the project:	1 to 2
Equipment required (if any):	
Data required (if any):	1934 and 2010 orthoimagery, NPCA Natural Areas Inventory data
Software required (if any):	ArcGIS
Confidentiality	[Please indicate if you wish to have any presentations closed to public]

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Appendix B – Cartographic Products

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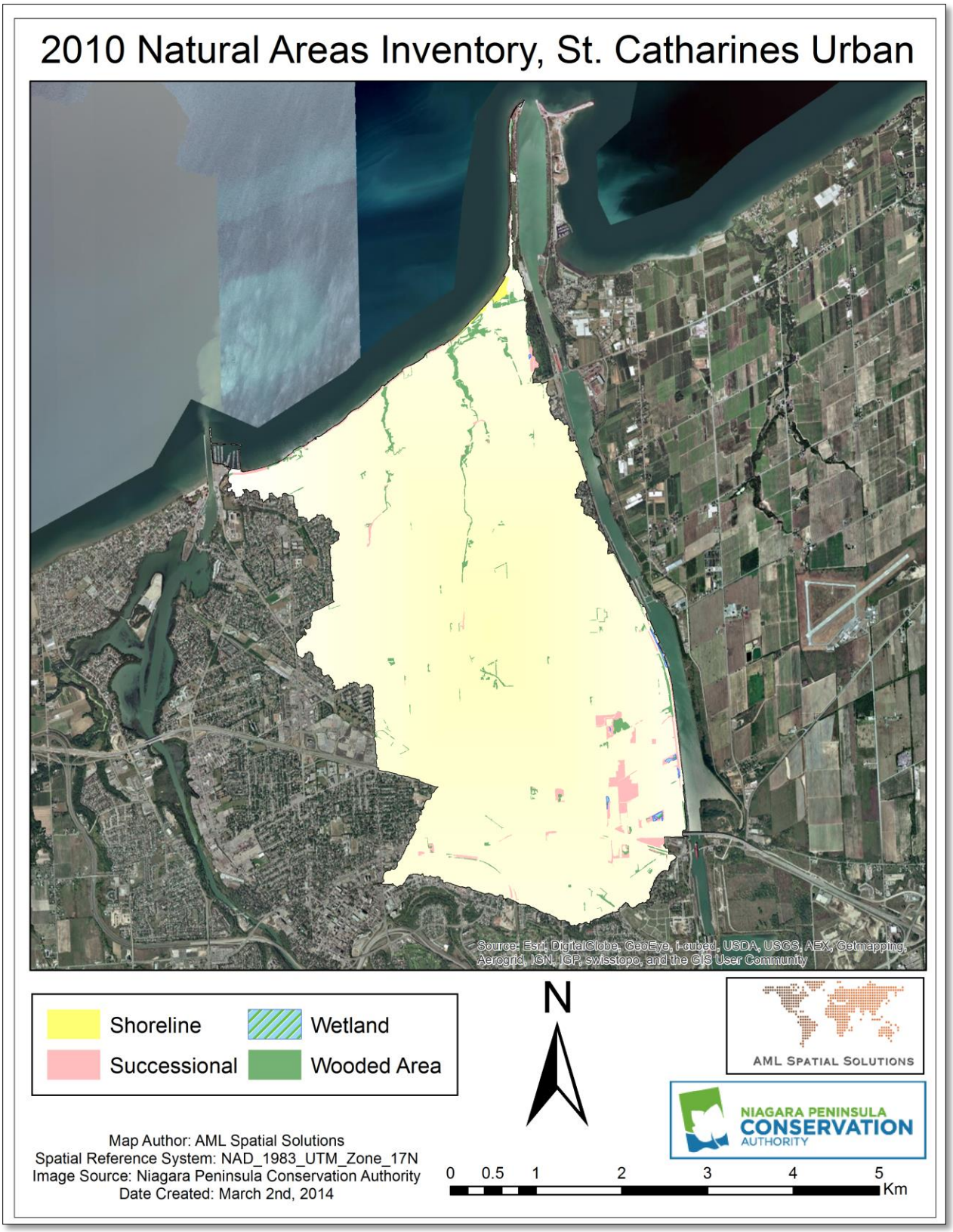

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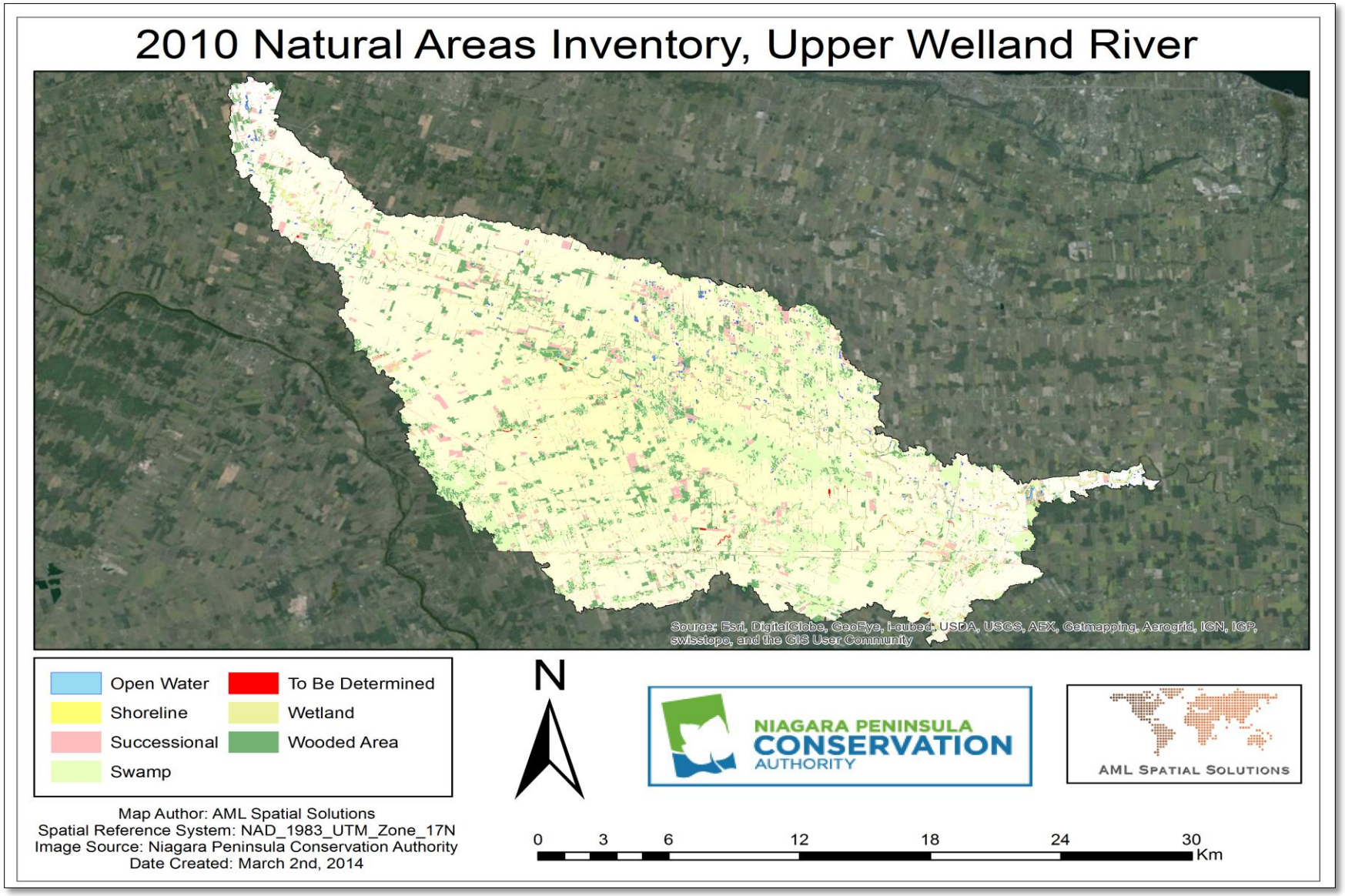

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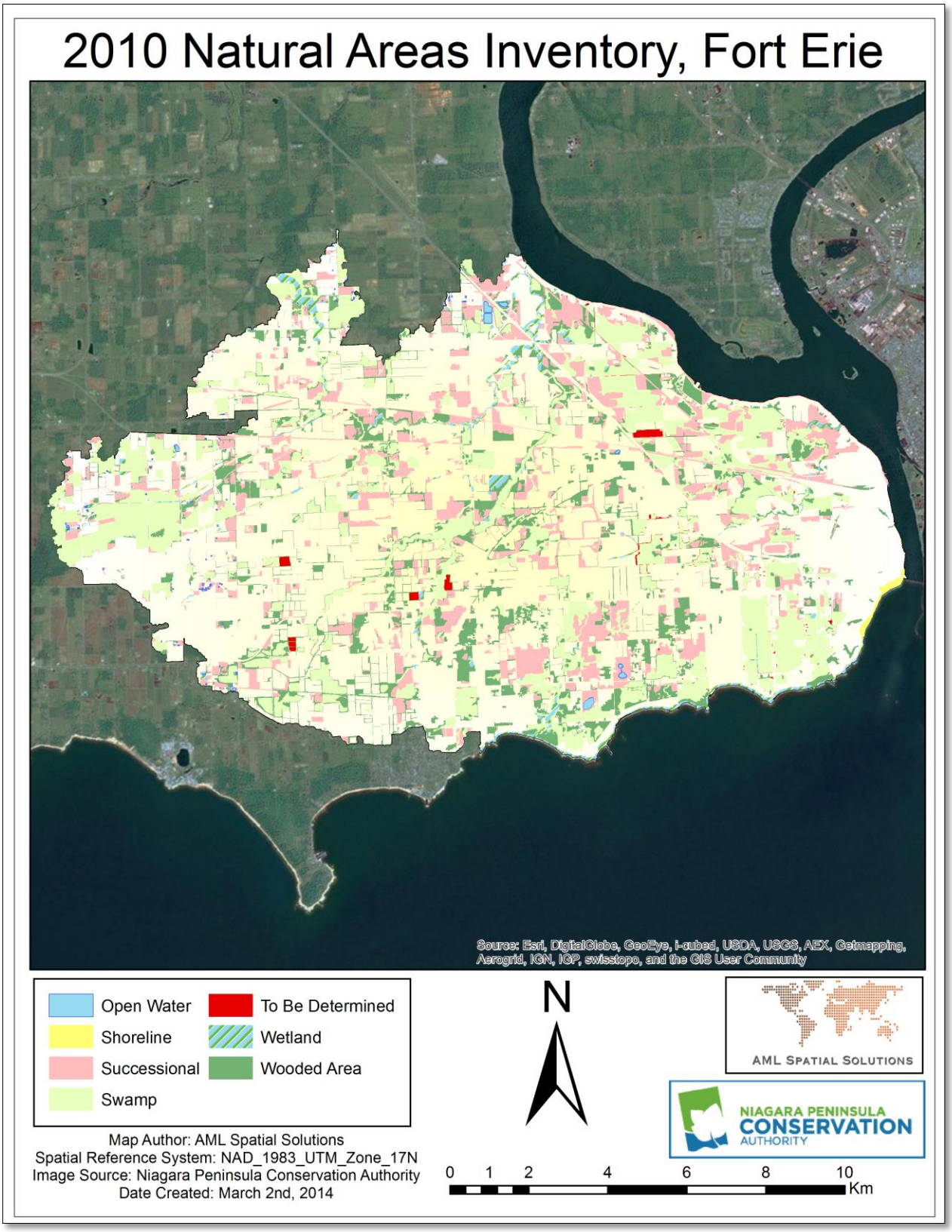

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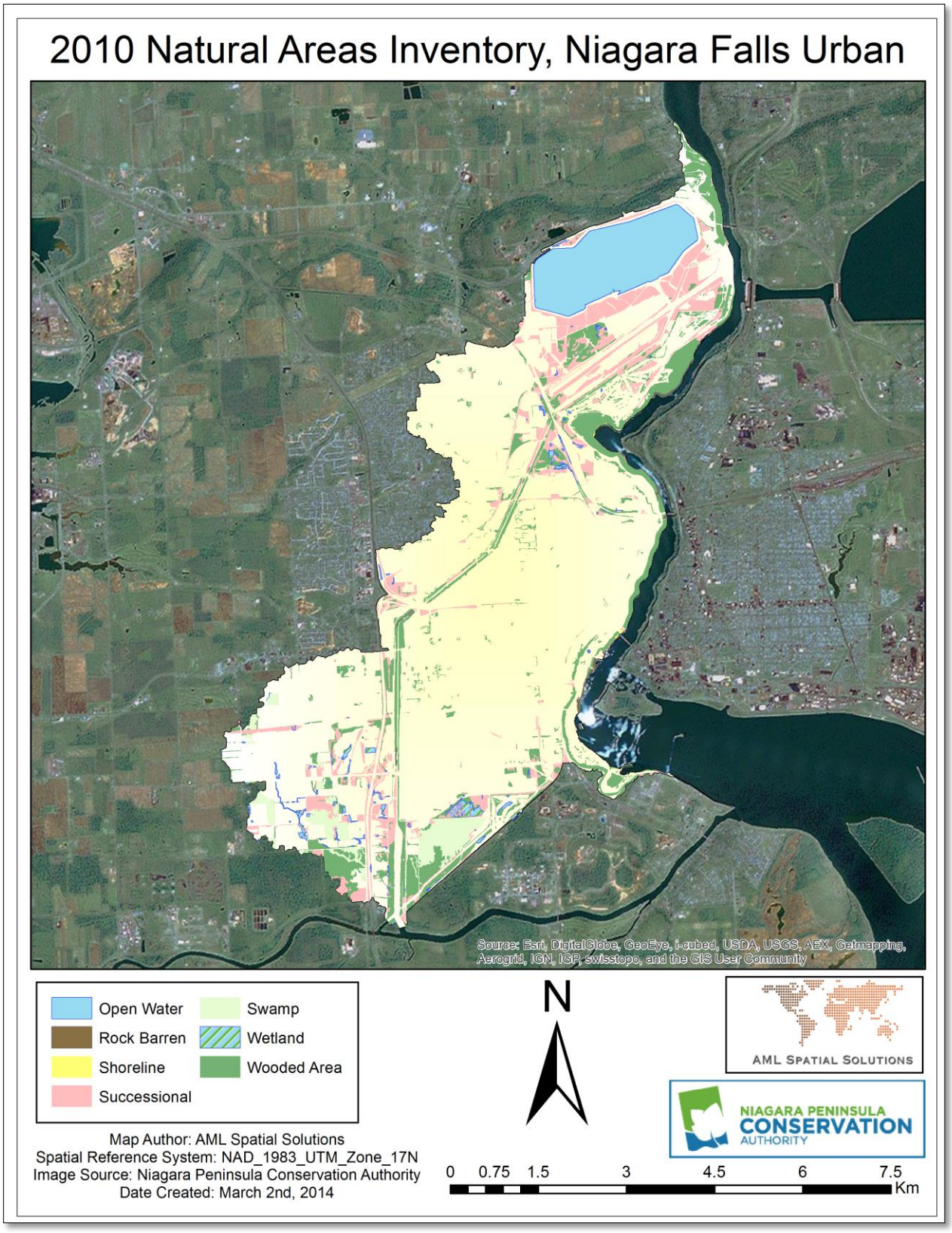

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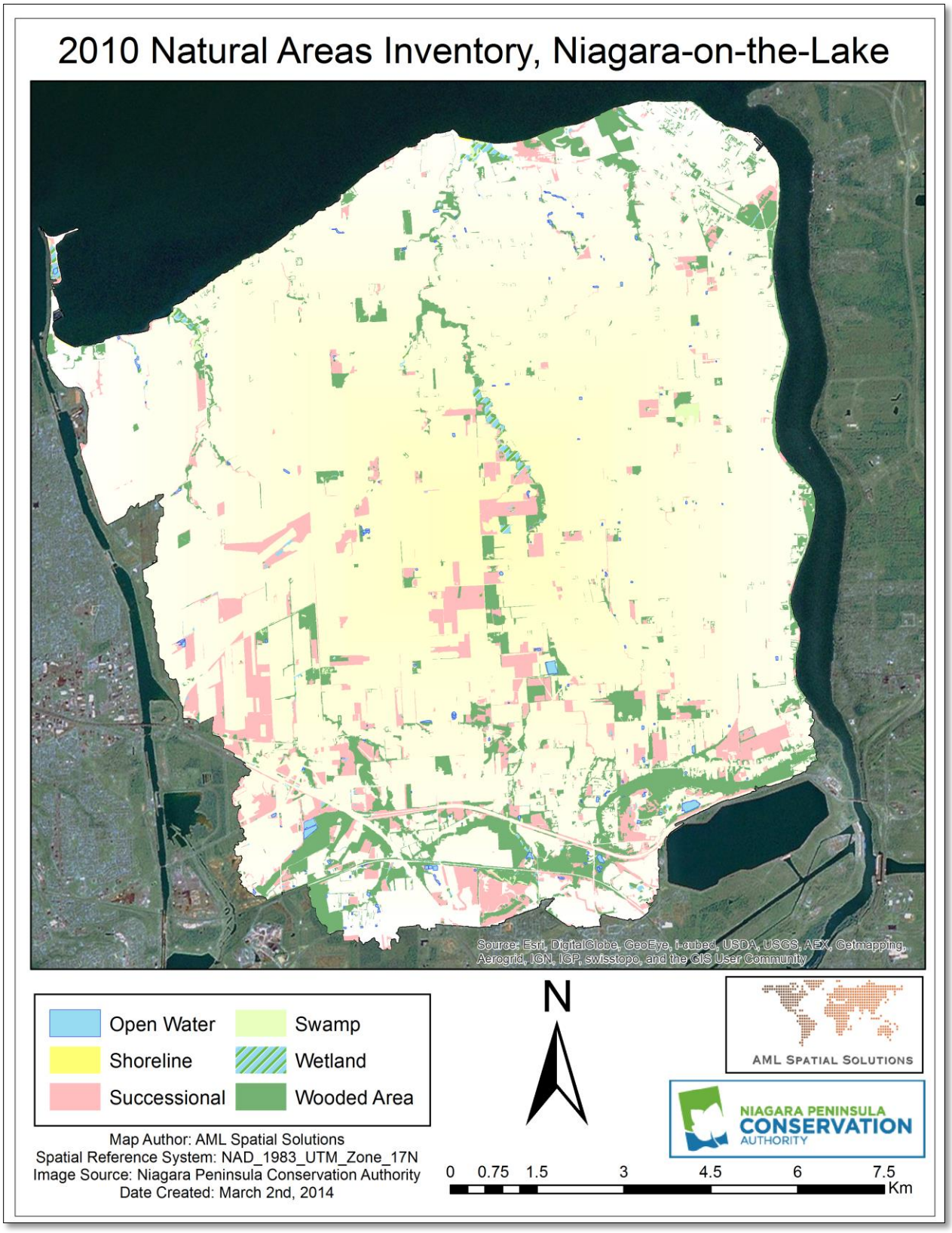

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Appendix C – Gantt Chart

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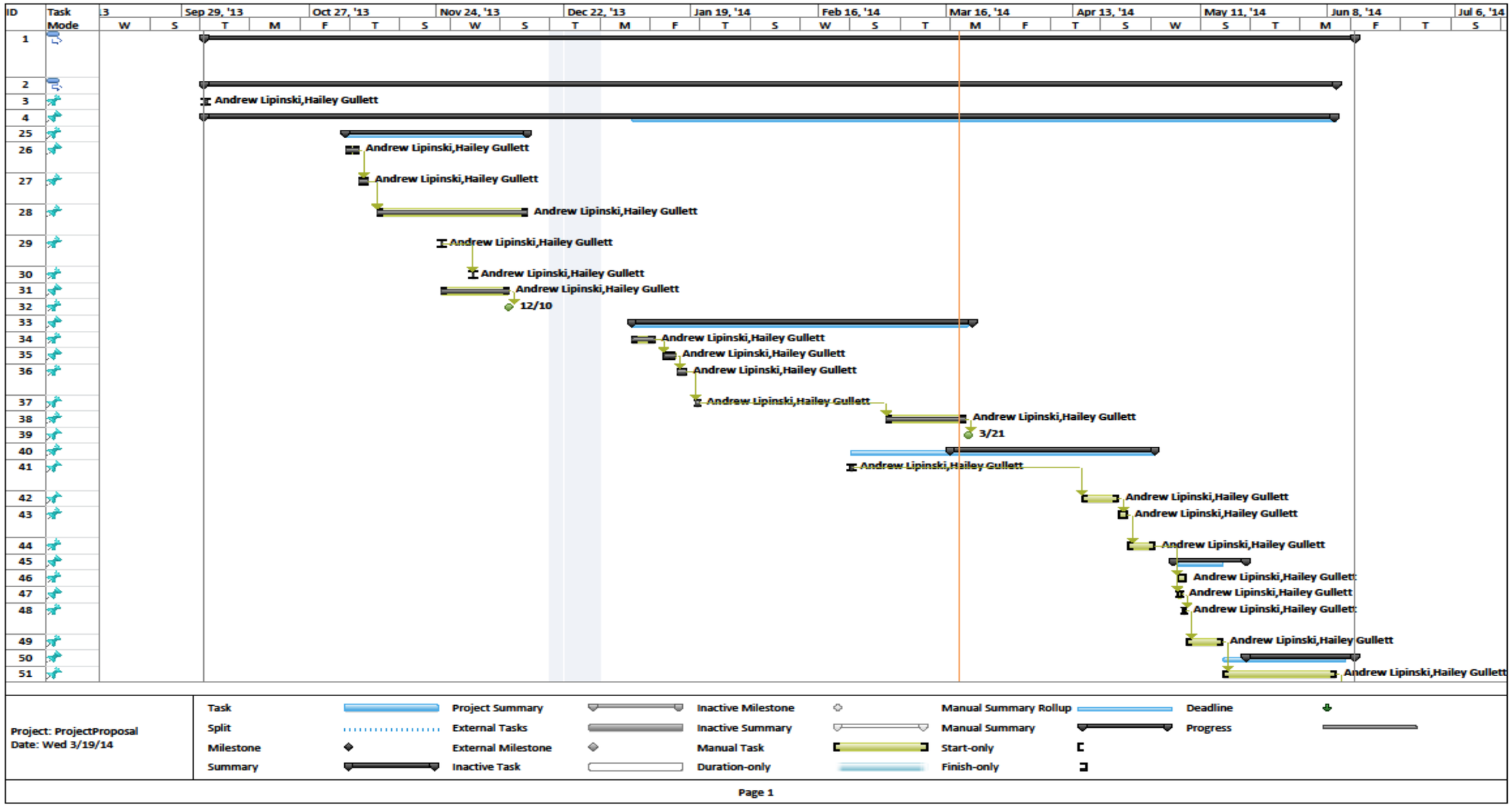
ID	Task Mode	Task Name	Duration	Start	Finish	% Comp.	Cost	Work	Actual Cost	Baseline Cost
1		**Quantification of Spatial Change of the Natural Areas in the NPCA Watershed from 1934 to 2010.**	**298 days?**	**Fri 10/4/13**	**Fri 6/13/14**	**61%**	**$27,375.00**	**359 hrs**	**$8,700.00**	**$27,975.00**
2		**Project Management**	**290 days?**	**Fri 10/4/13**	**Mon 6/9/14**	**40%**	**$3,450.00**	**40 hrs**	**$1,950.00**	**$3,750.00**
3		Planning	1.75 days?	Fri 10/4/13	Fri 10/4/13	100%	$1,050.00	14 hrs	$1,050.00	$1,050.00
4		**Meeting**	**289 days**	**Fri 10/4/13**	**Mon 6/9/14**	**35%**	**$2,400.00**	**26 hrs**	**$900.00**	**$2,700.00**
25		**Understand The Project**	**60 days**	**Mon 11/4/13**	**Fri 12/13/13**	**100%**	**$3,300.00**	**44 hrs**	**$3,300.00**	**$3,150.00**
26		Identify the Project Objectives	6 days	Mon 11/4/13	Wed 11/6/13	100%	$450.00	6 hrs	$450.00	$450.00
27		Define the Project Deliverables	4 days	Thu 11/7/13	Fri 11/8/13	100%	$225.00	3 hrs	$225.00	$225.00
28		Background Research on the Project	50 days	Mon 11/11/13	Fri 12/13/13	100%	$1,650.00	22 hrs	$1,650.00	$1,500.00
29		Create PPT Presentation for Proposal	0.25 days	Mon 11/25/13	Mon 11/25/13	100%	$150.00	2 hrs	$150.00	$150.00
30		Proposal Presentation	0.13 days	Mon 12/2/13	Mon 12/2/13	100%	$75.00	1 hr	$75.00	$75.00
31		Write Proposal Report	22 days	Mon 11/25/13	Mon 12/9/13	100%	$750.00	10 hrs	$750.00	$750.00
32		Proposal Report	0 days	Tue 12/10/13	Tue 12/10/13	100%	$0.00	0 hrs	$0.00	$0.00
33		**Data Acquisition**	**98 days**	**Mon 1/6/14**	**Fri 3/21/14**	**100%**	**$2,325.00**	**31 hrs**	**$2,325.00**	**$2,400.00**
34		Obtain data from client	10 days	Mon 1/6/14	Fri 1/10/14	100%	$300.00	4 hrs	$300.00	$75.00
35		Review and organize data	5.14 days	Mon 1/13/14	Wed 1/15/14	100%	$900.01	12 hrs	$900.01	$1,050.00
36		Create PPT Presentation for Progress	4 days	Thu 1/16/14	Fri 1/17/14	100%	$150.00	2 hrs	$150.00	$150.00
37		Progress Presentation	2 days	Mon 1/20/14	Mon 1/20/14	100%	$75.00	1 hr	$75.00	$75.00
38		Write Progress Report	26.61 days	Mon 3/3/14	Thu 3/20/14	100%	$899.99	12 hrs	$899.99	$1,050.00
39		Progress Report	0 days	Fri 3/21/14	Fri 3/21/14	100%	$0.00	0 hrs	$0.00	$0.00
40		**Update Spatial Inventory**	**50 days**	**Mon 3/17/14**	**Wed 4/30/14**	**9%**	**$13,425.00**	**179 hrs**	**$1,125.00**	**$13,800.00**
41		Clip NPCA Designated Watershed	1.88 days	Sun 2/23/14	Sun 2/23/14	100%	$1,125.00	15 hrs	$1,125.00	$1,500.00
42		Update Spatial Inventory	10 days	Tue 4/15/14	Tue 4/22/14	0%	$9,750.00	130 hrs	$0.00	$9,750.00
43		Create Feature Class for Old Growth Forest	4 days	Wed 4/23/14	Thu 4/24/14	0%	$2,400.00	32 hrs	$0.00	$2,400.00
44		Data Quality Check	4 days	Fri 4/25/14	Wed 4/30/14	0%	$150.00	2 hrs	$0.00	$150.00
45		**Perform GIS Analysis**	**24 days**	**Mon 5/5/14**	**Tue 5/20/14**	**0%**	**$2,700.00**	**36 hrs**	**$0.00**	**$2,700.00**
46		Identify areas of change	4 days	Tue 5/6/14	Wed 5/7/14	0%	$600.00	8 hrs	$0.00	$600.00
47		Quantify degrees of change	2 days	Tue 5/6/14	Tue 5/6/14	0%	$300.00	4 hrs	$0.00	$300.00
48		Identify potential rare species habitat	2 days	Wed 5/7/14	Wed 5/7/14	0%	$300.00	4 hrs	$0.00	$300.00
49		Generate Several Maps	12 days	Thu 5/8/14	Thu 5/15/14	0%	$1,500.00	20 hrs	$0.00	$1,500.00
50		**Project Summary**	**36 days**	**Wed 5/21/14**	**Fri 6/13/14**	**0%**	**$2,175.00**	**29 hrs**	**$0.00**	**$2,175.00**
51		Write Final Report	34 days	Fri 5/16/14	Mon 6/9/14	0%	$1,800.00	24 hrs	$0.00	$1,800.00
52		Create PPT Presentation for Final Report	2 days	Tue 6/10/14	Tue 6/10/14	0%	$300.00	4 hrs	$0.00	$300.00
53		Final Presentation	2 days	Wed 6/11/14	Wed 6/11/14	0%	$75.00	1 hr	$0.00	$75.00
54		Final Report	0 days	Thu 6/12/14	Thu 6/12/14	0%	$0.00	0 hrs	$0.00	$0.00
55		Deliver Final Products to Client	0 days	Thu 6/12/14	Thu 6/12/14	0%	$0.00	0 hrs	$0.00	$0.00

Page 1



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Appendix D – Project Overview Statement

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Project Overview Statement (POS)

Executive Summary

Project Name:	Quantification of Spatial Change of the Natural Areas in NPCA Watershed from 1934 to 2010
Last Updated Date:	5 November 2013
Author(s):	Hailey Gullett and Andrew Lipinski
Project Manager(s):	Hailey Gullett
Project Members:	Hailey Gullett and Andrew Lipinski
Client Name:	Tara Metzger, tmetzger@npca.ca, 905-788-3135 x 226
Client Organization:	Niagara Peninsula Conservation Authority

Project Business Case

Business Problem/Issue/Opportunity
Identify changes in natural areas using 1934 and 2010 orthoimagery for the entire NPCA jurisdiction.
Project Business Goal
Quantify the level of natural area habitat change and fragmentation in the Niagara Peninsula Watershed by using historical and current orthoimagery along with NPCA's updated natural areas inventory.

Primary Project Objectives

Primary Project Objectives
• Spatial inventory of natural area habitat change from 1934 to 2010 • Report identifying areas of and degrees of change by municipality including nature of change (+,-, change in density etc.) • Maps and statistic's identifying level of change

Project Benefits

Project Benefits
• Identification of areas containing old growth forests within the NPCA jurisdiction • Updated spatial inventory of natural areas • Comparison of natural area changes from 1934 to 2010

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