Peoples of Washington Historical Geographic Information System: Geocoding Culture using Archival Standards

by

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I dedicate this document to my family for their support and encouragement.

Table of Contents

List of Figures

List of Tables

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List of Abbreviations

ALA	American Library Association
APPM	Archives, Personal Papers, and Manuscripts
ASISO15489	Australian and International Standard for Records Management
DACS	Describing Archives: A Content Standard
DAHP	Department of Archaeology and Historical Preservation
EAD	Encoded Archival Description
ERD	Entity Relationship Diagram
GIS	Geographic Information System
GPS	Global Positioning System
HGIS	Historical Geographic Information System
ISAD	International Standard Archival Description
ISAD(G)	General International Standard Archival Description
ISAAR(CPF)	International Standard Archival Authority Record for Corporate Bodies, Persons, and Families
LOC	Library of Congress
MAGIRT	Map and Geospatial Information Round Table
NHGIS	National Historic Geographic Information System
NWDA	Northwest Digital Archives
POW	Peoples of Washington
POWHGIS	Peoples of Washington Historical Geographic Information System
RAD	Rules for Archival Description
SAA	Society of American Archivists

TESC	The Evergreen State College
TGN	The Getty Thesaurus of Geographic Names
USCD	U.S. Census Data
WISAARD	Washington Information System for Architectural and Archaeological Records Data

Abstract

The term “cultural geo-history” describes the specific connection of the culture in a given area to their environment and geographic space. For this project, the Peoples of Washington (POW) historical archive was cataloged based on GIS techniques, geocoding protocols, and the *Describing Archives: A Content Standard* (DACS) to create an intuitive and familiar tool for historical researchers and archivists to better understand the cultural geo-history of Washington State. The resulting tool, the Peoples of Washington Historical Geographic Information System (POWHGIS), combines a geodatabase and a web application to provide access to a small portion of the cultural history of Washington State as well as supplemental data from the Washington State Geospatial Portal and the U.S. Census. The application was beta-tested by users in order to evaluate the functionality of the tools, to provide adequate validation of the POWHGIS project and procedures. The POWHGIS project demonstrates that archival standards are useful in creating an accurate, informative, and usable HGIS tool that can increase the knowledge of and access to Washington State’s cultural geo-history.

Chapter 1 Introduction

This project aims to create a historical geographic information system (HGIS), including a geodatabase and simple web application for the Peoples of Washington (POW) Special Collection. This archival collection is housed within the Evergreen State College's (TESC) Malcolm Stilson Archives and Special Collections department. A web GIS application based on this information improves research on, and knowledge of, the cultures and population within Washington State. It allows historians, the academic community, and anyone with an interest in Washington's geo-history to perform research on the cultures found within the state boundary. Gaining access to this historical information as spatial data allows for visualization of the relationship between people and their geographic and cultural surroundings.

Another goal for this project's Peoples of Washington Historical Geographic Information System (POWHGIS) is the availability of digital access to the photos and documents of this collection for those researchers who do not have the ability to visit the archives in person. With online access from a distance, exploration of the data can be performed at the most convenient time and location for the researcher. By providing access to this information in a historical geodatabase made accessible through Web GIS, the aim is to help generate a higher completion rate and higher quality of historical publications for Washington State in general.

1.1 Motivation

Historians commonly utilize maps to describe their work, many enthusiastically drawing on a napkin during a meeting when asked about their latest pet project. With the recent advances in GIS analysis and technology, along with a new awareness of the benefits these latest improvements provide, historians are beginning to find the insight presented by GIS

irreplaceable in their work (Bailey and Schick 2009, 291-296; Dailey 2004; Gregory and Ell 2007; McGregor 2002, 161-166; Morillas-Torné 2012, 176-187).

With the current use of standards, a problem arises for cataloging archives by spatial information. Despite the trend of individual researchers having increased interest in the use of GIS in historical research and presentation, project teams, government sectors, and academic departments do not have consistent geospatial cataloging standards. If the creators of historical GIS databases begin to use a standardized method of describing the data within their collections, it would provide users with an easier way to access, process, and utilize varying sources and types of archival information.

Another major issue that is associated with geo-history and accompanying historical geodatabases is the question of data quality regarding coordinate precision, geographic names, and textual data. Many experts in history, geography, and spatial sciences have tried to address this issue with recommendations for geocoding processes and data integrity analysis (Boonstra 2010, 3; Knowles 2014, 206-211; Plewe 2003, 319-334; So, Wong, and Zhang 2012, 17). It is imperative that geodatabases using historical and archival data are structured and created with these data quality issues in mind. Archivists must take steps such as validation and peer review in order to ensure the integrity of the data sources.

1.2 Case Study: Peoples of Washington Special Collection

The Peoples of Washington (POW) collection contains donated materials based on the many different cultural histories that have been recorded in Washington State (White 1989). It consists of local newspaper articles, photographic images and their negatives, personal correspondences, and personal notes written by the collectors, all of which reflect the diverse population of the area. The collection was gathered between the years of 1986 -1989 and consists

of 2.375 cubic feet of shelf space. The bulk of the materials range from the 1920-1980's, however, a few of the photographs date back as far as 1882. This project focuses on processing just the photographic material and related textual data into a historical geographic database and accompanying web tool for public access. This information would enrich the knowledge and research capabilities of the many diverse user types that seek out this type of information. Aside from Washington State historians and academics, many other people could find this data useful, such as marketing firms, planning offices, and individual users seeking information for genealogies or local histories. The POW collection was chosen for this thesis project due to its size, geographic scope, and the close-to-completion state of processing, as well as the rich cultural data it will provide to the research community.

In order to expand the information that can be obtained on any given archival item and its cultural surroundings, this project combined the POW geodatabase with spatial data on ecoregions, transportation, and 1880 – 1980 United States Census County demographic data. In the context of this study, an ecoregion is an area of Washington State with distinctive climate, physiography, vegetation, soil, water, and animals, as defined by environmental, geological, and geographical factors (Oxford Press 2013). If researchers can link place-related information such as soil, watershed, habitat, ecosystem, population, nativity, and educational attainment to gain context for specific archival objects, they will be able to gain a better understanding of the cultural history of Washington State. Joining this data to the POW historic database calls for careful attention to spatial data and spatial thinking during the research process and for a broader understanding of the cultural geo-history of Washington. The goal is to put each archival item in context by matching it with detailed information on an identifiable boundary area.

1.2.1. Peoples of Washington Special Collection Literature

The literature that accompanies the Peoples of Washington (POW) Special Collection is a conglomerate of essays, photographs, and newspaper articles that were collected as a composite portrait of the cultural history of Washington State. The essays provided within the book entitled, *Peoples of Washington: Perspectives on Cultural Diversity*, were written by various scholars after many years of research and experience with the history of the peoples about which they write (White and Solberg 1989). The literature collection also contains numerous newspaper articles concerning the cultural diversity of Washington State, including pieces on individuals, families, businesses and cultural events such as parades, festivals, and funerals. Aside from the insight that these essays and newspaper articles contain, the collection has compiled a century of history into photographs. The Peoples of Washington exhibition book and frames only use a small portion of the available images, and much of the photographic collection is only available while visiting the library in person. This thesis project not only seeks to create and demonstrate the use of new geocoding standards for the creation of an HGIS database but also to digitize and provide an online GIS web application of the collection's images for access by the public.

1.3 Project Overview

The main focus of this thesis project is to create a historical GIS database and online GIS web application using the Peoples of Washington (POW) archive data and the identification/classification standards used by the Society of American Archivists (SAA 2008). The *Encoded Archival Description (EAD)* XML coding (Library of Congress 2002) and the *Describing Archives: A Content Standard (DACS)* (Society of American Archivists 2013) are used as a basis for table attributes and geocoding. These standards provide guidelines on how to create the metadata and item information about archival collections so that anyone familiar with

those standards can easily find what they are looking for. Ultimately, the use of DACS to create a historical GIS database helps to bring some standardization between collections. This is extremely important as an emphasis on geo-history becomes more common, and the usage of GIS methods and technology become a significant tool for historical and archival research. By using content standards for the geodatabase table attributes, archivists and researchers who have experience with using the DACS standards will be able to more easily access and understand the information provided by the Peoples of Washington (POW) historical geodatabase. By combining knowledge of the archival processes and standards with experience using GIS, the aim is an in-depth and workable geodatabase for the Peoples of Washington Special Collection. By engaging in building the database, effective geocoding practices based upon the DACS standards, adopted by the SAA, can be developed and reported.

Within the following chapters, the background research, methods, results, and a description of the finished project are recorded for future use and analysis. Chapter 2, the background section, defines the term 'cultural geo-history' in relation to people's historic connection to their geographic space. The archival concepts that formed this project, such as previous standards and usage from other HGIS projects using archival information, and technical considerations such as software and application options, are also explained in detail. Chapter 3, describes the data and methods used to form the POWHGIS project and how the varying aspects came together to create and gather user feedback on a coherent and useable database of archival information. Chapter 4 discusses the overall results of the project, including how the web application works as well as a discussion on the feedback received from beta testers such as archivists, historians, and GIS professionals. Finally, Chapter 5 contains a discussion of the key

learnings that geo-historians and archivists can take away from this project, as well as a conversation about the future possibilities of the POW project.

Chapter 2 Background and Literature Review

Previous research and literature use geo-history as a basis for analysis, however, no studies have been found that use archival classification standards in order to describe and catalogue the underlying geo-historical data and information. This chapter discusses the evolution of the term cultural geo-history as well as previous articles and projects that have used similar concepts and protocols in their research. This chapter will show the need for guidelines for implementing spatial data into archival collections to bring the numerous benefits of being able to map an area's cultural geo-history as well as to perform some rudimentary spatial analysis.

2.1 Cultural Geo-history

The online reference section of the Oxford Dictionary of Human Geography (2013) defines 'geo-history' as, "A geographical approach to history." However, the term's usage has evolved over time. Before historians and researchers realized the benefits of using spatial sciences in their work, the term 'geo-history' referred to the geologic history of space over time. As an example, Martin Rudwick (2008) uses the term in his book, *Worlds Before Adam*, where he discusses the geological history of Britain as well as the history of the study of geology. Then, as historical researchers began to make use of the spatial sciences, many started using 'geo-history' similar to that of the Oxford Dictionary definition and associating it with the practice of historical geography (Soja 2010). This project seeks to take the definition of this term further into the study of people, culture, and space.

A specific term has been developed for this study in order to best describe the type of historical database that the POWHGIS project will try to create: cultural geo-history. This term has been defined by this project as the history of a culture tracked by its connections to space and particular geographic location. The term also indicates a strong focus on cataloging the cultural

data provided by this type of archival collection. This thesis attempts to provide access to a portion of the cultural geo-history of Washington State via the historical geodatabase and web application interface.

2.2 Archival Content Standards

An important part of this thesis project is the usage of archival description standards to help form the basis of the geodatabase protocols for arranging, organizing, and listing the cultural items within the POW collection. Archival description standards are important for identification, location, and research within a physical archive space; however, they also play an important role in the organization of digital archives. When archive departments adhere closely to the standard description guidelines, it is possible for researchers and archivists to find items, folders, or boxes at any location that uses the same standards.

During the research to determine the best standards and approach to take, several content standards were examined. Ultimately, the Society of American Archivists (SAA) standards, Describing Archives: A Content Standard (DACS) was chosen. Other standards examined included the International Council on Archives General International Standard Archival Description (ISAD(G)), and the standard used by the National Archives of Australia, the Australian and International Standard for Records Management (AS ISO 15489). Aside from the DACS being adopted by the largest American association for archivists, this version is a newer standard and has since been updated with more detailed description than the ISAD or AS ISO 15489, and was chosen for use with the POWHGIS for those reasons.

The International Council on Archives provides several types of standards for various archival purposes, most notably for this project, the General International Standard Archival Description (ISAD(G)). This set of standards was adopted by the Committee on Descriptive

Standards in Stockholm, Sweden in September 1999. The 91 page document is very similar to the DACS standards in the content, form, and rules of how to describe an archive. In fact, the SAA used the ISAD protocols and descriptive elements as a basis for the new DACS standards during the council that created them.

Another international standard researched for this thesis project was AS ISO 15489. Used by the National Archives of Australia, the standard is in two parts. On the official website, it is stated that both parts apply to records in any format or media, created or received by any public or private organization. Part 1 is the actual standard and provides a framework for the benefits of records management, the need to identify the environment in which an organization operates and the importance of assigning responsibilities. Part 2 is the actual technical guidelines that include records management policies, roles and responsibilities, and developing records processes and controls to manage records, monitoring, and auditing record systems.

2.2.1. Describing Archives: A Content Standard

The most widely used content standard for archival collections in America is the Describing Archives: A Content Standard (DACS). Up until the early 1990's the descriptive standard used by the SAA was the Archives, Personal Papers, and Manuscripts (APPM) standard, however, this standard did not accommodate the availability of new electronic sources and protocols for digital collections or the usage of Encoded Archival Description (EAD). The EAD scripting language is an XML-based code that allows for easy creation of archival finding aids for both physical and digital archive collections. This coding includes basic entries for metadata and background information as well as more detailed information such as collection size, date range, collectors, and notes.

When EAD was launched in 1996, a discussion between the SAA and Canadian archivists began in an attempt to create a joint descriptive standard that incorporated both countries protocols and approaches to using the EAD coding. By 2003, it was evident that there were too many differences between the practices of each country to create a joint descriptive standard. As a result of these discussions the Canadian archivists have adopted the Canadian-U.S. Task Force on Archival Descriptions (CUSTARD) project as a basis for a new edition of their Rules for Archival Description (RAD) content standard, while the U.S. has attempted to use the outcome to create their own content standard, i.e., the DACS as it is used today.

When compared to other content standards such as the International Standard Archival Description (ISAD), the DACS protocols are very similar, yet designed to accommodate common practices used in the United States. For example, the 26 data elements used in both the ISAD and the International Standard Archival Authority Record for Corporate Bodies, Persons, and Families (ISAAR (CPF)), have been incorporated into the DACS. One exception is the Level of Description element from the ISAD because it did not allow for new additions such as digital media or geographic references. With the incorporation of these common international elements and its acceptance by the SAA, the DACS was the most logical choice for documenting the POWHGIS.

In comparison to the APPM, the content standard that the DACS replaced, the new standards contain all of the information that the second edition of its predecessor did. The difference between the two standards appears in their focus. While the APPM was focused specifically on the creation of catalog records, the preface of the DACS states: "(It) can be used to create any type or level of description of archival and manuscript materials, including catalog records and full finding aids" (SAA 2004, vii). Because the DACS incorporates not only the

entirety of the previously used APPM but also many of the elements from the International Standards, it was the most useful and adaptive content standard for the new protocols created for this project's needs.

The characteristics of the DACS archival standards that pertain to this project have to do with organization and identification protocols. A good portion of this information is referred to as metadata and description when referring to digital archives and services. Part 1 – Chapter 2, "Identity Elements," describes the location, title, date, extent, creator, and administrative/ biographical history of the physical collection. Part 1 – Chapters 2-5 includes information about the scope and content, arrangement, access, languages, finding aids, acquisition, and related materials. This information tends to be identical for each item as it pertained to the collection as a whole and was used as a basis for the description option for the POWHGIS and Web Map Application.

The standards found in Part 3, "Forms of Names," are the most important part of the DACS in relation to this project. Chapter 13, in particular, contains standards pertaining to Names for Persons and Families, Geographic Names, and Corporate Bodies. From this information, and protocol recommendations, an expansion to the DACS standards was created in order to handle the type of spatial data that was required to complete the POWHGIS. These recommendations, and the process used to carry them out during the creation of the POWHGIS project are explained in detail in Chapter 3.

2.3 Historical Databases

Gregory and Ell (2007) examine the creation of historical GIS databases. They describe the process of connecting historical attribute data with the associated spatial data. They mention three forms of this connection: a pair of coordinate data for each row, a geographic location, and

an existing attribute table that will allow for joining to a spatial dataset (Gregory and Ell 2007). The first form contains specific coordinate data for each item, usually taken at the site during field research with a Global Positioning System (GPS) device. The second form is a geographic location such as a street address, city name, or a place name such as the Olympic National Forest. The third form describes the joining of two spatial tables in order to generate the coordinate data for the locations via an attribute such as object_id, county name, or identification number, such as is used by the National Historical Geographic Information System (NHGIS).

Using GIS to catalog and analyze historical data is a relatively new practice, and one of the major issues is the availability of data. The POWHGIS project is an attempt to make available historical data on the cultures of Washington State so that simple spatial analysis can be performed using data from the POWHGIS, Washington State Geospatial Portal, and the U.S. Census. In order to communicate data between different sources and datasets, a common language must be established. Thus, this study attempts to incorporate the DACS archival standards into the creation of a geodatabase capable of allowing for spatial analysis.

Gregory (2008) also establishes the need for using spatial analysis in historical GIS research. He states the challenge this way: "We are only beginning to explore the major challenge of turning spatially referenced data in a GIS into information about historical geography. We risk failing this challenge if we restrict GIS analysis to mapping and publishing data on a Web site" (Gregory 2008, 144). Gregory is referring to the possibilities of historical investigation created by spatial analysis and other tools of ArcGIS Desktop's toolbox of data management features and warns of the dangers that may arise when these are left unconsidered. Historians too often stop short of the full range of spatial analysis.

2.4 Historical Geographic Information Systems (HGIS)

Using GIS databases to analyze cultural geo-history is a relatively new practice. However, there have been several Historical Geographic Information Systems (HGIS) created in the past using archival information. Examples of projects that have used historical GIS databases in their research have also provided excellent information on how to utilize this type of geodatabase while studying history. Although no project appears to use any archival standards such as the DACS, they do an informative job of setting up a beginning for GIS in the analysis of historical data.

One example is a study from Morillas-Torne (2012) that describes the creation of a historical GIS database using archival and national data. During their study, the author uses this data in order to analyze the evolution and territorial impact of the railway system of Europe over an 80-year period. Their attempt to combine archival data with readily available spatial data provides insight as to how this type of HGIS can be created and utilized. In relation to the POWHGIS project, this article helped to provide insight on processing archival data for use with GIS and inspired the inclusion of a railway network data layer into the POWHGIS.

Another example is a study by English et al. (2010), which is an insightful example for the POWHGIS project. This project not only deals with archival material, but how to bring many different forms of it together in order to create a workable and coherent HGIS database based on this type of archived information. It provides an example as to how to build and structure a geodatabase based on the combination of the multiple types of data that the POWHGIS project entails.

2.5 A Need for Content Standards in HGIS

Harris, Rouse, and Bergeron write, "Many humanities databases have been created in response to individual needs with little or no interaction with groups conducting similar research or with similar data collection needs" (Harris, Rouse and Bergeron 2010, 34). This statement evidences a lack of uniformity among historical GIS projects and that some form of standardization is greatly needed. They go on to state that many have realized that there needs to be a way to work with many different data sources, including the ability to join and merge divergent data sources (Harris, Rouse and Bergeron 2010). It is this very issue that has inspired the POWHGIS project. Using the already established archival standards as a base for new geocoding practices for cataloging archival items will assist in the universal understanding between the differing backgrounds of DACS users.

Kollen et al. (2013) discusses an attempt to establish guidelines and recommendations for cataloging and providing access to geographic (spatial) data and tools. In 2010, the American Library Association (ALA) Map and Geospatial Information Round Table Geographic Technologies Committee (MAGIRT) designated a subcommittee to investigate methods of spatial data cataloging and to make recommendations on technology, staffing, and software needs (Kollen et al. 2013). After studying the methods of eleven academic libraries and their associated spatial data catalogs, the spatial data subcommittee established a document that has the potential to help academic libraries decide on the best approaches for their spatial data catalogs, taking into consideration size, technology, budget, staffing, and access needs. Several of this study's recommendations had a great influence on the creation of the POWHGIS project's geodatabase. Considerations such as ease of use, search functionality, metadata, access to

download and print options, and which software provides the best solution for the HGIS's needs were essential to the creation of the database and web application.

2.6 Washington Information System for Architectural and Archaeological Records Data

One existing geo-historical database in particular had a major influence on the creation of the POWHGIS project: the Washington Information System for Architectural and Archaeological Records Data (WISAARD). This HGIS is run and maintained by the Washington State Department of Archaeology and Historic Preservation (DAHP) and funded by grants provided by sources such as the National Park Service, Washington State Departments of Transportation and Natural Resources, and the Federal Highway Administration. The award-winning success of the DAHP's setup and construction of a historical database based on the registered historic buildings of Washington State helped to form ideas of effective layout and ease of use for a project of similar types, such as the POWHGIS.

2.7 National Historical Geographic Information System

The National Historical Geographic Information System (NHGIS) is one of the paramount examples of a HGIS available online. The NHGIS is managed by the Minnesota Population Center of the University of Minnesota and is funded by ongoing grants obtained from the National Science Foundation and the Eunice Kennedy Shriver National Institute of Child Health and Human Development. Geared toward providing historical U.S. Census survey data from the late 1700's to 2014, the NHGIS provides boundary shapefiles, census summary tables, and time series tables free to the public. This type of data is extremely important to projects, such as the POWHGIS, which aim for statistical and spatial analysis of the U.S. population and demographic data over multiple decades.

2.8 Inside Idaho

Inside Idaho is a geospatial data clearing house for the State of Idaho housed and maintained by the University of Idaho Library. It is funded by grants from several grantor sources such as the Federal Geographic Data Committee, NSF EPSCoR, USGS Cooperative Agreements, the US Bureau of Land Management Idaho Office, the State Board of Education Technology Incentive Grant Program, and the UI Sustainability Center. Inside Idaho is an informative example of an HGIS as it contains historic air photos and historic maps as well as the topographic and elevation maps, and current aerial imagery. It is this type of HGIS that provided the example of combining historical GIS archival data with current maps for ecology, transportation, and U.S. demographic data for the POWHGIS.

Chapter 3 Methods

The methods used to create the POWHGIS merge procedures from archival processing with skills and techniques from geographic information science. Practical considerations in establishing geodatabase structure and data validity helped to create a straightforward and easy-to-use base for the entry of data collected using standard archival collection processing procedures. **Figure 1** outlines the workflow that was followed while creating the Peoples of Washington Historic Geographic Information System. In the following chapter sections, each phase is described in greater detail in order to allow for reproduction of the database and web application creation process.

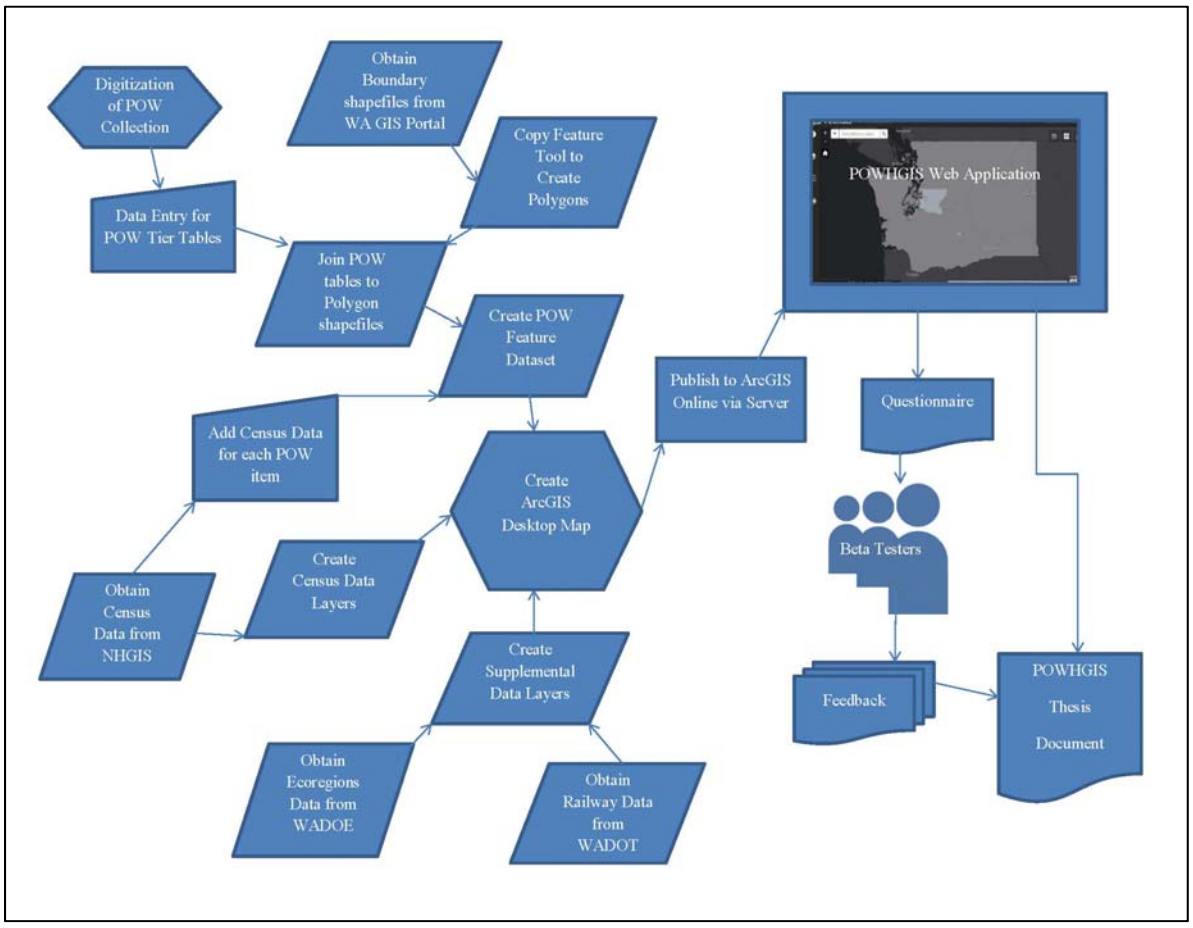

Figure 1 Work Flow of POWHGIS

3.1 Project Objectives

The Peoples of Washington Historical Geographic Information System (POWHGIS) project has four objectives: provide geographic visualization, allow basic spatial analysis, present visual representation of the photographs from the Peoples of Washington (POW) Special Collection, and establish usable geographic reference protocols for archival data. In order to support basic spatial analysis, a related objective was to associate U.S. Census demographic data with specific archival items. These objectives were completed using the tools available with Esri's ArcGIS Desktop program and linked with features provided by Esri's ArcGIS Online website and application options.

In order to complete the final objective, protocols were defined based on DACS procedures approved by the Society of American Archives (SAA). This content standard acknowledges the need to be expandable since new types of content will become available over time, requiring flexibility in the creation of additional standards. This thesis project documents geocoding protocols and methods in order to establish a reusable process in creating HGISs using archival and historical data while providing a case study in the POWHGIS itself.

3.2 Geodatabase Protocols

In order to adequately record and enter each photographic item of the POW collection into a geodatabase, geocoding protocols were created that adhere to the recommendations for item description made by the DACS. According to the Esri GIS Dictionary, geocoding is "an operation for converting street addresses into spatial data that can be displayed as features on a map…" (2016). For the POWHGIS project, we take this definition in a general sense, using archival processing techniques to find information similar to street addresses in order to place photographic items on a map. The first of these protocols is to record the physical archive

location of each item using information such as container, folder/file, box, shelf, and identification number. Secondly, as recommended by the DACS, the Getty Thesaurus of Geographic Names has been used to establish a baseline geographic reference known as "geogname" for any item without a specific address associated with it. The "geogname" tag has a pre-established preferred spelling, is associated with a specific geographic location type (i.e. island, inhabited place, county), and has pre-recorded coordinates associated with each location. The specified geographic coordinates are meant to standardize place locations within the archives that use the SAA methods of creating metadata and catalogs.

Many of the POWHGIS photographs do not have textual references with adequate location information. Due to this lack of recorded geographic data and the absence of detailed identifiers within the DACS standards, a secondary geographic referencing attribute, the "geogreference" tag, was created. This attribute is based on the "geogname" tag guidelines established by the DACS; however, it provides a geographic reference based on the archival processing protocols used by many archives while processing new collections for data and information. Archival processing protocols used to establish "geogreference" data include: 1) Any geographic reference within written material, such as street address as well as place names and locations, and 2) Any geographic reference found in a photograph such as street signs, park signs, business signs, or addresses on background buildings or mailboxes. This data extraction process is based on practices used by archivists and their teams while processing new additions to a collection and falls within the DACS boundaries for additional standard creation.

For those items that do not provide a geographic reference via their written material or visual hints within the photograph, an Internet search for subject terms was used. Such subject terms included business, person, or place names; parade or event titles and dates; and physical

geography such as major rivers or lakes, coastal, or mountain references. In order to determine the coordinates for such subject terms, a Google Maps search was performed. There were three steps used in locating this information: 1) Google search for subject keyword(s); 2) Right click on location – select "What's Here?"; and 3) Record latitude and longitude provided. By following these steps for all archival items that do not provide a specific location reference; the database was kept within the DACS requirements even when the TGN "geogname" tag was unavailable. Although geographic data acquired by this process was cross- checked with several different details about the item, such as proximity to similar cultural items, correct spelling, and comparison of photographic background to Google Earth's Street View, the accuracy of these points may still be flawed.

Even after the extensive steps to geo-reference and code the items within the POW collection, in the end, there were still images that could not be completed. These images can be assumed to be within Washington State due to the nature of the collection. They were coded for Washington State and were included within the Washington State boundary layer of the POWHGIS web application, making them available to the public.

In some rare cases, photographic items in the POW collection not only lacked geographical reference data but titles and descriptions as well. Although these items had been previously processed and cataloged with their associated culture, there was significant information missing. In order to better represent these items, and to allow them to be included in key term searches, the Library of Congress subject headings were used in order to adequately describe the image content. In these cases, a search was done on the Library of Congresses website (Library of Congress 2016) for main subjects within a photo. For example, an untitled photograph of a policeman in Spokane, WA was described using the subject headings, "African

American," "Police," "Spokane, Washington," and "History". This allows a researcher to access these untitled photographs through the POWHGIS search function with accurate results.

As an example of the geo-coding process, consider **Figure 2**, which shows a parade float in Seattle, WA as is recorded in the item's description. However, while looking at the image, the float has the words "E. Union E. Madison Mardi Gras" written on its side, which provides a detailed geographic reference hint. Upon using Google Maps to locate E. Union and E. Madison, it was found that they cross at a very busy intersection of Downtown Seattle, WA. A stated above, a new attribute, termed "geogreference", was used to record this type of data. Using Google Map's "What's Here?" option, by right-clicking on a location, provided fairly precise coordinates for a location of this type. This location process provides a more focused approach to locating and mapping an item's geographic location when this data is not provided. Those items that lacked an associated place name, geographic reference or coordinate data were entered into the Washington State POW layer as it is the maximum boundary layer in this project.

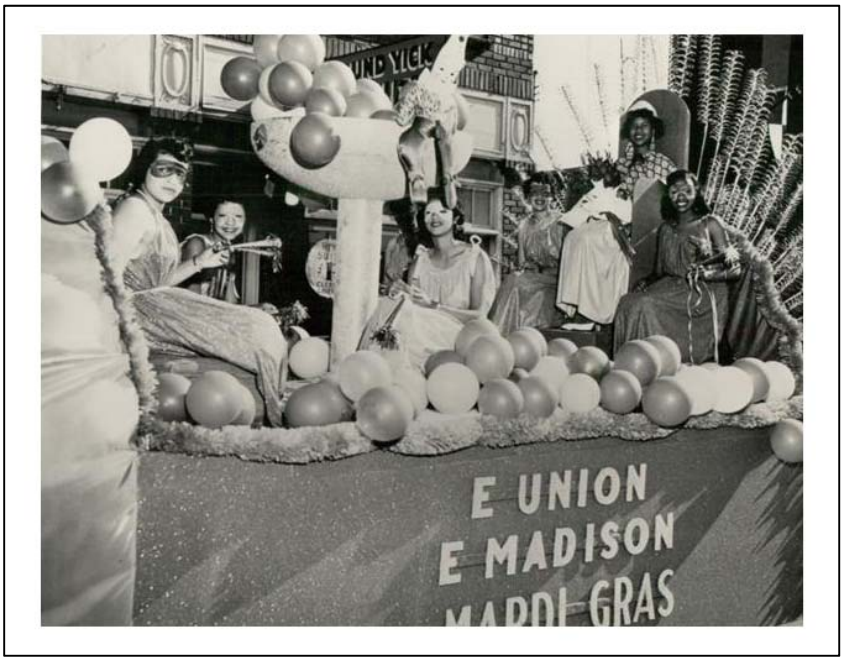

Figure 2 African-American Community Float 1950's

Table 1 Breakdown of Geocoding

Addresses Provided	19
Geocoding Process	102
Google Maps	17
Total Archival Items	138

Table 1 provides a breakdown of the varying levels of the geocoding processes and techniques. There were by far more items that required the new geocoding processes created for this project than either had addresses provided or enough detailed information where the Google Maps geocoding type was effective.

3.3 Database Methods

In order to create the POWHGIS geodatabase, several tables were created to produce the required polygon layers used in the database structure. The data tables that have been created for this project are the Peoples of Washington (POW) tables, The Getty Thesaurus of Geographic Names (TGN) table, and U.S. Census Data (USCD) tables for each decade from 1880 - 1980. These tables provide enough data on each entity to perform some rudimentary spatial analysis using the POWHGIS on the cultures that populate the state of Washington.

3.3.1. Peoples of Washington HGIS Entity Relationship Diagram

The information that was needed for each item in the collection in order to create the Peoples of Washington Historical Geographic Information System (POWHGIS) geodatabase included: object_id, container, title, type, subtype, culture, date, state, county, city, address, geogname, geogreference, coordinates, census data, and a .pdf scan of the original item. The original database for the POWHGIS project has been created from the physical collection of

items using the previously mentioned geocoding protocols. Tables were created in Microsoft Excel using the established attributes. These tables were joined using the geogname and TGNName attributes, which contain the same attribute data and required no further processing. This allowed the POWHGIS to remain within the parameters of the original DACS standard practices. **Figure 3** shows the Entity Relationship Diagram (ERD) for the POW and TGN tables, including the data type such as text, long integer, or geometry.

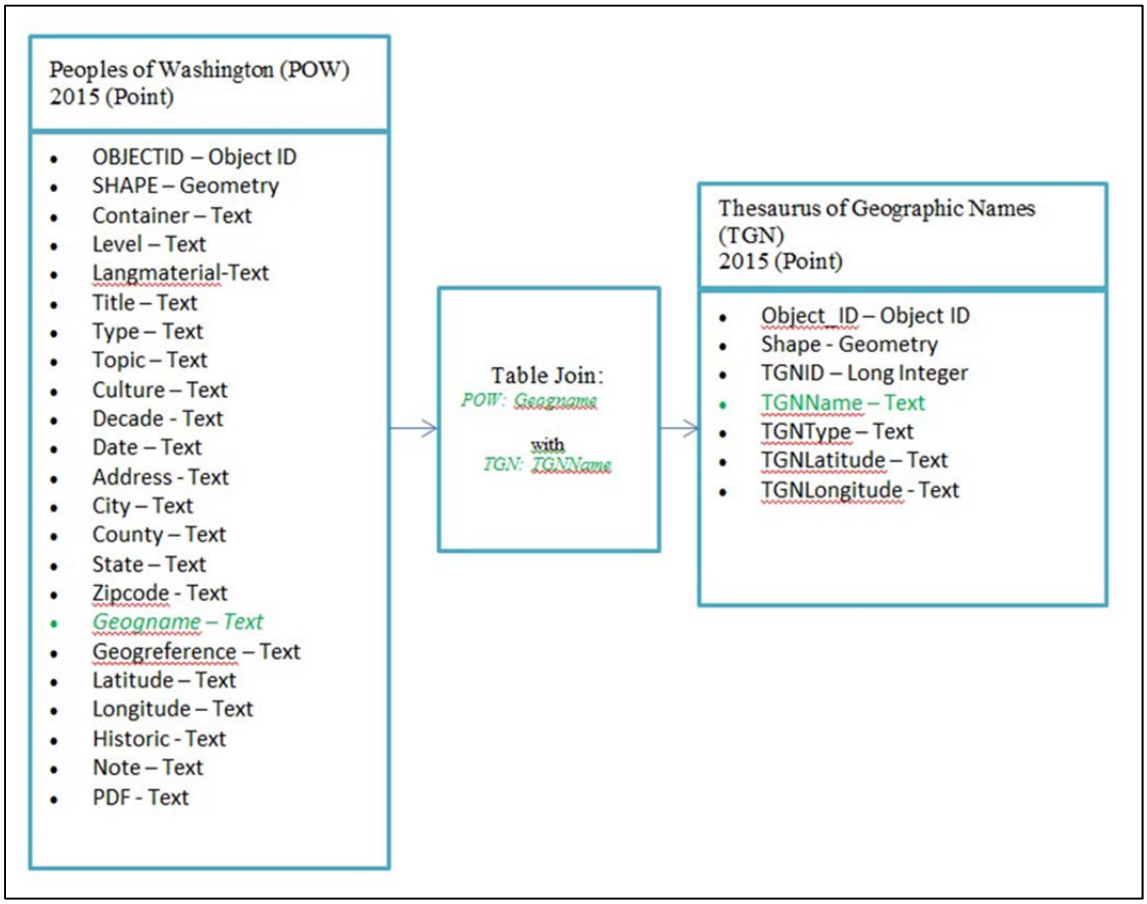

Figure 3 ERD of POW Table and TGN Join

3.3.2. Peoples of Washington (POW) Table

The attributes for the POW table were completed by establishing the container, level, and langmaterial (language that the material was recorded in) attributes based on the physical location and description of each item and provided by the archival documentation recorded by

the collection's source, a TESC instructor by the name of Sid White, and the Northwest Digital Archives (NWDA) finding aid. The attributes for each archival item's title, type, topic, culture, location, and note were established via written material on each item and also provided by the archival documentation. The status of a building's historical registration was found using the WISAARD historical geodatabase that was described in Chapter 2. In order to stay within the constraints of the DACS, the "geogname" has been documented in the TGN table and established via The Getty Thesaurus of Geographic Names data as recommended by the SAA. When no "geogname" could be found, the 'geogreference' procedures described above were used in an attempt to determine an item's location using Google Maps and relevant search terms. Coordinate and location data for address, geogreference, latitude, and longitude were noted using the newly established geographic referencing protocols described above. It is important to note that the coordinate data used by both the TGN and Google Maps is in decimal degrees and the coordinate system is the World Geodetic System 1984, thus making the spatial data from both processes compatible. A .pdf of each item was created by digitization of the photographs via hand scanner, providing for a direct link between the archival item and the researcher in the POWHGIS online web application. Finally, census data from the NHGIS for the county associated with each item was manually entered into the attribute table using the Editor tool. This was a necessity to allow for the basic spatial analysis that is available for this type of HGIS geodatabase.

Table 2 includes the detailed information on each attribute of the POW table, including the EAD or DACS standard definition if applicable. The appropriate EAD or DACS tag definitions used in this table are derived from the novice-friendly eadiva.com website (EADIVA

2012). These definitions are simplified so that the non-expert reader will have little trouble understanding their meanings and usage.

Table 2 Peoples of Washington Attribute Table

Attribute	Description
Container	This attribute is described as <container> and is a sub-element found within <archref>, or <did> which encodes information about the container used to hold the materials. It may identify type and number. It's generally used to specify a number or other designation associated with a box at the folder level, or possibly a folder number at the item-level (DACS 2013).
Level	This tag designates whether this is a class, collection, file, fonds, item, otherlevel, recordgrp, series, subfonds, subgrp, or subseries. Classifications related to the POW project are: subseries name abbreviation (i.e. AA - African American), item number, and box and file or folder number. This is shown as AA -1 1/2.
Langmaterial	A prose statement enumerating the language(s) of the archival materials found in the unit being described. For most of the collection, this is "English."
Title	This tag records the formal name of work listed in the finding aid.
Type	This attribute denotes the type of archival item. For the current POWHGIS, this is the only photograph.
Topic	This attribute labels the type of event that the item relates to; it includes political event, portrait, family portrait, group portrait, settlement, entertainment, parade, immigration or military.
Culture	This attribute notes the culture that the item relates to.
Decade	This attribute is associated with the Census Data provided for each archival item. It allowed for the USCD and POW tables to be joined. A date of 1926 equates to the 1920 Census.
Date	This attribute refers to the known date that the item was created; the recorded dates range from around 1820 to 1986.
Address	This attribute contains the Street Address of an item's original location, photographer, or site, if available. If not available, it has been marked as missing data within the Note section.
City	This attribute denotes the city name that the item was created in.
County	This attribute refers to the county that the item was created in.
State	This attribute notes that the item was created within Washington State.

Zipcode	This attribute notes the zipcode for a specific Address.
Geogname	This attribute refers to the lowest hierarchical standard geographic name for a location based on the Getty Thesaurus of Geographic Names used by the DACS standards. The proper noun designation for a place name, natural feature, or political jurisdiction.
Geogreference	This attribute will describe any geographic references other than coordinate data or street address, i.e., cross-streets, port, train station, or city hall.
TGNLatitude	This attribute will contain the latitude designated by the TGN.
TGNLongitude	This attribute will contain the longitude designated by the TGN.
Historic	This attribute denotes whether a building, found within a photograph or mentioned in the written material, is in the national or state historic register.
PDF	This attribute is a link to the .pdf file found on the archive website associated with the POWHGIS.
Note	This attribute allows for any additional information or notation associated with a specific item.

3.3.3. Getty Thesaurus of Geographic Names (TGN) Table

The location process starts with determining the geographic name attribute, geogname, using archival records, and descriptions. This recorded geographic name is then paired with the information from the Getty Thesaurus of Geographic Names (TGN), as is recommended by the DACS archival standards. The attributes for the TGN were completed by establishing the lowest place name within the TGN hierarchy of places and using the specified coordinate data, place type, spelling, and ID number. For example, the Capitol Hill neighborhood has its own TGN information that separates it from the City of Seattle, thus narrowing the scope and scale of geographic information for each archived item. **Table 3** includes the attribute definition data for the Getty Thesaurus of Geographic Names (TGN) data table, including standard geographic coordinates for each location. The data acquired from the TGN includes the standard geographic name, ID number, place type, and standard coordinates. This information is recommended by the DACS standards in relation to the geographic name or “geogname” tag identification.

Table 3 The Getty Thesaurus of Geographic Names Attribute Table

Attribute	Description
TGNID	The identification number of each geographic name in the TGN database.
TGNName	The preferred name of the geographic location.
TGNType	The type of geographic location such as inhabited place, state, county, or island.
TGNLatitude	The standardized latitude of a geographic location according to the TGN database. This attribute shows the exact standard coordinates for latitude based on the <geogname> tag.
TGNLongitude	The standardized longitude of a geographic location according to the TGN database. This attribute shows the exact standard coordinates for longitude based on the <geogname> tag.

3.3.4. The U.S. Census Data Table

In order to allow for a more detailed understanding of the data provided by the POWHGIS, U.S. Census data has been added to the combined POW and TGN tables. For example, a photograph associated with the Japanese culture taken in the year 1926 in a particular county would be associated with that county's 1920 U.S. Census demographic data such as population, nativity, and education. By providing this information, it permits a more detailed understanding of an archival item as well as allowing for a more in-depth spatial and temporal analysis. In order to successfully accomplish this goal, several U.S. Census Data (USCD) tables were created by downloading data and shapefiles from the NHGIS (2016). The decades associated with the POWHGIS that has been acquired are for the century between 1880 and 1980. To integrate the Census data into the POWHGIS, the Census headings for every decade were added manually to the POW tables and then the data for each item was entered via copy/paste. This manual data entry and validation ensured clean joins of the data to create accurate attribute tables in ArcGIS desktop.

Separate layers for each Census Decade 1880 – 1980 were also added to the database to provide a separate visual representation of the demographic data. When active, these layers provide a pop-up with the associated data for the use of research beyond that associated with a specific item directly. In addition, access to the Census Data for each item by decade and county allow for a researcher to search the database for subject headings, for example, "family portraits," in the POWHGIS web application with the Seattle layer turned on and find African American cultural items from the 1950's, and then compare the demographic data provided for those specific items.

The census layers were created by downloading the data tables for the pertinent information from each decade along with the accompanying shapefile and then joining them using the provided GIS Join attribute. As this data contains the entirety of the United States, the next step was to select by attribute all items that were found within Washington State and create a new layer from the selection. This was done for each Census decade from 1880 – 1980. Each new selection layer was then exported as a geodatabase shape file and then imported as an existing feature class into the POWHGIS geodatabase under the feature dataset, Census. Although each item has the associated Census data for that particular entry, not all counties within Washington State are represented this way. As such, the Census feature dataset allows for researchers to take a look at the entire state, county by county, in order to get an idea of how the data compares. For instance, if a researcher were interested in the Chinese population that helped to build the railroad pass in the 1880-1890's, they would not only want to take a look at the King County population data but the surrounding counties as well, especially those that the railroad runs, though. This would allow them to see if that particular population returned to Seattle, WA, stayed where they finished their work or left the state completely. **Figure 4**, shows an example of

the ERD for the 1980 Census Table manually joined with the POW Table by using the County Name and Decade attributes.

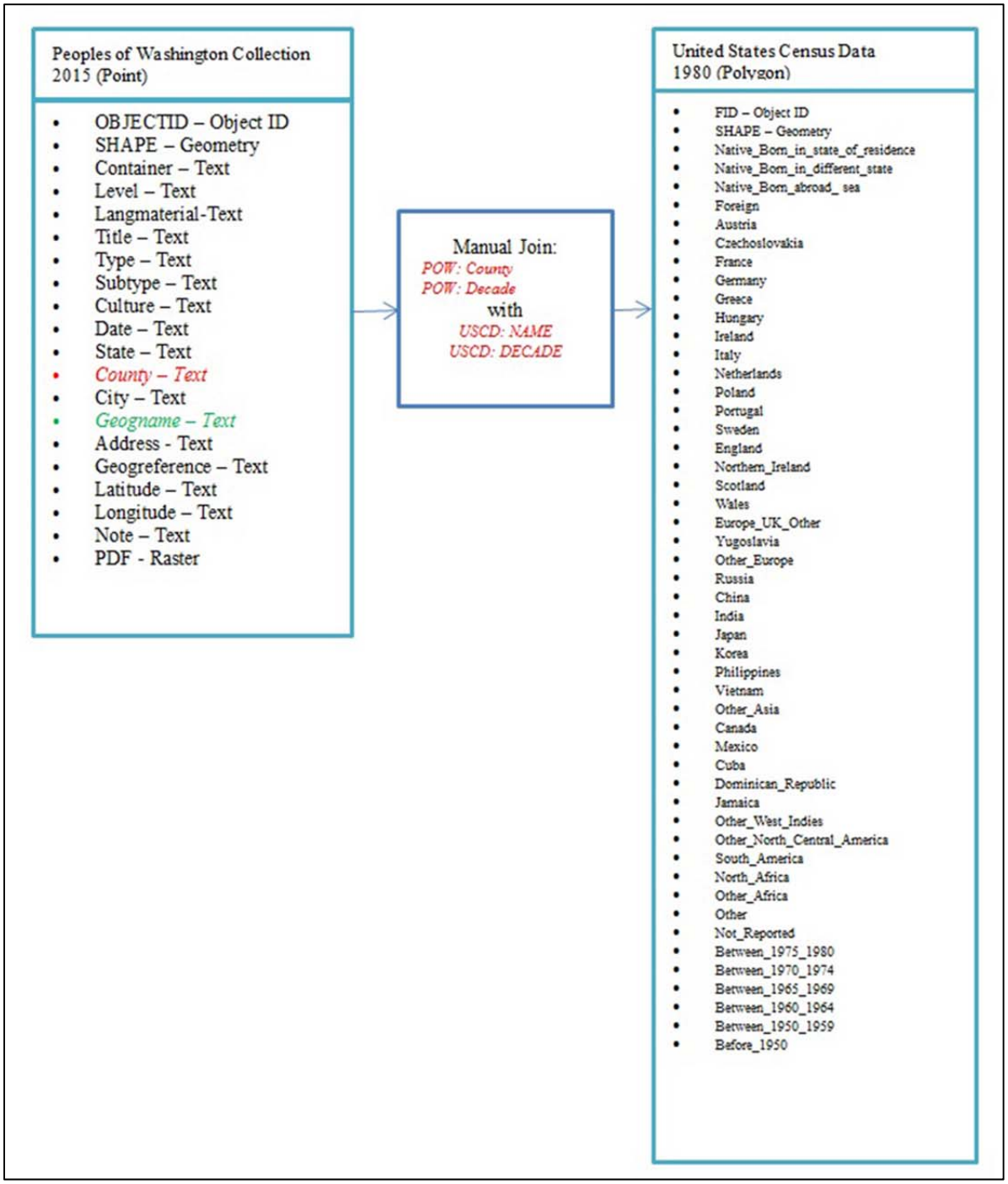

Figure 4 Entity Relationship Diagram for POW and 1980 U.S. Census Data Table

3.3.5. POW Collection Metadata

The metadata and archival description for the POW collection is uniform throughout the database. This data includes the TESC Archive Department's physical street address, description of the POW collection as a whole, finding aid information, and detailed listings of each subseries and what it contains. Appendix A contains the pre-written metadata from the finding aid for the Peoples of Washington Collection that is required for physical archival location. The data is extremely useful for a researcher who may decide they want to travel to the archive in person and locate a specific item, the associated notes, and search through the rest of the POW collection.

3.4 ArcGIS Desktop Map

An ArcGIS Desktop map has been created based on the POWHGIS database that contains all of the information from the POW, TGN, and USCD tables, plus a few extra layers of supplemental information. Layers within the map document include the various tiers of the POWHGIS, including state, county, cities, and individual addresses. The several separate feature classes related to the spatial hierarchal level of each archived item are as follows:

- Washington (Polygon) - This layer consists of the boundary of Washington State and provides a popup with information about items without any other specific geographic reference. This boundary has been determined with data provided by the official Washington State Geospatial Portal (WAGIC 2015). A few items have no spatial data or are located outside of the State boundary. However, they have still been associated with the culture of Washington State and will be included in that layer.

- Counties (Polygon) – This layer is based on the county boundaries within Washington State and provides a popup with information about items based within a specific county, e.g., King County. This boundary has been determined with data provided by the Washington State Geospatial Portal (WAGIC 2015).
- City (Polygon) – This layer is based on individual city limits within Washington State and provides a popup with information about items located within the city boundary, e.g. Spokane. This boundary has been determined with data provided by the Washington State Geospatial Portal (WAGIC 2015).
- Addresses (Point) – This layer represents the items that have been georeferenced to specific latitude/longitude coordinates using protocols established for this project. For example, the Old Masonic Lodge in Tacoma has a physical address that was located using Google Maps and coordinate data recorded for that specific point location.

Representing individual items at their correct spatial tier posed a complication, as individual points are not usually represented by polygon layers when working with GIS. The Addresses layer was not an issue as specific latitude, and longitude data was available for each point location. City, county, and state polygons, however, were needed in order to represent those items without specific address point data. In order to correctly represent these items, a process was used in order to create multiple polygon entries within one feature class attribute table.

The first step in creating the polygon feature classes for a city was to obtain the city boundary as a shapefile. This data was obtained from the State of Washington Department of Ecology GIS data list as the City and Urban Growth Areas (2016). From this original shape file, each city was selected by attribute using the city name, exported as a feature class, and then

imported into the POWHGIS under the POW feature dataset. The next step was to edit the attribute table of the city layer, select the first line, which contains the accurate shape and area data, and then to use the "Copy Features Tool", found within the Advanced Editor toolbar. This tool allows for the creation of another entry, within the attribute table, using the same geometry of the previously highlighted line. By clicking on the center point of the city polygon, marked with an X, a second polygon is created within that attribute table. This process needed to be completed for each item associated with that city boundary. For example, the Wapato city feature layer had only three items associated with it. However, the Seattle City feature layer had 54 total polygon lines that needed to be associated with that city's layer. Once the attribute table contained the proper number of entries to associate with the individual items, a table join with the POW city data tables was completed using the ObjectID attribute, as the polygon shapes were the same for every item. This process added the items for that city into each new polygon entry, thus allowing the data to be displayed in the appropriate spatial tier. This process was necessary in order to preserve the tiered spatial representation of an item. Instead of specific coordinate data that represented an archived item, the polygon geometry was used. No other way to represent this type of spatial relationship was found to be adequate, including rearranging the geodatabase structure.

Supplemental data layers that have been added to the POWHGIS are an ecoregions layer obtained from the Washington State Geospatial Portal (WAGIC 2015), and also a railroad layer obtained from the Washington State Department of Transportation's geo-spatial webpage (WSDOT 2015). The ecoregion and railroad layers were added in order to provide examples of how related information can be associated with a historical geodatabase such as the POWHGIS. The railroad layer, in particular, helps to set the context of some of the archival items, since, for

many decades in which the archival items were created, railroads were the primary means of long distance travel. The railroad layer contains current ownership information, however, as very little new track has been laid since the 1920's, this layer is also historically accurate. With access to extra information of this type, researchers are capable of a more in-depth study and thus will expand the accuracy and breadth of historic documents on Washington State history.

Table 4 describes the symbology chosen for each feature within the ArcGIS Desktop Map software. Each feature element is described in detail along with a short description of why each was chosen. This helps future developers to decide what elements to use or change for their own HGIS projects.

Table 4 Symbology Descriptions

Feature Type	**Symbology Description**
POWHGIS – Addresses	This small house image was chosen to represent a specific address location, usually an office building or home.
POWHGIS – Polygon Boundaries	City limits, county and state polygons are represented by their individual boundaries with a 1 pt. border line. Colors were chosen randomly by the ArcGIS Desktop program.
Supplemental Data – Railroads	The railroad system is represented by the stock railway symbol provided by the ArcGIS Desktop program.
Supplemental Data – Ecoregions	The ecoregions layer is represented by a Categories – Unique Values by the L4 Name label. The colors were randomly set by the ArcGIS Desktop program.
Supplemental Data – U.S. Census	The U.S. Census data is represented by Decade and Washington County boundaries with a 1 pt. border line. Colors were chosen randomly by the Arc GIS Desktop program.

Upon completion, these layers were published to ArcGIS Online as a Service in order to create a working map image layer. Publishing to ArcGIS Online via ArcGIS Desktop is the most accurate and accessible transfer of the data to a public forum. The map image layer was then edited to determine the web map's default scale, and orientation, as well as popup capabilities

and legend. Once these settings were established, it was saved as a web map, which can be utilized by the POWHGIS web application to create a visualization of the entire database.

3.5 Web Application Goals

The POWHGIS web application was created using the ArcGIS Online Web AppBuilder. This platform provides a means for the data contained within the archival collection to reach end users who may find the data important. This application allows for cartographic visualization of the material, basic spatial analysis using ArcGIS Online tools, and detailed searches using the search tool.

An overview of the capabilities of the POWHGIS web application includes many widgets and settings that the ArcGIS Online Web Application Builder provides developers. The most relevant of these options is the ability to geographically visualize the layers of the POWHGIS map online. The Base Map Gallery allows for base map changes centered on user preference, and all options have been left available in order to allow for a broader choice of comparison and display. An Attribute Table View provides detailed attribute data such as item name, location, date, type, coordinates, and census data linked to each item via county. The Popup option provides known attribute information about each archived item in an easy-to-use format. This data will be identical to that found in the attribute table view. The Search Tool, although rudimentary in its capabilities, allows for a search of the POWHGIS layers based on such choices as culture, date, location, item type, event type, and archival location. The Charts widget allows for a visual representation of the Census Demographic Data of a specified decade, which helps to provide a better understanding of an item's relation to the culture of Washington State. The Print Tool allows for printing of maps with specific data that has been queried by a user into .pdf format. These are all basic functions found in many interactive web applications that allow

for a researcher to fully access and utilize the information. User-friendly interfaces, such as those provided by Esri's ArcGIS Online, allow for the easy and quick creation of useful tools, such as those found in the POWHGIS web application.

A major web application function that allows for an in-depth analysis of the POWHGIS and the data that is accompanied, such as the census data or railroad layers, is the Analysis Tool. This tool allows for select spatial analysis options such as the calculate density, find existing location, and find nearest objects analyses types. The Calculate Density tool will calculate the number of point features in an area from least dense to most dense and display the results as a density map using light-dark colors. The Find Existing Locations tool will search the data for items that meet certain criteria specified by the users. The Find Nearest analysis option allows a user to find how close a specific item is in relation to a landmark, such as how many items are found within 1 mile from a railroad track. Knowing this location would greatly add to the understanding of the immediate geographic space of a cultural item. These three spatial analysis options can greatly increase the insight about an item and its relationship to geographic space and an area's cultural geo-history.

The completed POWHGIS Web Application has many different aspects, functions, and widgets included within its development. An important decision for the POWHGIS project was to use the ArcGIS Online platform instead of Google Maps API, coding by hand or other similar options available for this kind of HGIS project. ArcGIS Online was chosen due to its convenient connection with the ArcGIS Desktop and Catalog as well as the fact that it is quickly evolving and adding new and useful tools, widgets and features to its platform.

3.6 Overall Design

The design of the POWHGIS web application began while developing the initial geodatabase tables. Consideration of each individual layer's requirements and functionality was extremely important in the final outcome of this project. Once the geodatabase structure was established, the polygons based on each spatial tier were created based on shapefiles provided by the Washington State Open Data Bridge, which included city limit, county, and state boundaries. It was decided that polygons would best spatially represent the archival items that do not have specific point data. Using the Getty Thesaurus of Geographic Names coordinate data as points to represent those items on the map would have been misleading to general users unfamiliar with the project or how the DACS archival standards work.

Once the polygons were established, visual cartographic changes were made in order to produce a map for the POWHGIS web application that was both useful and easy to observe. These changes included a decision on colors for each layer, boundary colors, and styles, starting base map and a house icon for addressed items. Brighter more noticeable colors and a wide borderline were used for smaller city limits, such as Wapato, WA, while, somewhat darker colors were used for large city limits such as Seattle, WA. It was decided that, although not as initially useful as a topographic or street map, the dark grey canvas was the most eye-catching base map for the data which this project was most focused upon. The smaller cities, such as Yakima or Wapato, were lost within the colors, topography, and labels of options such as the national geographic or topographic maps, and unless the map was zoomed to the smaller city layer, it was easily missed. The dark grey canvas base map brings these smaller boundaries forward in a more eye-catching manner. Finally, in order to represent the archival items associated with a specific address, a simple image of a house outline was used. This icon was chosen due to its

representative nature as well as the fact that a more stylized, detailed 3-D image icon would not have been publishable from ArcGIS Desktop to the ArcGIS Online platform. The finished product portrays the data collected within the historical geodatabase in a visually pleasing and understandable manner while still providing important spatial and historical information that researchers would find very useful in their work. **Figure 5** shows the POWHGIS web application with all POWHGIS, Census, and supplemental layers turned on.

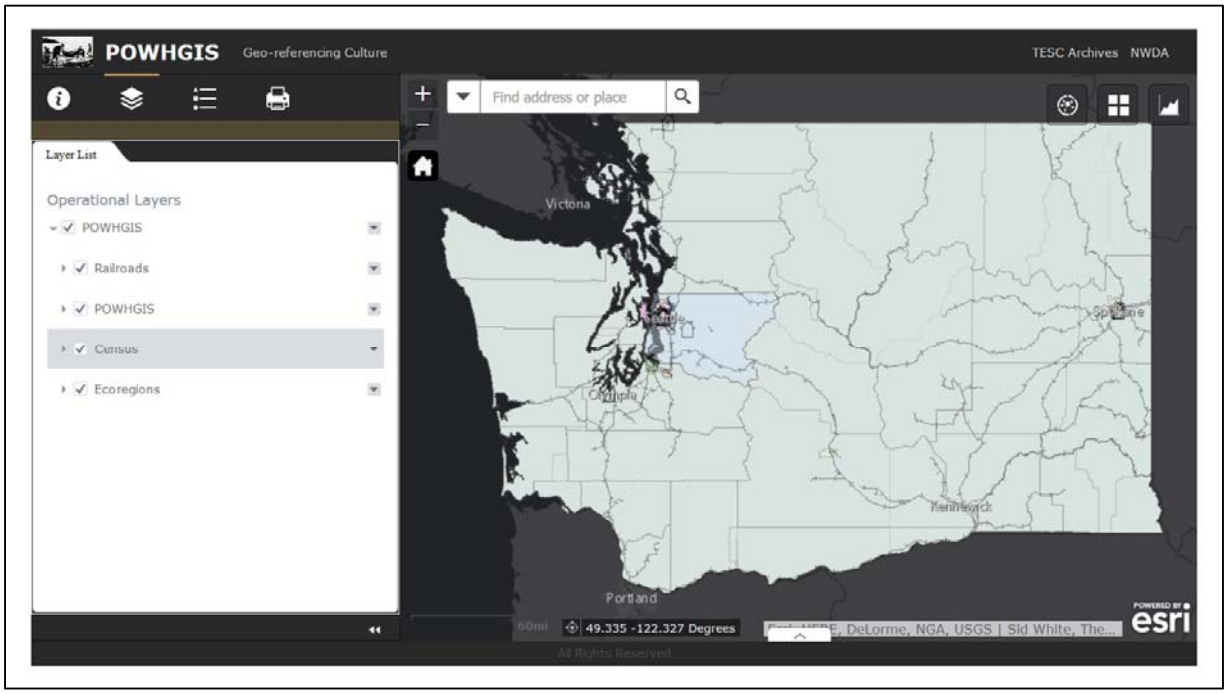

Figure 5 POWHGIS

3.7 POWHGIS Validation

In order to test the final database, the TESC archivist, geospatial professionals, a member of the Washington State Department of Archaeology and Historic Preservation's (DAHP) GIS department, and history researchers, were asked to utilize the database as if they were searching for answers to a specific cultural geo-historic question. Their reactions and analysis of the final project are included in Chapter 4 as a partial validation of this thesis project.

While determining the selection of beta testers for the Peoples of Washington Historical Geographic Information System several aspects were taken into account. First and foremost, their proximity within Washington state. This was considered important as they would most likely be more engaged with the project's contents then a person that lives out-of-state. Secondly, testers that worked in departments that had similar projects, scholarly interests, or possible future HGIS collections were considered. Finally, it was determined that testers needed to have extensive experience in at least one of the following areas: GIS, archives or historical research.

Once these possible contacts were determined through a reputational method, an email was sent out that contained a bit of background detail about the POWHGIS, the thesis writer, and a short questionnaire. This email was meant to inform the testers about the project and ask for their participation in the review and validation process. With their feedback, a more detailed results and analysis chapter was possible as well as identifying future changes for the POWHGIS project.

The user survey, which can be found in Appendix B, focuses on the functionality and usefulness of the web application and geodatabase, and the overall impressions and opinions of the beta user. The first section of the questionnaire asks about the overall appearance of the web application, and if the tools and options are clearly accessible. The second section asks the beta tester to use several aspects of the POWHGIS such as the search and chart functions as well as how the layers and legend displays. The third section focuses on the users overall impressions on usefulness and functionality, as well as asking for recommendations on data that would help increase the helpful information that the POWHGIS web application provides.

Chapter 4 Results

The results of the Peoples of Washington Historical Geographic Information System, including the use of the newly created geocoding protocols based on the DACS cataloging standards, are promising. An operational HGIS geodatabase and accompanying web application have been created in order to demonstrate the use and functionality of the methods and standards used in this project. In this chapter, each of the widgets and functions used by the web application is described in detail, with accompanying screen shots for demonstration. In order to better validate and understand the success of the POWHGIS, several beta testers were asked to participate in a user survey that tested the main functions and operation of the web application. Their experiences and responses reported here, give important suggestions for the future of the POWHGIS project.

4.1 Final Database

In its final form, the POWHGIS geodatabase has two feature data sets, POW and Census, and two layers for railroads and ecoregions, which have been used as examples for supplemental data. The main POW feature dataset has thirteen feature data classes including a point class for specific addresses, ten city polygon layers, one King County layer, and one Washington State layer. These separate layers signify the varying spatial relationships that the POWHGIS encompasses. The Addresses layer contains the eighteen archival items that had physical addresses associated with them and represents the lowest tier of spatial relationship as point data. They are represented as a building symbol on the ArcGIS Map and can be clicked upon in order to access a popup window with detailed information about each location.

The ten city polygon layers represent the next level of spatial relationship. These layers contain the archival items for which no address information was provided, but where a city

location could be associated with each one based on written material accompanying the object or using this study's new geocoding policies as detailed in Chapter 3 above. Many of these layers contain only one to three items; however, Seattle has fifty-four associated archival items within its city boundary. Item information can be accessed by clicking on the polygons or opening the attribute table via the layer menu.

The final levels of the hierarchy include counties and the state itself. The King County tier represents the few items that were associated with the county but have no specific city or address data associated. Currently, King County was the only county with such objects. Finally, the Washington State tier layer represents all the archival items that had no county, city, or address information associated with them, or had no spatial reference at all, except that it was part of the POW collection, and thus associated with the State of Washington in general. **Figure 6** shows the ArcGIS Catalog view of the POWHGIS geodatabase and all of its accompanying layers.

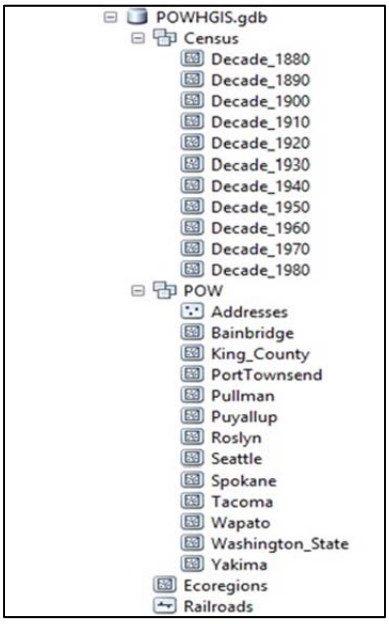

Figure 6 ArcGIS Catalog View of the POWHGIS

The supplemental U.S. Census feature dataset provides informative data that enhances the research capabilities of users of the POWHGIS Web Application. The data for the U.S. Census layer and associated shape file boundaries was obtained from the National Historic Geographic Information System (NHGIS 2010). The U.S. Census feature data set contains the feature classes for each Census Decade from 1880 – 1980.

As an example of the census layers, **Figure 7** shows a pop-up box with demographic data for Jefferson County in the Washington Territory in 1880, which appears when an individual county is selected. These layers represent the population data by county and decade and include data on race, nativity, gender, education, and total population. This type of information can be associated with archival items found within the POWHGIS in order to provide further insight on the cultural population of each item's associated decade. For example, if a researcher completed a search for African American items found within Seattle in the 1950's, the accompanying Census data would provide information on how many African Americans were in Seattle at that time, what their nativity data was, and how that population compared to the White, Hispanic or Chinese populations. This type of data can greatly enhance the understanding of an archival item, the time the photograph was taken, and the population that the item is associated with, thus increasing the accuracy of the research.

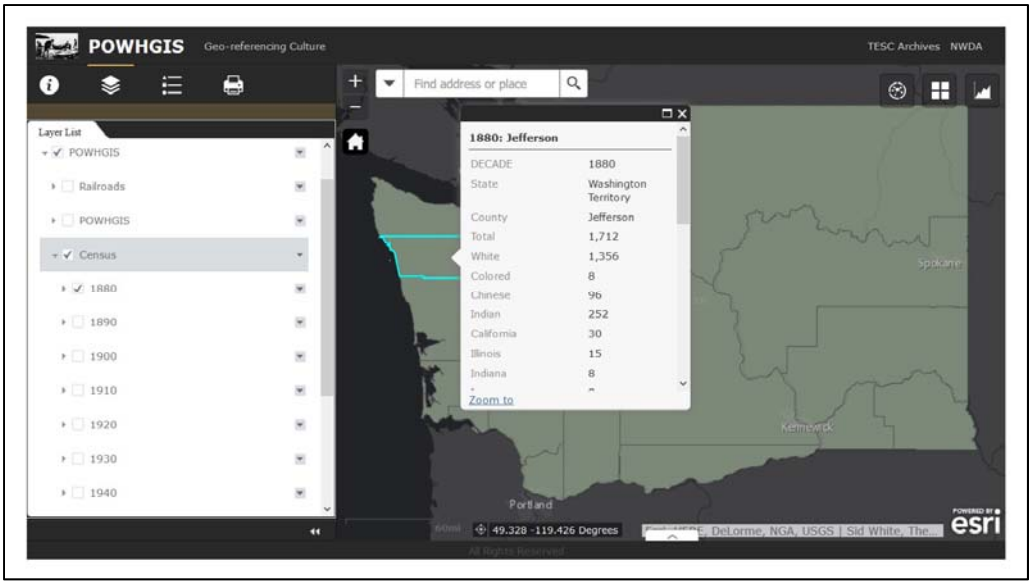

Figure 7 U.S. Census data layer for Jefferson County in 1880.

Further supplemental data layers for ecoregions and railroads are excellent examples of the types of associated data that can increase the understanding of an archival item and its place in Washington State's history. The ecoregions data was obtained from the Washington Department of Ecology via the Washington State Open Data Bridge website and is shown in its final form in **Figure 8**. The classification has been set to show the individual types of ecoregions so as to give a better view of the various types of environments found within Washington State. This type of data can help to understand why a particular group of people preferred this area over others, such as land for farming, logging, fishing or other cultural or material reasons. For example, the land found between Puget Sound and the Cascade Mountains is rich farm land and has been developed as such since the first settlers arrived in the area, thus it is no surprise that farmers and laborers of many different cultures settled in the area in order to raise crops or to find work.

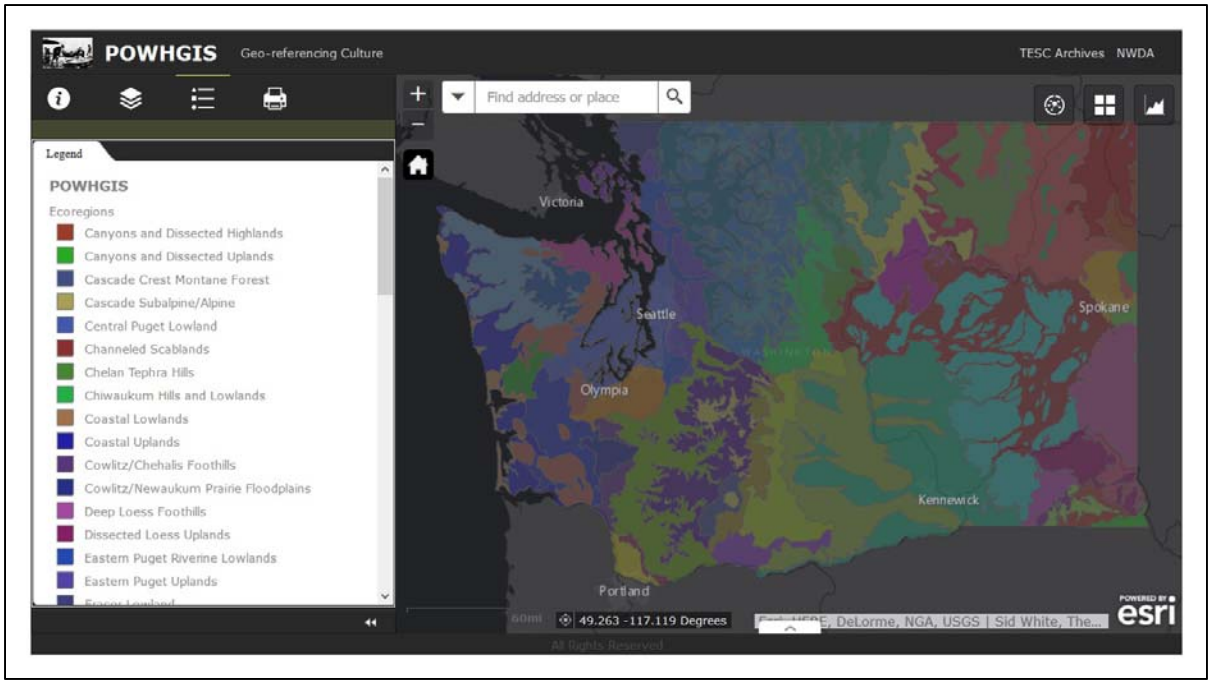

Figure 8 Ecoregions Layer

The railroad supplemental layer is included to show the type of transportation data that can be extremely important in historical research. By being able to perform a spatial analysis of the archival items found within a mile or two of a railroad track, a researcher can gain valuable insight into the history of an item, its associated culture, and its environment. For example, if a researcher chose to do a spatial analysis of Chinese archival photographs found within a half mile of the railroad tracks, they could get an idea of what types of connections that that culture had to the railway transportation network, including its construction and the many laborers that are associated with its maintenance and engineering. All of the recorded railroads within Washington State are shown via the POWHGIS Web Application in **Figure 9**. Note the change of the Base Map option to the Light Grey Canvas in order to better visualize the railroad network across the state. By providing supplemental data such as the ecoregion and railroad layers, a historical geodatabase, such as the POWHGIS, can greatly increase the accuracy, detail and

understanding that historical researchers have of an archival item, associated culture and spatial reference.

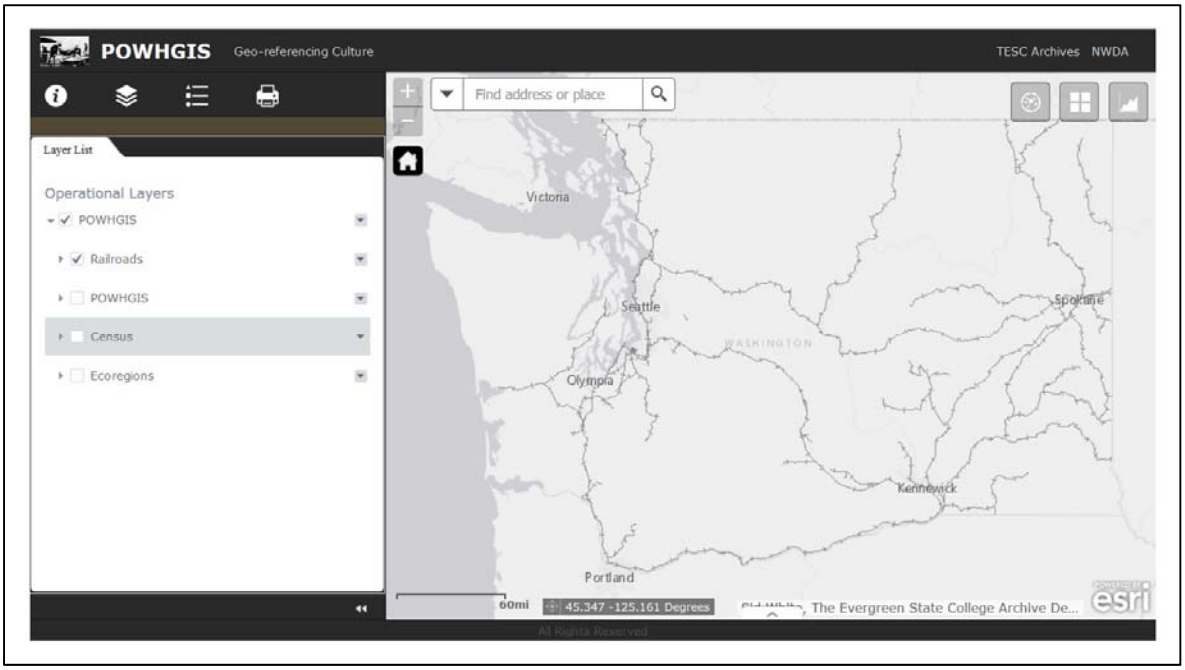

Figure 9 Railroads of Washington State

4.2 Basic Functions of the POWHGIS Web Application

The Esri ArcGIS Online Web AppBuilder for ArcGIS platform includes some very basic functions that many well-known user friendly navigation applications use as well. For instance, mapping applications such as Google Maps, Map Quest, Yahoo Maps, National Geographic, and other similar programs, use basic functions such as the home button, zoom in or out, base maps, links to outside webpages, about information tab, layer and legend options, and a basic print. **Figure 10** shows how these basic functions appear in the Tab based template selected for the POWHGIS web application, while **Table 5** provides a short description of each individual function and how they operate within the POWHGIS and ArcGIS Online in general.

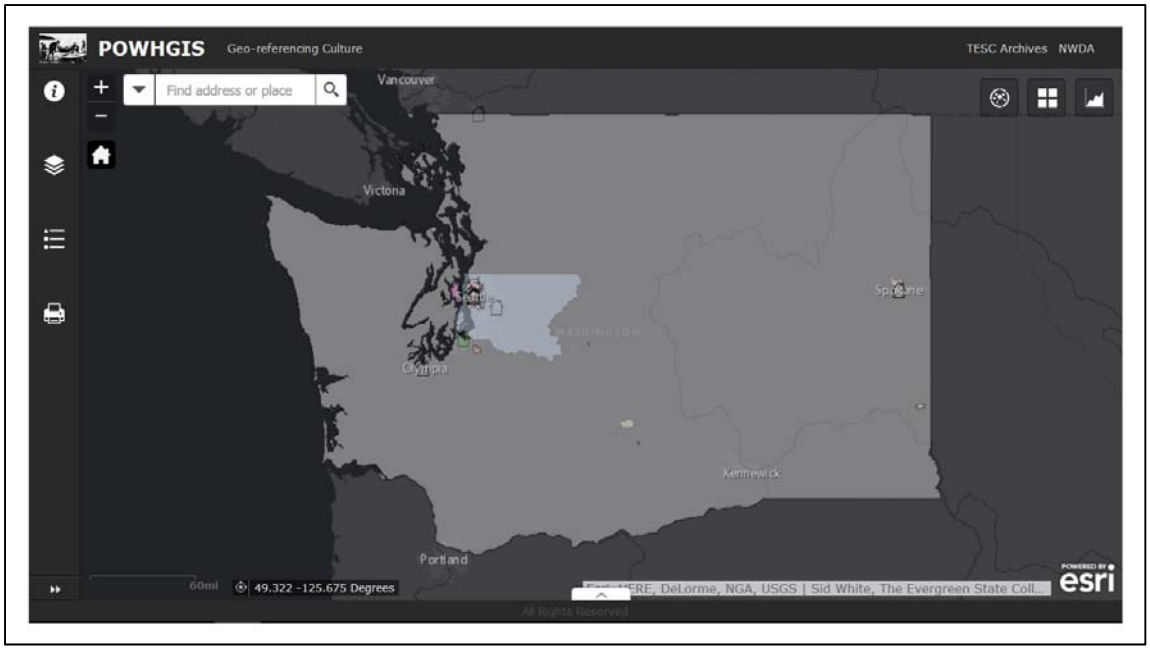

Figure 10 Home View

Table 5 Basic Web AppBuilder Functions

Home	Refocuses spatial scale and orientation to the original map's settings. For the POWHGIS that is a 1:5,000,000 ratio centered over Washington State.
Zoom	Zoom scale in and out to enlarge or minimize the map extent and focus.
Base Maps	The type of background map that is available to help increase the understanding of a geographic space. For the POWHGIS, the dark grey canvas is the primary base map.
Outside Links	HTML hyperlinks to supplemental data or web pages can be added to the Attribute tab of the Web AppBuilder. The POWHGIS provides links to the TESC archives and the Northwest Digital Archives webpages.
About	This tab allows for any directions for using the application, proper citation, background information or other important comments to be provided to the user.
Layers	The layers tab allows for multiple layers to be turned on or off as well as providing access to settings and to the attribute table of each layer.
Legend	The legend tab allows for visualization of the layers that have been turned on, thus allowing for customized research, cartography and results.

Print	The basic print function allows for a customized web map to be printed in .pdf file format. For example, if a user printed a map centered on Seattle with only the addresses and railroads layers turned on they would receive a .pdf of those selections alone.
Search	The search function allows for a user to find specific items based on keywords and selected layers. For example, if a user turned on the Spokane layer and did a search for 'Parades', they would get a results pull-down menu of all the items within Spokane, WA that contained the key term.

4.3 Pop-up Information

An important part of the POWHGIS Web Application is the pop-up window that displays the detailed information on each individual item within the database. There are pop-up boxes enabled for each of the layers in the geodatabase, including the railroads and ecoregions. They provide one of the ways for users to access the data on the archived items in a clear and manageable format. In order to obtain a more detailed understanding of an area's cultural items, more than one layer may be activated for each item. For example, if the city polygon of Seattle is clicked on the map, a popup box will appear for every item from three layers associated with that location, Seattle, King County, and Washington State. This allows for a broader initial search of cultural items associated with a certain geographic location, culture, and decade. **Figure 11** shows the maximized pop-up information box for an item from King County. Not only does it show the type and organization of information available, it also shows that the user is on (1 of 87) items that have been associated with the area where the user selected on the web map.

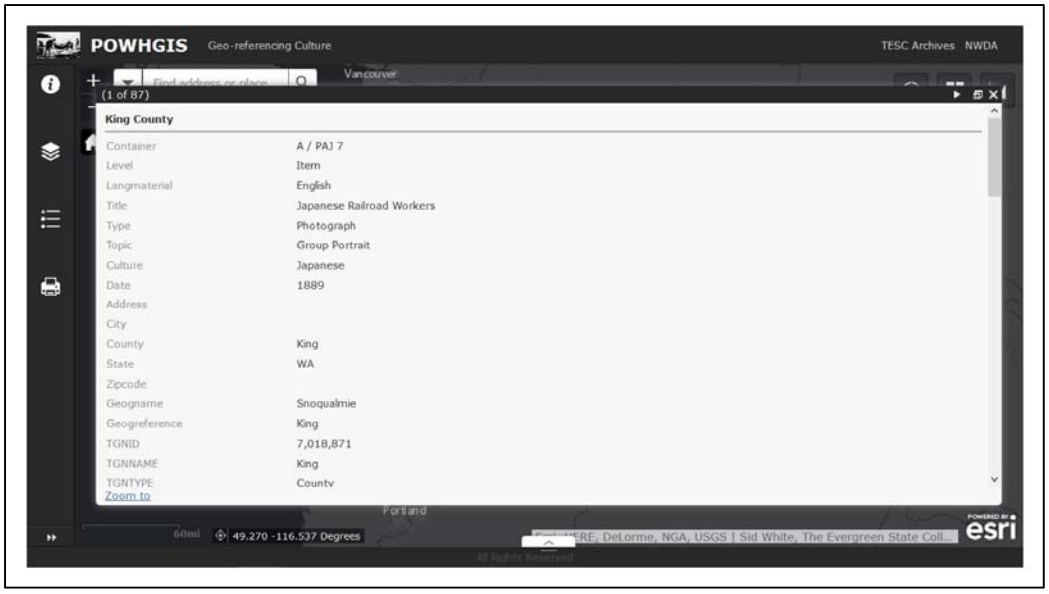

Figure 11 Popup Information Window

4.4 Search Function

Perhaps the most useful function of the entire POWHGIS Web Application is the Search Function. This widget allows for users to search by key terms in order to narrow down the results to center upon their research topic. Key terms such as those based on culture, topic, date, geographic place, and keywords can be used to bring up a list of all the items, across the entire POWHGIS geodatabase, which contain that term. In the example of **Figure 12**.A, the keyword 'parade' was entered into the Search textbox and a drop down menu of items, listed by the Container attribute, appears. The web map automatically zooms to the first item in the list as shown in **Figure 12**.B, as it is the default selection of the search widget. When another item is selected, the web map will once again automatically change its orientation and scale to focus on the selected item. For example, making the selection for the address point, AA 17 will automatically send it to the item in question, greatly zoomed in from the city layer, shown in **Figure 12**.C. Maximizing the accompanying pop-up window, **Figure 12**.D, will display the

pertinent information about the selected item, allowing users to research items using their selected research terms and geographic location.

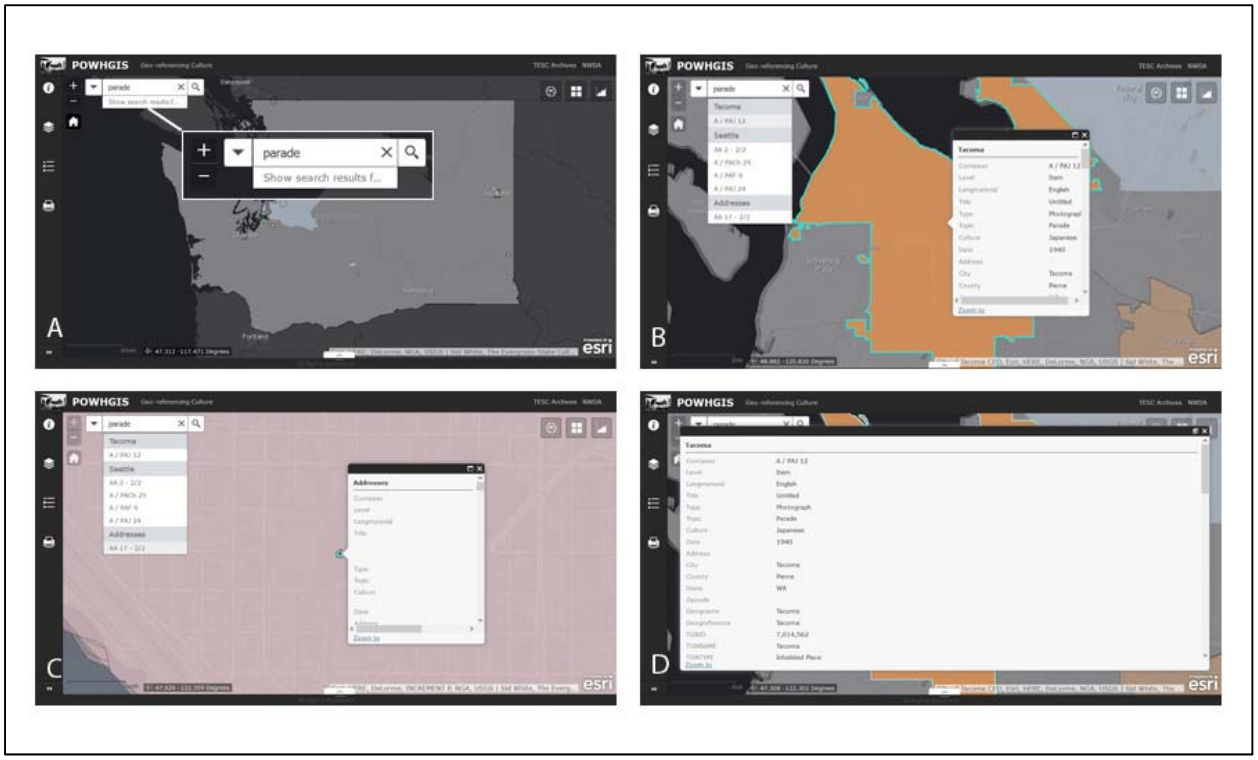

Figure 12 A - Parade Search Term, B - Tacoma, C – Address, D - Pop-up

4.5 Charts

An interesting and useful option that is provided by the ArcGIS Online Web Appbuilder platform is the ability to provide a Charts Widget. This widget allows the developer to provide various charts based on the database that the web application is built on. For example, the POWHGIS geodatabase contains U.S. Census data from 1890 on Education for each county of Washington State. The Charts Widget allowed for a bar chart and a pie chart to be created based on this information. **Figure 13** shows the outcome of the bar chart and the visualization of the data that it provides.

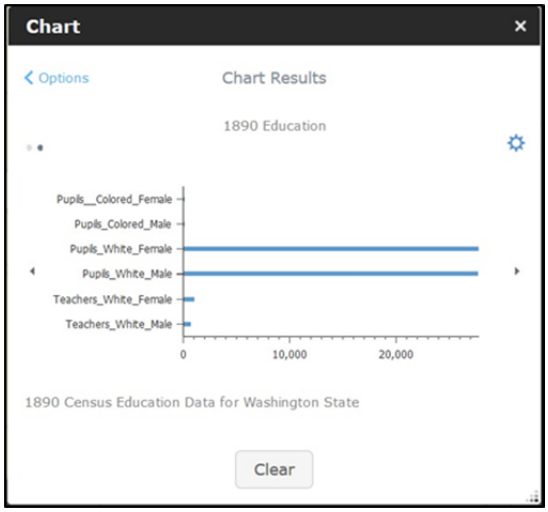

Figure 13 Bar Chart

4.6 Spatial Analysis

Another interesting tool that the POWHGIS provides researchers is the ability to perform some rudimentary spatial analysis of the geodatabase. **Figure 14**.A shows the current analysis options, including Calculate Density, Find Existing Locations, and Find Nearest. Each of the performed spatial analysis options will create a temporary layer within the Web Application so that the user may interact with the results of each one. The Calculate Density tool only works with point data or line data and is limited to the layers for addresses and railroads. **Figure 14**.B shows the results of this basic spatial analysis for the Addresses layer, showing that the majority of the addressed archived items reside in the Seattle area. The next analysis option, Find Existing Locations, allows for more advanced users to create query expressions in order to find items that are similar to the requested phrase. In the example, **Figure 14**.C, a simple query for finding all of the Addresses completely within the Seattle layer was successfully performed. The third available spatial analysis option is the Find Nearest tool. This allows a user to find geodatabase items that are within a certain distance of another feature layer. For example, if you conducted a Find Nearest tool analysis on all of the items in the Addresses layer that are within 1 mile of the

nearest railroad, the results would look similar to **Figure 14**.D. This tool allows for a researcher to associate certain items with important nearby features such as railroads, ports, or city centers. By clicking on the highlighted points in the results layer, the detailed pop-up window for those items would appear allowing for a more accurate geographic analysis then previously available.

Figure 14 A – Analysis Options, B – Calculate Density, C – Existing Locations, D –Nearest Neighbor

4.7 Beta Tester Feedback

The response received from the user feedback survey was encouraging, detailed and contained some excellent comments and recommendations. Those who participated included an archivist, historical researcher, archaeologist, and GIS professionals. The different types of beta testers provided a wide range of backgrounds, usage requirements, GIS knowledge, and professional interests. There were some universal themes that ran through the majority of the feedback surveys pertaining to the usability, functionality, and overall usefulness and appeal of

the POWHGIS web application and geodatabase. The feedback, comments and recommendations that were provided will greatly influence the future of the POWHGIS as well as any similar projects. **Table 6** provides insight on how many beta users participated and whether their responses were favorable or unfavorable.

Table 6 User Feedback

Feedback	**Favorable**	**Unfavorable**
Appearance clear	6	0
Tools unobstructed	6	0
Home Key functionality	6	0
Search Function	4	2
Layer Widget	5	1
Legend Widget	6	0
Census Layer	4	2
Charts Layer	2	4
Print Function	6	0
Useful for Research	6	0
Overall	6	0
Participants – 10 invited; 6 responded		

4.7.1. Overall Appearance

According to the feedback, the overall consensus on the appearance of the POWHGIS web application was positive. The dark grey canvas basemap is a nice contrast to the bright colors used for the city and county polygons, and fits well with the light colored layer of the state boundary. All of the widgets, icons and tabs were correctly positioned and easily accessible. The one major issue that the beta testers noticed was that when the Ecoregions layer was turned on along with the POWHGIS layer, some of the POWHGIS polygons disappeared against the multi-colored supplemental background's layer. This color issue caused the loss of some of the visual data and forced the beta users to manually click on those areas via the layer tab in order to access the information on those archival items. This issue could be easily remedied in the future by reorganizing the color scheme of the Ecoregions layer and individually matching up contrasting colors in the POWHGIS layers in order to bring them out against the supplemental layer. All in all, the beta testers found the POWHGIS appearance and aesthetics acceptable and easy to view.

4.7.2. Functionality

The feedback on the functionality of the POWHGIS is where it became obvious that there are some issues with the ArcGIS Online Web AppBuilder's current capabilities and functions. The major issue that arose in all of the user feedback questionnaires had to do with the pop-up information box. Whenever a user selected an item from the map, search results or attribute table, the popup box would appear, however, it is extremely small and in some cases inaccessible without changing the map aspect. In order to get a useable view of the pop-up window's data, a user must click on the enlarge button at the top right corner of the window. Although some users realized that a larger window was available, many did not notice the option, thus making it extremely bothersome for them to access the data. If GIS professionals and researchers familiar

with both the POWHGIS application and using ArcGIS Online in general struggle with clearly viewing the data, then a public user would most certainly have trouble as well. It was recommended that in order to possibly fix this issue that many of the attribute table headings should be shortened, thus allowing all of the data and information to be shown within that first, much smaller pop-up box. Another issue with functionality that was brought up referred to the access of the attribute table. Some found it cumbersome to use the right-click menu of each layer to open the attribute table; many did not realize that clicking on the small arrow at the bottom of the web application's window would bring all of the attribute tables into view, separated by different tabs, such as shown in **Figure 15**.

Figure 15 Attribute Table

4.7.3. Search

The feedback on the search function varied depending on the experience and familiarity with the POW collection and ArcGIS Online web applications of the beta tester. Those familiar with the POW collection were able to successfully use the search function with very little issue. However, users with no previous knowledge of the web application, database setup, or ArcGIS online, found the tool confusing. Furthermore, the issue with the size of the initial pop-up window made it seem that the search had returned items with no data attached to them, unless they had already encountered the maximize window option. Several suggestions were made by the GIS professionals that could reduce the confusion, such as adding title information to the

search results, including a detailed how-to explanation in the Info tab, and adding a thumbnail of each item within the pop-up information box.

4.7.4. Charts

As the chart function provided by ArcGIS Online Web AppBuilder is a new widget that has not yet been well developed, the feedback was mixed. The potential for increased data analysis and understanding was obvious; however, many users had great issue with the appearance and functionality of the current system. The pie chart option does not adequately label or display the data. The labels overlap on top of the chart and the ability to edit text, colors, and display is greatly lacking. The user can manually turn off the labels within the settings options, however, this is not apparent and thus none of the beta testers located this option. The bar chart is adequate for displaying information on a small scale with 2 – 5 data headings and a narrow difference in data results. However, if a user has requested a bar chart with more than a few selections, the headings and results are skewed, and in some cases, not shown at all. Although the chart function does have potential to be a wonderful tool, as it stands now, the widget is not quite adequate for research, analysis, or presentation.

4.7.5. Comments and Recommendations

There were some very encouraging comments and feedback about the overall concept of the POWHGIS web application and geodatabase. The historical researchers that tested the POWHGIS found the information to be very intriguing and liked the capability to compare the archival collection items to supplemental data like the census, ecoregions, and railroad layers. They felt that this type of information provided new insights into the history that may otherwise be missed. They also enjoyed the ability to see the images and accompanying information in a geographical representation that they could interact with to search for specific cultures, events,

dates and key terms. The feedback from the GIS professionals was much more technical in nature and has the potential to greatly increase the aesthetics and usability of the POWHGIS. One professional recommended that a Story Map template would be an easily understandable and visually impactful alternative to the current tool; however, this type of template does not allow for spatial analysis, the chart widget, or search functionality. This recommendation would be a wonderful accompaniment to the more advanced research tool that has been created for this thesis project and would be useful for less experienced researchers. Another professional suggested that a more detailed and readily available how-to document would help to take the POWHGIS from a good tool to an amazing resource. By providing a detailed, step-by-step instruction document, users would be able to have a better understanding of the information that the POWHGIS provides. Elements such as the search tool, attribute table and pop-up window access, spatial analysis, and chart widgets need to be explained as to their usage and results. All in all, the POWHGIS validation questionnaire and beta test was an informative and influential process.

Chapter 5 Discussion and Conclusion

The Peoples of Washington Historical Geographic Information System has successfully combined techniques and technology used in GIS with the standards and cataloging processes of archival description. A web application that offers basic spatial analysis, allows for cartographic visualization of the data, and provides online public access to the POW image collection has been created. Although there are forerunners in terms of historical geographic information systems (HGIS) based on archival data and published to the web, none use established archival description guidelines, policies, and practices that could standardize the use of such data in a geodatabase. This project incorporated the already recognized archival description standards used by the Society of American Archivists into the process of creating a historical geodatabase.

5.1 Overall Project Discussion

Using standardized policies, processes and techniques to describe and organize archival data used in creating geodatabases could greatly impact the future of historical and archival research and presentation. The DACS standards allow for expansion and establishment of new protocols as old media types evolve and new types are created. By utilizing these types of standards to create HGIS geodatabases, a whole new level of accuracy and availability will improve future data creation, geodatabase organization, public and private access, as well as allowing for visual cartography, and basic spatial analysis of the historical archive data.

Overall, the new geocoding and geodatabase creation protocols used for the POWHGIS project were successful. These protocols were effective due to the expansive nature of the DACS standards on which they were based as well as the available GIS tools and techniques used for both creating and organizing the archival data used in the HGIS geodatabase creation. The

finished web application that was created based on the POWHGIS geodatabase provides useful cartographic visualization, spatial analysis, and online access to the archived data.

Expanding these guidelines to the use of the Library of Congress subject headings and the SAA standards will allow for a broader type of user base, one that already has knowledge of using and accessing established archives. By using familiar and well-known processes, protocols, description, and attribute headings to create, organize, and maintain a HGIS geodatabase the developer immediately makes the data intuitive and more appealing to historical researchers. Making it easier and more instinctual for the targeted audience to understand and obtain geo-referenced archive data will increase the accuracy, detail, and availability of historical research. It will also assist in the documentation and presentation of the historical archive data in question.

Creating historical geographic information systems based on the DACS will also help to increase researchers' understanding of history and the geographic connections that may influence it. By correctly creating, organizing, and maintaining historical data in this manner, a researcher can obtain visual representation of the data using cartographic techniques. Reading about how many historic barns arose within the deserts of south-central Washington after the Columbia River dams were built is nothing compared to seeing a spatial-temporal map of each farm as it was established. Providing a visual cartographic display of the archive data will bring a whole new level of understanding to historical research and presentation.

Combining GIS techniques with the archival standards have put several tried and true GIS methods to new purposes. Creating an HGIS based on the DACS requires a new outlook on using GIS practices and establishing geodatabases. The first example of GIS techniques that were used in a distinctive manner for this project is the establishment of the geodatabase attributes according to the DACs standards. The second example is the use of the copy feature

option of the advanced editor toolbar in order to create multiple boundary polygons within a single layer that represent individual items. The unconventional use of these established GIS methods are discussed in detail in order to provide an understanding of how expansive using the DACS description standards can be in order to adequately describe a HGIS.

The establishment of the geodatabase attributes was based on the recommendations of the Describing Archives Content Standards (DACS) method of archival description. These description standards differ greatly from other examples of geodatabase attribute headings that have been used in past HGIS. Although they make very little immediate sense to a GIS professional, a researcher familiar with the DACS and LOC subject headings would immediately recognize and understand them. This is a preferred outcome as the end-user should be the main focus when it comes to understanding and utilizing the data. By using the DACS standards to create the attributes of the original geodatabase, a historical researcher already familiar with utilizing archives and the Library of Congress subject headings will have a more in-depth understanding of the data due to that previous experience.

Perhaps the most unusual portion of the POWHGIS project was the tiered spatial representation that the archival data required. In order to adequately display archive items without a specific point location, polygons were used to represent the level of spatial information available. In this process, the polygon geometry represented individual items in the same way that exact latitude/longitude coordinate data did. For example, if the city of an item was known, it was symbolized by a polygon of the city's border, instead of a single point. However, this posed a problem in some cases where there were many items found within a specific city, such as Seattle. In order to correctly represent the spatial relationship, without creating 54 separate city boundary layers, the copy feature option, found within the Advanced Editor toolbar, was used to

create duplicate geometries within the original attribute table. This method allowed for the unique tiered spatial representation that the POWHGIS required. This provides an example of the type of unconventional uses for established GIS practices that using archival description protocols to establish a geodatabase necessitates.

5.2 Contribution to GIS

The methods and new geocoding protocols used during the creation of the Peoples of Washington Historical Geographic Information System contribute to the GIS profession in several different ways. First, it highlights the ability of GIS to serve widely in support of other academic fields. Second, it demonstrates the value of library science and its description standards in the creation of geodatabases. Third, the tool demonstrates the use of overlapping polygons to represent the spatial tiers associated with archival collections.

GIS has been used in many different fields including earth sciences, marketing, travel, diplomacy, military intelligence, and the media, just to name a few. In recent years, historians and archaeologists have begun to use it in the social sciences as well; however, it has been piecemeal, with little to no standardization between organizations, academics, libraries or individuals. An important contribution to GIS and the social sciences that the POWHGIS project makes is an attempt to present methods and a working example of the outcome that standardization can create.

Combining GIS techniques and practices with archival description standards can contribute to both areas of expertise. End-user focused historical geodatabases can be created using archival processing techniques to create data that is most useful and interesting to a historical researcher. Using established archival rules and standards to organize historical geodatabases will make the data intuitive and accessible by users already familiar with the

standards approved by the Society of American Archivists as well as the Library of Congress. Creating new geocoding techniques based on DACS will help GIS professionals interested in expanding into the social sciences to create standardized historical geodatabases. To further this standardization, the usage of the Library of Congress subject headings for Untitled/Unknown items will greatly improve the detail and accuracy of a historical geodatabase when implemented into a user platform allowing for search and spatial analysis capabilities. By using the established DACS protocols with geodatabase creation methods, a historical geographic information system can be created that provides detailed and accurate information arranged in a format that archivists, researchers, academics, and the general public can easily understand.

Technical and methodological techniques used in new and informative ways can also greatly contribute to the general knowledge base of GIS. In the POWHGIS project, it was necessary to represent individual events with polygon geometry. The advanced editor tool, 'Copy Feature' was used to represent multiple polygons contained within a single boundary line, layer, and attribute table. A step-by-step description of the method used to complete this task can be found in Chapter 3.4ArcGIS Desktop Map. Being able to visualize the archival items in their spatial representative tiers allows for a greater understanding of those items and the history that they represent, contributing greatly to both GIS and the social sciences.

Another contribution to the academic and GIS fields that the POWHGIS makes is to allow for more accurate spatial representation of archival items based on referenced geographic location, such as address, city, county, or state. By following the new geocoding protocols created for this project, it is possible to gain more detailed and accurate geographic data about a specific item. For instance, using the business sign in the background of an item, with little to no other spatial data are written in the paper work can provide more specific coordinates such as an

address or street crossing. The geocoding procedure that the POWHGIS uses can also be implemented for other collections, such as art, artifact, document, and photography collections. It might also be useful for helping to geocode genealogies, where the recording of place names in family records are sporadic and evolve with changing geographies (Ray 2016).

GIS professionals are always looking for new and innovative ways to explore the world using their skills and knowledge. For example, bringing the use of geospatial referencing and visualization into archival collections found within academic and government archives can be greatly beneficial to their patrons. GIS can help to create more detailed and visual finding aids for the archived collections can increase online and computer access to the materials, and can be a wonderful platform for creating digitized archive collections. POWHGIS also illustrates the usefulness of these geospatial tools and techniques in the fields of history and archaeology by presenting a method to visualize historical geographic connections to people and place, to allow for spatial analysis of correctly organized data, and by allowing geo-referenced archaeological and historical data to be compared to other established spatial data from areas such as transportation, ecology, fish and wildlife, and demographics. Finally, the POWHGIS geocoding protocols and HGIS geodatabase creation opens the door to creating genealogical HGIS that can allow users cartographic visualization of family heirlooms such as photographs, land deeds, identification cards, military documents, immigration documents, and similar items. Using the methods and techniques outlined in the POWHGIS project also gives users the ability to map out their heritage using documents pertaining to birth, death, military, education, immigration, and religion.

5.3 Limitations

There are two areas of limitations that required troubleshooting which deserves to be mentioned so that others are aware of them and can find solutions of their own that adequately deal with the issues. The major issue that the POWHGIS encountered was the trial and error period for representing archival items as polygons. A secondary area of concern is the functionality and appearance of the POWHGIS web application published using the Esri ArcGIS Online Web AppBuilder browser program. Both troubleshooting requirements were successfully completed, and in some cases, multiple solutions put forth.

5.3.1. Spatial Tiers and the 'Null Geometry' Issue

Null Geometry, a rare and extreme issue appeared in the first attempts to represent the tiered spatial relationship of the POWHGIS archival items. The initial method tried included creating a new polygon layer by copy/ paste and then by digitization. The first created multiple layers for the same boundary file. While this works technically, having 130+ layers, one for each item is excessive and bad mapping practice. The second method used was attempting to edit the attribute table of a single layer to represent the multiple items from the same location. This method would have not only created the same results as the first but would have also been extremely inaccurate and time-consuming. For several reasons, such as lack of coordinate data and the inability to edit the original layers geometry, this method repeatedly failed, presenting the null geometry issue for the first time.

The null geometry issue was a significant concern with the continuation of the POWHGIS project. After significant time spent troubleshooting, it was determined that there were three possible ways to work around this issue. The methods included using the replace geometry tool, using both points and polygons to try and represent the data, and by using the

"Copy Feature" option of the advanced editor toolbar. The first option would have required extensive re-digitization of a spatial tier's boundary for every item included in the attribute table of the polygon layer in question. Although technically feasible, this method would be inaccurate, extremely time-consuming, would require manual digitization that could be physically harmful, and take up an unacceptable amount of digital storage space. The second option of having all of the archival items represented by the TGN coordinate point features and associated with their boundary polygon layers would also have been another method to overcome the null geometry issue, however, it would have been confusing to an end-user without detailed instruction and troubleshooting, as well as exceedingly inaccurate as a visual representation.

The most straightforward and streamlined solution to the null geometry issue was using the 'Copy Feature' option of the Advanced Editor toolbar in ArcGIS Desktop. This allowed for the creation of the separate polygons that represented the individual archived items associated with city, county or state boundaries. It was then possible to edit the attribute table or import table data using the join operation. The 'Copy Feature' option is the quickest and most spatially accurate method to provide the final solution to the spatial tier and 'null geometry' issue.

5.3.2. ArcGIS Online Web AppBuilder

Although the ArcGIS Online Web AppBuilder was the easiest and most compatible final platform for the POWHGIS, the version utilized in this study as-is – out of the box - posed some significant limitations to functionality, usability, and aesthetics. The first issue that was discovered was the fact that none of the detailed and attractive 3D icons that can be used in ArcGIS Desktop could be published to the ArcGIS Online platform. Although an aesthetics issue, the inability to describe items in as much visual detail as possible was disappointing. Secondly, lack of tools for customizing the appearance of popups, search results, and charts was

also detrimental to the overall clarity and professional look of the final web application. The limited capability to add and work with images and outside links within the popup information window, attribute tables and about tab also had a restrictive effect on the overall presentation and functionality of the POWHGIS web application. Finally, the fact that the search function is currently limited to one key term at a time presented some issues with the creation of the original database in terms of search compatibility in layers and attribute tables. Despite these issues with overall aesthetics and search functionality, the ArcGIS Online Web AppBuilder platform was the most efficient and compatible option for working with the POWHGIS geodatabase and ArcGIS Desktop Map application.

The latest version of the ArcGIS Online WebApp Builder that was released in December of 2015 allows for a more hands on approach to the creation of web applications. The new version allows for more customizable widgets and themes as well as greater compatibility with smart phones, tablets and PC's (Esri 2015). A release in March of 2016 will also allow for developers to access the source code of the web application which would greatly reduce the development issues of the version used for this project, including access to 3D objects (Esri 2016). Using these new versions was not a viable option for this project due to time constraints and release dates.

5.4 Future Work on the POWHGIS

The future of the Peoples of Washington Historical Geographic Information System is just beginning. The beta version used for this project will be improved with the recommendations of the beta testers and then moved to its final location at The Evergreen State College ArcGIS Online Organization and the Archive Department's official website and servers. This would mean setting up a role for public users with a credit cap that would not allow

individuals to expend all of the allotted Esri service credits used for the POWHGIS, a practice that could otherwise be extremely expensive. For example, according to Esri's website a spatial analysis performed using the ArcGIS Online Spatial Analysis option is 1 credit per 1,000 features. During the creation and testing of the POWHGIS Spatial Analyst tool, 10 test analyses were run which cost about 1.6 total service credits. For a small database such as the POWHGIS with only a couple hundred features, it would not be very expensive, however, for a larger collection at a State or University archive with thousands of items, such processes could become unsupportable if not monitored and limited.

The first of the intended improvements to the POWHGIS in the future includes changing the city polygon colors so that they stand out against the background of the ecoregion and U.S. Census layers. In addition, utilizing a new developer account for Web AppBuilder, would allow for greater access to the source code of the application, permitting a solution for a great deal of the changes and appearance issues that the original Web AppBuilder did not provide a means to fix.

Adding other supplemental data could also greatly increase the usability and functionality of the POWHGIS. Other types of useful information could include a more detailed transportation network including ports, truck routes, and airports. Still more possibilities include the location of historic farms and government administration buildings, wildlife migration routes and habitats, a more detailed map of crop types and growing conditions, and many other types of supplemental data depending on the type of research that is being performed.

Another important advancement envisioned for the future of the POWHGIS is providing access to additional types or categories of images, newspapers, historical records, and notes on each item. These would include an expanded database with digitized versions of all the items

within the collection, not just photographic material. The final and most highly desired expansion is to include the larger Washington Folklife Archive Collection, as well as any similar collection that the archives may obtain in the future, within a larger geodatabase for the TESC Archive Department that includes multiple collections of historical importance.

5.5 Conclusion

In conclusion, the Peoples of Washington Historical Geographic Information System represents a successful step forward in not only bringing GIS into other academic and professional fields of study but also providing a method of standardization for that expansion. By creating a means for historical researchers to not only gain digital access to archive collections but to also gain spatial reference and cartographic visualization of the historic data, historical geodatabases, such as the POWHGIS project, will increase the level of accuracy and geographic understanding of the history of Washington State. Other Historical Geographic Information Systems such as the National Historical Geographic Information System (NHGIS), the Washington Information System for Architectural and Archaeological Records Data (WISAARD), and projects like Inside Idaho, are successful and inspiring attempts to provide geographically referenced historical and archived data.

Although on a much smaller scale than the government funded examples, the POWHGIS has presented useable and replicable processes and techniques to adequately represent individual items within an archival collection on spatial and cartographic levels. The new geocoding protocols based on the DACS archival description standards are capable of creating clear, spatially accurate, and informative historical geodatabases that can greatly increase our overall knowledge and understanding of history and its geographic associations. The organization of the historical geodatabase created for the POWHGIS project was greatly influenced by the

geocoding protocols and has been praised by several GIS professionals and historical researchers. Also, the 'Copy Feature' method of cartographically representing the unique spatial tier that the archived data required was effective and visually appealing. The overall feedback from the beta users was positive and represented the general success of the POWHGIS project.

The Peoples of Washington Historical Geographic Information System presents a successful illustration of how creating spatially representative digital collections of archived and historical collections can be achieved. Providing broader access to the historical data and accompanying photographs of such a collection can have a dramatic impact on the quality and detail of historical writing, research, and education. It is this increase in data quality and access that inspired the initial creation of the POWHGIS geodatabase, opening the door to further development of standardizing geocoding practices and protocols used in the formation of historical geographic information systems.

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Appendix A: POW Collection Metadata

Metadata Tag	Description
TitleProper	Peoples of Washington Collection
Repository	The Evergreen State College Archives and Special Collections 2700 Evergreen Parkway NW L-2309 Olympia, WA 98505 http://archives.evergreen.edu 360-867-6126
Extent	2.375 cubic feet
Abstract	The Peoples of Washington Collection collects the research and exhibit materials related to the Peoples of Washington Project conducted by Sid White and Pat Matheny-White from 1986-1989.
Accessrestrict	Collection is open to the public.
Arrangement	This collection is divided into three series: Series I: Research Materials, Series II: Exhibit Materials, and Series III: Miscellaneous Materials. In Series I, the original arrangement of the subseries has been maintained, although the files were arranged alphabetically by cultural group; Series II has been arranged alphabetically by file; and Series III is yet to be arranged.
Relatedmaterial	The Sid White Papers contain materials related to the Peoples of Washington collection, especially the records of Exhibit Touring Services, which documents much of the tour of the Peoples of Washington exhibition.
Processinfo	Excepting two boxes of miscellaneous materials that remain unprocessed, the collection is now fully processed with special attention given to materials related to the Washington State Women's History project.
Scopecontent	The collection consists largely of photographs, photographic materials, and photocopies of news clippings and photographs. In addition, there are bibliographies, notes, timelines, demographics, academic articles, books, chapters from books, research abstracts, museum pamphlets, periodicals, newsletters, drafts of exhibit texts, administrative materials and the actual framed displays used in the exhibit. The materials were mostly collected between 1986 and 1989 as research and preparation for the exhibition and publication of the Peoples of Washington project in 1989. All photocopies were presumably made during this same time period, regardless of the date of the article or photograph.

Description	According to Pat Matheny-White, the "Peoples of Washington project was developed by Sid White, member of the Evergreen faculty and director of the college exhibitions program, who served as grant writer and project director. Evergreen Faculty Librarian Pat Matheny-White was research director and producer of bibliographies, and resource guides. The Peoples of Washington Archive is a research and teaching resource focusing on cultural diversity in Washington State, and is a major outcome of a Washington State Centennial exhibition and publication project that was carried out under the sponsorship of The Evergreen State College during 1986-1989. Primary funding support for the project came from the 1989 Washington State Centennial Commission, with additional support from the Washington Commission for the Humanities and Great American Savings Bank. Total grant funding amounted to $137,100. The purpose of the Peoples of Washington project was to provide broad public recognition to the diverse cultures and communities in Washington State, both in the past and the present. The materials in the Peoples of Washington Archive, reflecting the scope of the centennial project, consist mainly of photographic materials documenting various aspects of history and life in Washington ethnic communities.

Appendix B - POWHGIS Beta-Tester Questionnaire

Presentation

1. Is the appearance of the POWHGIS application clear and easy to read?

2. Are available tools easily accessible and unobstructed?

Usability

3. If you are a researcher or archivist, is this type of web application useful for conducting research? Comments?

4. What kind of changes or recommendations would you make to improve the usability of this kind of project?

Functionality

5. When the Home key is clicked does the map refocus to the State of Washington?

6. Type in any of the following keywords:

African American
Chinese
Japanese
Parade
Group Portrait
1880
1950
Seattle
Thurston
98504
Railroad
Immigration

Please describe your experience with the search function.

7. Please click on the Layer widget and click through the various layers available. Do the layers draw quickly and clearly? Do they line up the to the base map and POWHGIS layer?

7a. For future developments of this project, what other types of data would be useful as a researcher?

8. Turn on the Ecoregions layer and click the Legend widget. Does the legend appear reasonable and easy to understand?

9. Turn on the Census Layer and select two decades. Select a county and enlarge the Popup window. Is the Popup window legible? Is data provided easy to understand?

10. In the right corner, please click the Charts widget. Find the 1980 – Native vs Foreign Chart and consider the presentation of both Pie and Bar chart options by pressing the arrows on either side of the window. Do they function in a usable way?

11. Please try the print option. Did it function correctly?

12. Please take a few moments to make any overall comments, recommendations or complaints on the POWHGIS project.