BCIT GIS Student Project Proposal

Analyzing Access to Primary Care in British Columbia

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Abstract

This project analyzes the accessibility of primary care facilities across British Columbia to identify service gaps and propose optimal locations for new facilities. Due to geographic barriers such as mountainous terrain and uneven distribution of facilities, disproportional access to health care has been created. These barriers will be quantified by conducting a network analysis with open-source data on roads and healthcare facilities. The British Columbia Index of Multiple Deprivation (BCIMD) will also be incorporated to identify where poor geographic access intersects with high social vulnerability. The technical workflow involves creating a PostGIS database for data management, performing origin-destination cost matrix calculations in ArcGIS Pro, and developing a custom interactive web map using the Leaflet JavaScript library. The project requires approximately 360 hours of work and will be conducted from January 9, 2026, to May 22, 2026. Key deliverables include an interactive web map dashboard, a static recommendation map, and a vulnerability and gap analysis report. This project will help Health Authorities in planning the building of new clinics, and the public will gain access to more equitable primary care.

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Introduction

Access to primary healthcare is fundamental in determining population health (Stange et al. 2023). Due to British Columbia's geography, which ranges from dense urban areas to remote mountainous regions, the ability to access healthcare can be challenging. This document outlines a Geographic Information Systems (GIS) project that will analyze geographic access to primary care in British Columbia. The project investigates spatial accessibility using network analysis tools and correlates these findings with socioeconomic deprivation indices (Neutens, 2015). The following sections will give a detailed overview of the project, the data sources required, the schedule for completion, and the methodology used to conduct the analysis.

Project Statement

This project analyzes geographic access to primary care facilities in British Columbia by calculating travel times for all census dissemination areas (DA). It identifies vulnerable populations by overlaying access metrics with the BC Index of Multiple Deprivation (BCIMD) and uses a location-allocation model to propose optimal sites for new healthcare facilities.

Project Sponsor

This is an applied research project formulated by the student and will not have a sponsor. It will be assigned to a BCIT faculty member who the student will report to and may receive guidance from.

Project Objectives

The primary objective of this project is to evaluate the equity of primary care distribution in BC and provide data to support the planning of new healthcare facilities. To achieve this, there are three specific objectives for this project. First, the travel time and distance from every DA to the nearest primary care facility will be calculated using a road network dataset. Second, areas where communities face both long travel times and high

scores in the BCIMD will be determined. Finally, three to five optimal locations for new primary care facilities that maximize coverage for underserved populations will be chosen.

There will be a variety of technical work involved in completing this project. A PostgreSQL/PostGIS database will be set up to manage spatial data schemas. It requires developing Python scripts to clean data from open sources. ArcGIS Network Analyst will be used to achieve core objectives. Finally, the results will be published as an interactive web map using HTML, CSS, and the Leaflet JavaScript Library.

All parts of this project are expected to be completed on time except for a comprehensive report that will be completed only if time permits. If time permits, automating workflows will also be completed.

This project will extend the classroom learning done in the GIS Advanced Diploma. Many concepts and techniques learned will serve as the foundation for further exploration. For example, courses such as GIST 7100 (Fundamentals of GIS) and GIST 7128 (ArcGIS 1: Introduction) introduced file-based spatial data management. This project will advance into enterprise-level data management. By implementing a PostGIS backend, the project extends the learning of file geodatabase concepts taught in GIST 7132 (Database Fundamentals) into a multi-user SQL environment. Furthermore, the project expands web mapping concepts that were introduced in GIST 7130 (GIS Computing and the Internet). This project will require learning and applying different uses of JavaScript and the Leaflet library to build a fully interactive web dashboard.

The student has a few key strengths that he can rely on, and a few weaknesses he must develop to successfully complete the project. His background in cartography from previous courses will ensure high quality map deliverables. He has also developed the necessary skills to create Python scripts to clean the source data. The student has learned the basics of HTML, CSS, and JavaScript but must expand on this and learn the more advanced abilities of JavaScript and Leaflet to build an interactive web dashboard. One of the main challenges the student will face is with skills that he will learn concurrently with the project's phases. Although he will learn about advanced python scripting and enterprise

systems, he will require learning outside the classroom to automate Network Analyst workflows and to deploy a PostGIS database.

The completion of this project will help prepare the student for further employment in the GIS industry. This project mirrors the workflow of modern GIS analysts by simulating a full data lifecycle-from acquisition and database management to analysis and web deployment (Use the Five-Step GIS Analysis Process 2018).

Project Deliverables

This project will produce three deliverables designed to communicate findings to stakeholders.

- Interactive Web Map: A web-based dashboard allowing users to toggle layers, view travel times to service areas and view vulnerability scores of different communities
- Location Recommendation Map: A static map that shows proposed optimal sites for new facilities
- Vulnerability and Gap Analysis Report (if time permits): A comprehensive report detailing the methodology, statistical findings of the “hot spot” analysis and demographic profile of underserved areas
- Automated workflow model (if time permits): A model created in ArcGIS Pro ModelBuilder that automates the workflow of the network analysis

Project Background

The student is interested in this project due to his background in health sciences. He believes that combining geography and public health is a critical field. He wants to see how spatial data can reveal invisible barriers to care that statistical tables overlook (Neutens, 2015). He has also been directly affected by the travel time to primary care.

This project is being completed due to British Columbia facing a documented shortage of primary care providers (Mason et al. 2024). Not only is the number of physicians important, but so is the location of these care providers. Studies have shown that better access to healthcare leads to improved overall health outcomes, while lack of access leads

to higher mortality rates (Sanmartin and Ross 2006). This project provides a spatial context to understand this issue.

This project fits very well into the growing sector of Health GIS. The healthcare sector is becoming increasingly reliant on using GIS to transform complex datasets into tools that help in decision-making (Odunayo Josephine Akindote et al. 2023). This project will be creating another tool that provides valuable data on accessibility to healthcare facilities. This type of analysis will greatly benefit many parties. Health authorities will benefit as the data will help manage budgets and growth in population. It will also help health planners as they can use the results to plan and justify funding for new clinics (Abdelhafiz and Abdel-Samea 2013). Finally, the public will ultimately benefit from more equitable access to primary care.

Project Data Sets

Open government data from federal and provincial sources will be used for this project. Table 1 outlines the key datasets. The study area for this project will be the entire province of British Columbia.

Table 1: Project Data Sets

Data Set	Type	Why Needed	Projection	Accuracy	Where It Is	Data Format
Open Database of Healthcare Facilities	Point	Network analysis	WGS84		Statistics Canada Open Data	CSV/ GeoJSON
Road Network File	Line	Travel routing	NAD83		Statistics Canada Open Data	Shapefile/ GDB
Census Boundaries (Dissemination Areas)	Polygon	Population demand	NAD83		Statistics Canada Open Data	Shapefile
BC Index of Multiple Deprivation	Table	Vulnerability attribute data	N/A		BC Centre for Disease Control	XLSX/CSV

BC Health Authority Boundaries	Polygon	Final report	NAD83		BC Data Catalogue	Shapefile

Data Dictionary

Table 2 defines the major attributes from the source datasets relevant to the analysis of this project.

Table 2: Data Dictionary

Layer Name	Feature Type	Attributes	Value	Description
Facilities	Point	Facility Type	Ambulatory health care services	Clinics/Outpatient centres
		City	Text	Municipality name
Roads	Line	Rank	1-5	Road classification (Hwy vs Local)
		Speed	30-120	Speed limit in km/h
Census (DA)	Polygon	DA_ID	Number	Unique Dissemination Area ID
		Pop Total	Integer	Total population count
		Senior Pop	Integer	Population aged 65+
BCIMD	Table	Vuln Score	1-5	Vulnerability score
		Dep Index	High/Low	Deprivation rank

Work Breakdown Structure (WBS) Table

This project is divided into seven major phases, estimated to require 360 total hours (300 technical, 60 management)

Table 3: Work Breakdown Structure

Task Number	Task Name	Estimated Hours Total Work	Resources Needed
1	**Phase 1: Project Initiation**		
1.1	Define Project Scope & Objectives	4.00	MS Word
1.2	Sponsor Meeting	2.00	
1.3	Select GIS Software & Tools	2.00	MS Excel
1.4	Identify Data Sources & Requirements	2.00	MS Excel
2	**Phase 2: Data Acquisition & Preparation**		
2.1	Download Road Network File	1.00	Web Browser
2.2	Download Open Database of Healthcare Facilities	1.00	Web Browser
2.3	Download Census 2021 Data	1.00	Web Browser
2.4	Download BC Health Authority Boundaries	1.00	Web Browser
2.5	Clean & Filter Facility Data	24.00	Python
2.6	Pre-process Census Data	24.00	Python
2.7	Sponsor Meeting	1.00	
2.8	Project Management (Track Progress, Scheduling Problems)	8.00	
3	**Phase 3: Database Implementation**		

3.1	Set up PostgreSQL/PostGIS	6.00	PostGIS, PostgreSQL
3.2	Create Schemas	4.00	PostGIS, PostgreSQL
3.3	Develop ETL Scripts for Data Ingestion	20.00	Python
3.4	Import All Cleaned Data	4.00	PostGIS, PostgreSQL
3.5	Sponsor Meeting	1.00	
3.6	Project Management (Track Progress, Scheduling Problems)	8.00	
4	**Phase 4: Analysis - Access Mapping**		
4.1	Build Network Dataset	20.00	ArcGIS Pro
4.2	Run Service Area Analysis	14.00	ArcGIS Pro
4.3	Run OD Cost Matrix	12.00	ArcGIS Pro
4.4	Validate Network Analysis Results	4.00	ArcGIS Pro
4.5	Sponsor Meeting	1.00	
4.6	Project Management (Track Progress, Scheduling Problems)	8.00	
5	**Phase 5: Analysis – Vulnerability**		
5.1	Process BCIMD/Socioeconomic Scores	12.00	ArcGIS Pro
5.2	Spatial Join: Merge Access Times with Vulnerability Data	2.00	ArcGIS Pro
5.3	Identify "Hot Spots"	10.00	ArcGIS Pro

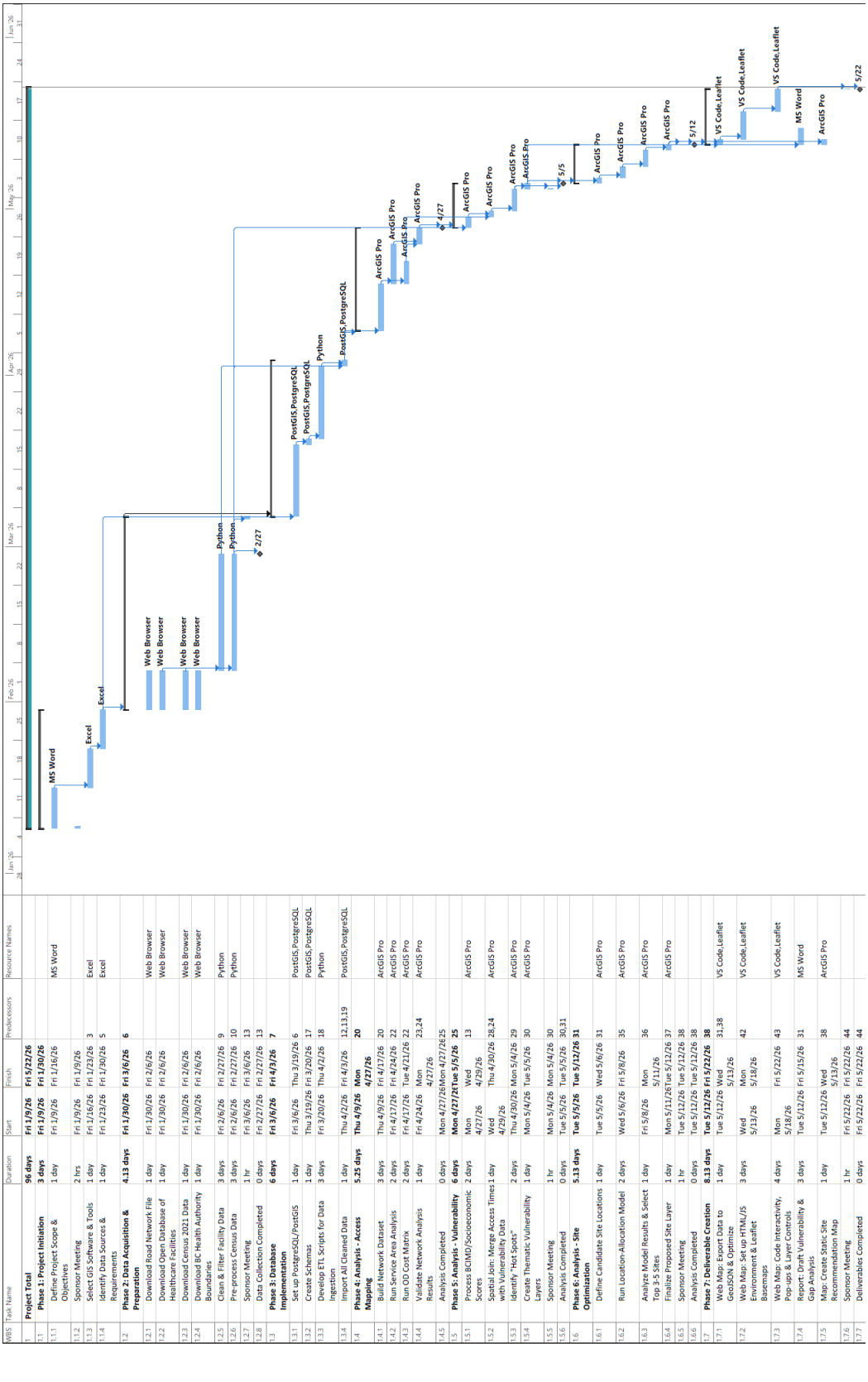
5.4	Create Thematic Vulnerability Layers	2.00	ArcGIS Pro
5.5	Sponsor Meeting	1.00	
5.6	Project Management (Track Progress, Scheduling Problems)	9.00	
6	**Phase 6: Analysis - Site Optimization**		
6.1	Define Candidate Site Locations	8.00	ArcGIS Pro
6.2	Run Location-Allocation Model	16.00	ArcGIS Pro
6.3	Analyze Model Results & Select Top 3-5 Sites	8.00	ArcGIS Pro
6.4	Finalize Proposed Site Layer	8.00	ArcGIS Pro
6.5	Sponsor Meeting	1.00	
6.6	Project Management (Track Progress, Scheduling Problems)	9.00	
7	**Phase 7: Deliverable Creation**		
7.1	Web Map: Export Data to GeoJSON & Optimize	8.00	VS Code, Leaflet
7.2	Web Map: Set up HTML/JS Environment & Leaflet Basemaps	24.00	VS Code, Leaflet
7.3	Web Map: Code Interactivity, Pop-ups & Layer Controls	32.00	VS Code, Leaflet
7.4	Report: Draft Vulnerability & Gap Analysis	24.00	MS Word

7.5	Map: Create Static Site Recommendation Map	2.00	ArcGIS Pro
7.6	Sponsor Meeting	2.00	
7.7	Project Management (Track Progress, Scheduling Problems)	9.00	
	Total	360.00	

Gantt Table and Chart

The project follows a discontinuous schedule from January 6, 2026, to May 22, 2026, utilizing Fridays, Thursday/Fridays, and full weeks as seen in the figure on the following page.

Figure 1: Gantt Table and Chart



WBS	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Project Total**	**96 days**	**Fri 1/9/26**	**Fri 5/22/26**		
1.1	**Phase 1: Project Initiation**	**3 days**	**Fri 1/9/26**	**Fri 1/30/26**		
1.1.1	Define Project Scope & Objectives	1 day	Fri 1/9/26	Fri 1/16/26		MS Word
1.1.2	Sponsor Meeting	2 hrs	Fri 1/9/26	Fri 1/9/26		
1.1.3	Select GIS Software & Tools	1 day	Fri 1/16/26	Fri 1/23/26	3	Excel
1.1.4	Identify Data Sources & Requirements	1 day	Fri 1/23/26	Fri 1/30/26	5	Excel
1.2	**Phase 2: Data Acquisition & Preparation**	**4.13 days**	**Fri 1/30/26**	**Fri 3/6/26**	**6**	
1.2.1	Download Road Network File	1 day	Fri 1/30/26	Fri 2/6/26		Web Browser
1.2.2	Download Open Database of Healthcare Facilities	1 day	Fri 1/30/26	Fri 2/6/26		Web Browser
1.2.3	Download Census 2021 Data	1 day	Fri 1/30/26	Fri 2/6/26		Web Browser
1.2.4	Download BC Health Authority Boundaries	1 day	Fri 1/30/26	Fri 2/6/26		Web Browser
1.2.5	Clean & Filter Facility Data	3 days	Fri 2/6/26	Fri 2/27/26	9	Python
1.2.6	Pre-process Census Data	3 days	Fri 2/6/26	Fri 2/27/26	10	Python
1.2.7	Sponsor Meeting	1 hr	Fri 3/6/26	Fri 3/6/26	13	
1.2.8	Data Collection Completed	0 days	Fri 2/27/26	Fri 2/27/26	13	
1.3	**Phase 3: Database Implementation**	**6 days**	**Fri 3/6/26**	**Fri 4/3/26**	**7**	
1.3.1	Set up PostgreSQL/PostGIS	1 day	Fri 3/6/26	Thu 3/19/26	6	PostGIS,PostgreSQL
1.3.2	Create Schemas	1 day	Thu 3/19/26	Fri 3/20/26	17	PostGIS,PostgreSQL
1.3.3	Develop ETL Scripts for Data Ingestion	3 days	Fri 3/20/26	Thu 4/2/26	18	Python
1.3.4	Import All Cleaned Data	1 day	Thu 4/2/26	Fri 4/3/26	12,13,19	PostGIS,PostgreSQL
1.4	**Phase 4: Analysis - Access Mapping**	**5.25 days**	**Thu 4/9/26**	**Mon 4/27/26**	**20**	
1.4.1	Build Network Dataset	3 days	Thu 4/9/26	Fri 4/17/26	20	ArcGIS Pro
1.4.2	Run Service Area Analysis	2 days	Fri 4/17/26	Fri 4/24/26	22	ArcGIS Pro
1.4.3	Run OD Cost Matrix	2 days	Fri 4/17/26	Tue 4/21/26	22	ArcGIS Pro
1.4.4	Validate Network Analysis Results	1 day	Fri 4/24/26	Mon 4/27/26	23,24	ArcGIS Pro
1.4.5	Analysis Completed	0 days	Mon 4/27/26	Mon 4/27/26	25	
1.5	**Phase 5: Analysis - Vulnerability**	**6 days**	**Mon 4/27/26**	**Tue 5/5/26**	**25**	
1.5.1	Process BCIMD/Socioeconomic Scores	2 days	Mon 4/27/26	Wed 4/29/26	13	ArcGIS Pro
1.5.2	Spatial Join: Merge Access Times with Vulnerability Data	1 day	Wed 4/29/26	Thu 4/30/26	28,24	ArcGIS Pro
1.5.3	Identify "Hot Spots"	2 days	Thu 4/30/26	Mon 5/4/26	29	ArcGIS Pro
1.5.4	Create Thematic Vulnerability Layers	1 day	Mon 5/4/26	Tue 5/5/26	30	ArcGIS Pro
1.5.5	Sponsor Meeting	1 hr	Mon 5/4/26	Mon 5/4/26	30	
1.5.6	Analysis Completed	0 days	Tue 5/5/26	Tue 5/5/26	30,31	
1.6	**Phase 6: Analysis - Site Optimization**	**5.13 days**	**Tue 5/5/26**	**Tue 5/12/26**	**31**	
1.6.1	Define Candidate Site Locations	1 day	Tue 5/5/26	Wed 5/6/26	31	ArcGIS Pro
1.6.2	Run Location-Allocation Model	2 days	Wed 5/6/26	Fri 5/8/26	35	ArcGIS Pro
1.6.3	Analyze Model Results & Select Top 3-5 Sites	1 day	Fri 5/8/26	Mon 5/11/26	36	ArcGIS Pro
1.6.4	Finalize Proposed Site Layer	1 day	Mon 5/11/26	Tue 5/12/26	37	ArcGIS Pro
1.6.5	Sponsor Meeting	1 hr	Tue 5/12/26	Tue 5/12/26	38	
1.6.6	Analysis Completed	0 days	Tue 5/12/26	Tue 5/12/26	38	
1.7	**Phase 7: Deliverable Creation**	**8.13 days**	**Tue 5/12/26**	**Fri 5/22/26**	**38**	
1.7.1	Web Map: Export Data to GeoJSON & Optimize	1 day	Tue 5/12/26	Wed 5/13/26	31,38	VS Code,Leaflet
1.7.2	Web Map: Set up HTML/JS Environment & Leaflet Basemap	3 days	Wed 5/13/26	Mon 5/18/26	42	VS Code,Leaflet
1.7.3	Web Map: Code Interactivity, Pop-ups & Layer Controls	4 days	Mon 5/18/26	Fri 5/22/26	43	VS Code,Leaflet
1.7.4	Report: Draft Vulnerability & Gap Analysis	3 days	Tue 5/12/26	Fri 5/15/26	31	MS Word
1.7.5	Map: Create Static Site Recommendation Map	1 day	Tue 5/12/26	Wed 5/13/26	38	ArcGIS Pro
1.7.6	Sponsor Meeting	1 hr	Fri 5/22/26	Fri 5/22/26	44	
1.7.7	Deliverables Completed	0 days	Fri 5/22/26	Fri 5/22/26	44	

Project Methodology

The project will begin with the initial data preparation phases by acquiring raw CSV and Shapefile data. Python scripts will be created to clean the facility data, filtered for primary care facilities, and handle missing values.

During the third phase, a PostGIS database will be initialized. Schemas will be created to separate different types of data. Scripts will be created to automate the loading of data.

Phases four through six will involve using ArcGIS Pro software and its Network Analyst tools. A network dataset will be built incorporating road speed limits. The tool will then be used to generate travel time polygons, and then the OD Cost Matrix tool will calculate specific travel times to each DA. These results will be spatially joined with BCIMD data to identify high-vulnerability clusters. Finally, the Location-Allocation tool will identify optimal new facility sites.

The final phase of deliverables will include a final web map built using the Leaflet JavaScript library, HTML, and CSS for stylization. The static maps for optimal sites will be created using ArcGIS Pro layouts.

Conclusion

This project outlines a 360-hour work schedule for analyzing primary care access in British Columbia. By using PostGIS for data management, ArcGIS Pro Network Analyst for travel modeling, and Leaflet JavaScript library for visualization, the project will identify areas with critical gaps in primary care access. The final deliverables, including an interactive web map and an analysis report, will provide insights for health equity planning in British Columbia.

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