IMPLEMENTING A NEW FIRE HALL IN THE CITY OF CHILLIWACK

Monday @ 4pm Group 2
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GEOB 270
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ABSTRACT

In our project, we are UBC Arts Co op students on a work term with the fire department in the City of Chilliwack. The fire department is in need of a new fire hall, as they are having difficulties responding to emergencies that are further out from the city core in a timely manner. We are tasked with the job of implementing a new fire hall, in order to increase fire safety in the region and improve response time for residents in need of emergent aid. Our main goal is to identify an appropriate location for the fire hall that will not disrupt current agricultural land use, yet allow residents to benefit from the additional fire hall. Variables we considered in creating the new fire hall included locations of current fire halls, restricted areas, densely populated areas, main transportation routes, and city parks. The data for our project was sourced from the Open Data Catalogue for the City of Chilliwack. We found 5 locations within the city boundaries of Chilliwack that may be suitable for implementation of a fire hall. We determined the most appropriate location for the fire hall to be Map 4 Figure 5, because the area is in a dense metropolitan and residential zone, close to Highway 1, and does not disrupt restricted lands.

DESCRIPTION

Through working alongside the city and the fire department, our goal as Arts Co op students is to find an appropriate location for a new fire hall, using ArcGIS to visually present our findings to the City of Chilliwack. From our observations, we believe there are presently not enough fire halls in the region, as the current halls are far apart, and a significant distance from some areas. This results in a slower response time for those who live in the suburbs of the city. The landscape is predominantly agricultural land, meaning that block size in the suburbs is large and roads are infrequent, which increases the time of travel from fire halls. Though a firefighter's primary task is to assist in emergencies involving fires, they are also trained in first aid, and respond to all emergent 911 calls (sokanu, n.d.). We hope to increase the average speed of response time for residents in the City of Chilliwack, by implementing this new fire hall. We also considered environmental factors, land reserves, and that restrict our area of selection for the fire hall.

The City of Chilliwack, located in British Columbia, Canada, is located 102 km east of Vancouver, and consists of a small downtown region, suburbs, and agricultural lands (Fire Department - City of Chilliwack, 2017). The total population as of 2016 was 83,788 permanent residents and the city boundary includes 54.09 km^2 of land area (Government of Canada, S. C., 2017). Our project site will need approximately a surrounding density of 1,000 residents for 1 firefighter to be most effective (Sells, 2012).

We collected our data from the City of Chilliwack Open Data Catalogue. The data consists of Shapefiles, and layers we acquired for our maps included City of Chilliwack Boundary, Neighbourhoods, Zoning, Previous Forest Fires of 2017, Existing Fire Halls, Fire Hydrants, Agricultural Land Reserve, City Parks, Contour Lines, Roads, and Water Flow.

METHODOLOGY

Before we could begin our analysis of the area, we first had to search for relevant data, which we found from The City of Chilliwack Open Data Catalogue. Additional research was conducted for background information, such as population and fire hall requirements, and acquired from a variety of online sources (see Bibliography). We deemed the Open Data Catalogue to be a reliable source, since it was published by The City of Chilliwack, an official government website. From this source, we selected specific shapefiles that were relevant to our analysis (see Description section for names).

After inserting these layers into ArcMap, we began manipulating them to create four sets of maps. All of these maps contributed to the process of determining where the best location for a Fire Hall would be. The most suitable location must demonstrate certain criteria, as noted in the Discussion section. For details of specific tools and processing see the Flow Chart in Appendix III, and for sets of maps see Appendix II.

The first map we created, Map 1: *Agricultural Land Reserve (ALR) in City of Chilliwack (Protected Agricultural Land – No Development Permitted)*, was created to provide visual representation of the areas where development of a fire hall would not be permitted. This includes the Chilliwack Boundary, Neighborhoods, Contour Lines, Roads, Water Courses, Fire Halls, Fire Hydrants, and Agricultural Land Reserve (ALR) layer. All layers were clipped to fit within the Chilliwack Boundary layer. Since no development is permitted on the ALR area, it was placed semi-opaquely overtop of the Neighborhoods and Zoning layers, to clearly show what land could not be developed upon.

The second map we created was Map 2: *Fire Halls in Relation to Forest Fires in the City of Chilliwack (Forest Fire Incidents in 2017)*. The intent for this map was to review the current location of fire halls, and proximity to recent forest fire sites. To create this map, the Chilliwack Boundary, Neighborhoods, Zoning, Contour Lines, Roads, Water Courses, Fire Halls, Fire Hydrants, and Previous Forest Fires from 2017 layers were clipped to fit within the Chilliwack City Boundary. Changes to symbols, neighborhoods, and zoning were made to emphasize specific data.

We then analyzed the two maps we had produced. Using the “select by attributes” tool in ArcMap, the percentage of land that could potentially be the location of a new fire hall was determined (see Discussion section for detailed calculations). From this area and the criteria previously set, we created Map 3, *Potential Zoning for New Fire Hall in City of Chilliwack (Five Potential Locations for a New Fire Hall - Overview)* which shows five potential locations. To highlight these areas, a polygon tool was used. The final set of maps, Map 4: *Potential Zoning for New Fire Hall in City of Chilliwack (Five Potential Locations for a New Fire Hall – Details)*, shows these polygon regions in more detail. To create these detail views, a clip tool was used.

Finally, to prepare our maps for presentation, the standard map elements such as a title, legend, north arrow, title, coordinate system, projection, datum, and scale were added to the layout view.

DISCUSSION & RESULTS

Discussion

In 2017, the Chilliwack Fire Department responded to 858 calls for service, including activated alarms responses, emergency medical aid calls, and fire responses (Government of Canada, S. C., 2017). This is an increase of 384 calls (44.5%) compared to this time in 2016 (Fire Department - City of Chilliwack, n.d.). The amount of incident responses have been increasing since 2015, with 2017 comprising of the most emergency responses to date (Fire Department - City of Chilliwack, n.d.). Of these, 130 calls have been fire-related in July-August alone, with 106 of the 130 calls being associated with outdoor fires. The City of Chilliwack is located in the Lower Fraser Valley region, a region known for dry and hot conditions in the summer months, and is more prone to wildfire burning (The Chilliwack Progress, 2017). Lori Daniels, an associate professor of forest ecology at the University of British Columbia, states that "firefighting efforts over the last 60 to 100 years have allowed for denser forests with a lot of dead material on the ground. Now, when the province has hot, dry weather and lightning strikes or there is a human ignition, the fires are much more severe and fast-moving" (The Chilliwack Progress, 2017). Therefore, the City of Chilliwack highly values accurate display of past emergency-related data, and provides open-source GIS Data to its residents, as well as preventative programs such as Fire & Safety education for all of its residents (Fire Department - City of Chilliwack, 2017). In 2017, 166 Fire and Life Safety sessions were delivered to the community (Fire Department - City of Chilliwack, 2017).

There are 6 "response areas" of land that surround each of the 6 fire halls (see Image 2 in Appendix II), individually spanning over 250 km^2 of land (Fire Department - City of Chilliwack, 2017). They collectively staff a total of 31 full-time firefighters, and 130 paid on-call firefighters. As stated on the City of Chilliwack's website, all risk assessment data is utilized in their fire protection planning process, through "virtually displaying fire incidents", meaning staff and residents are able to view the type and regularity of emergent calls in the current response zones (Fire Department - City of Chilliwack, 2017.). The fire hall located in Downtown Chilliwack (45950 Cheam Avenue) receives the majority of calls at 420 in 2017, which is 49% of total calls (Fire Department - City of Chilliwack, 2017.). This region is a central urban space but also extends into the suburban agricultural region as well.

It should also be noted that when conducting research with sensitive data, such as emergency responses, ethical precautions are necessary to ensure the privacy of Chilliwack residents. As cartographer Brian Harley argues, mapmakers are ethically responsible for the effects of the maps that they create (Haley, 1990). The use of personal GIS data is a contested practice, and therefore is best approached from internalist and externalist points-of-view (Crampton, 1995). Our analysis covers a topic that may lead to a security breach of residential address data, if proper ethical standards are not met. The URISA "GIS Code of Ethics" instructs that we, as users of GIS technology, must oblige to individuals in society (Section IV of the code) by respecting and protecting individual privacy, such as sensitive

information encompassing emergent calls (URSIA, n.d). Our data has been aggregated, meaning we have divided our data by census tracts, and no therefore individual point data can be detected. The fire incident data does not reflect individual households, but rather a large block of area that has been affected by fires in the past. We used only data from official and trustworthy government sources, such as Chilliwack's Open Data Catalogue and Census Canada.

Map 1, *Agricultural Land Reserve (ALR) in City of Chilliwack (Protected Agricultural Land – No Development Permitted)*, represents fire hall locations and their relative positions in relation to certain land use areas. It highlights specific census neighbourhood tracts, as well as the Agricultural Land Reserves (ALR). Land use in the City of Chilliwack is evidently majorly agricultural, in relation to urban living space. By viewing the Attribute Table values of the ALR layer, it was determined that it comprises 169,682,981 km^2 of the entire City of Chilliwack, which has a total shape area of 291,793,825 km^2 itself. Thus, ALR takes up 58% of the total area of Chilliwack. This consequently limits the majority of the region from being developed (for uses such as a fire hall), due to regulations surrounding this reserved land. Each of the 6 current fire halls are located within neighbourhood zones, and determining where to place a new one without breaching agricultural land poses a challenge.

Map 2, *Fire Halls in Relation to Forest Fires in the City of Chilliwack (Forest Fire Incidents in 2017)*, displays fire halls in relation to forest fires that occurred in the City of Chilliwack in the year 2017. It additionally showcases where current fire hydrants are located. This map also highlights major roads and Highway 1, as this relates to fire truck response time. When travelling on major roads and the highway, fire trucks will be able to move faster in comparison to when they must navigate smaller and busier residential roads. This map is additionally significant in aiding city planners further assess where new roads could be constructed, in order to access certain regions more efficiently.

Consequently, through compiling data from Chilliwack's Open Catalogue and Census Canada, we were able to visually identify where recent fires occurred, their relative position to fire halls and densely populated areas. By next analyzing the combined layers, including Neighbourhoods, ALR regions, Zoning, Fire Halls, Fire Hydrants, and Roads, we are able to conclude that the best location for the new fire hall would be in Figure 5 (see *Potential Zoning for New Fire Hall in City of Chilliwack (Five Potential Locations for a New Fire Hall - Overview* and - *Details* in the Appendix). Currently, the area that Figure 5 is encompasses is between the two major metropolitan zones, with most of Chilliwack's 83,788 permanent residents inhabiting these zones (Government of Canada, S. C., 2017). These regions of Chilliwack receive the most frequent emergency 911 calls, and though there are fire halls already located at the center of these two zones, it would be beneficial to include another between them. Due to the small and busy residential roads that surround the current fire stations in these dense zones, response time may be inhibited, and including another fire hall could provide great reduction. This location is additionally close to Highway 1, meaning that if needed, the firetrucks from that hall could travel quickly in either direction along the highway, to service the region to the west towards Figure 1, as well as the expanse of land to

the east near Figure 3. Therefore adding this fire hall may allow for the halls in the more dense urban areas to focus on calls in those regions, while the firefighters from the new station could provide support when needed, as well as faster response times for the suburban areas.

Each of the 6 different response areas that the current fire halls cover (see Image 2 in Appendix II) currently do not reflect the proportion of 911 calls each receives. The more dense urban regions in response areas 1 and 4 receive a far greater number of emergent calls, however still are expected to provide service to expansive areas. Though this may be somewhat reprimanded by an increased number of firefighters and trucks for those halls, located the new fire hall between those zones would likely significantly reduce the burden.

Furthermore, locating the new fire hall within Figure 5 would not conceivably interfere with current land use. The area outlined does not include ALR, but consists mostly of residential land. This land is not extremely dense, and therefore there is decent potential for development and rezoning if necessary.

Results

We have identified 5 potential zones for the implementation of a new fire hall based on an array of variables such as population density, proximity to existing fire halls, documented history of forest fire locations, land use, and major roads. The resultant zone that was deemed to provide the most benefits with an additional fire hall was Figure 5 (see Map 3 and 4, Figure 5). This decision was based on our analysis as discussed above. This zone is between heavily populated urban regions, is close to Highway 1, and does not conflict strongly with current land use.

If, due to some outstanding reason, the fire hall were not permitted to be located in the Figure 5 zone, then the second best option would be the Figure 1 zone (see Map 3 and 4, Figure 1). This area is also conveniently close to Highway 1, has a history of nearby fires, as well as would provide similar relief for the fire halls in the dense urban response areas. However it is further than Figure 5 from these highly populated areas.

The Figure 4 zone (Map 3 and 4, Figure 4) would be considered the third choice for a new fire hall. Locating an additional fire hall in this region would likely greatly help to reduce pressure on the current fire hall in response area 4. That response area is more highly populated and has both smaller and busier roads than many other areas, and therefore response time could be constrained. Adding the new fire hall would therefore help alleviate the burden. However it would likely not prove as beneficial as the zones of Figures 5 and 1, due to it only being close to response area 4, rather than between response areas 1 and 4 as is the case with Figures 5 and 1.

The zone of Figure 2 (see Map 3 and 4, Figure 2) would be considered fourthly, for similar reasons to Figure 4. It would aid in reducing the pressure for the densely populated area that response area 1 is responsible for, though would have the same downfall in that it only relieves burden to the single dense area rather than the two that Figures 5 and 1 contribute to.

The last zone to be considered for the additional fire hall would be in Figure 3 (see Map 3 and 4, Figure 3). It is near a conglomeration of residential land that does not currently have a very close fire hall, and similar to Figures 5 and 1, it is also close to Highway 1. However, locating a new fire hall in this area would not be as beneficial to the majority of the population as locating it in any of the other zones, since it is further from the most densely populated regions.

ERROR & UNCERTAINTY

The purpose of this map analysis was to determine where to implement a new fire hall, based on local need. To derive our findings, we came to a final decision based on primarily visual interpretation of our maps, as opposed a population density normalization to discern where the most people resided, in each response zone. Our 5 suggested fire hall sites were based on where variables such as population density, proximity to existing fire halls, documented history of forest fire locations, land use, and major roads. Using this data, we selected five broad zones for potential fire halls (Figures 1-5), however, we do not have a specific location within the suggested zones. This is because we are not aware of the more detailed specifics of the land, in terms of what is already built in those zones due to the secure and ethical nature of our data. This somewhat creates a range of uncertainty for each zone.

While this analysis attempted to combine all data layers necessary to minimize error and uncertainty, there were some datasets we were unable to find. It would have been beneficial to our analysis to have data about domestic and commercial fires, motor vehicles accidents, and population density for each specific neighbourhood. Moreover, additional information about the average daily frequency of emergent calls to each current fire hall or average response time in each current fire hall's response zone would have aided in determining which stations are the busiest and could subsequently use more support.

Furthermore, we had to make some generalizations in order to present our data clearly. For example, the "Valley North" neighbourhood included the Fraser River (Map 1). We changed the colour of the neighbourhood, which was previously brown, to blue in order to clearly show that there was a body of water, and not land. Due to this change in colour, land in Valley North may appear to look like water.

Another variable that we did not directly cover in our maps was population density of Chilliwack, since the data for each neighborhood was not available. Instead, we included a map from online of the population density persons per square kilometre in 2006 (Geography Division, S. C., 2009) (see Image 1). While this data is relatively accurate and unbiased, it is slightly outdated, being from 11 years ago. Ideally, we would have used more recent population density data, which could perhaps come from a survey or other governmental documentation.

We must note that there exists a degree of uncertainty in all data used in our analysis, even if the data is collected from a trustworthy governmental database. We must consider how they obtained the data, for what purpose, potential biases and generalizations. We do not know how our data was collected, nor for what purpose. Likewise, we selected our data to

meet the confines of our project idea. In doing so, we simplified our data, and a viewer may be unaware of our generalizations. If our maps and findings are subsequently used for further research or analysis, the degree of uncertainty would increase.

FURTHER RESEARCH

Although we attempted to include as much data as possible, we were unable to find the frequency and locations of household and commercial fires, instead we only found information about forest fires. With the addition of this information, we could have perhaps offered more accurate and knowledgeable recommendations for the new fire hall. Furthermore, data on the age and building materials of structures, demographics (elderly and those with greater health emergency risks) and more statistics on emergencies could help to refine where the most desirable location would be. There is great potential for creating an additional map that portrays travel times, distances, and average speed on main roads. Creating this map would provide further relevant information to contribute to our analysis

Moreover, it would have be ideal if we could have found the areas where fires most frequently occurred over time. By depicting the fire occurrence over several years, instead of only 2017, we could determine hotspots, and thus locations that may require more emergency personnel nearby. In the future, we could even develop interactive maps that show these changes in hotspots over time.

In addition, obtaining further details on building site regulations would have improved the accuracy of our suggested locations. After subsequent research, we were unable to determine how a location is selected to build a fire station in Chilliwack, and what specific criteria must be met.

Lastly, engaging with feedback from community members, firefighters, and various stakeholders would help us determine where the public believes there needs to be another fire hall to provide faster services. Perhaps through conducting a survey or by interviewing local officials, we could determine where to implement a new fire hall based on their personal demand.

While taking into consideration these areas of further research, there is a possibility that we could have found a more suitable and necessary locations, or narrowed down the choices for possible sites.

APPENDIX I - BIBLIOGRAPHY

Crampton, J. (1995). The Ethics of GIS. *Cartography and Geographic Information Systems*, *22*(1), 84–89. https://doi.org/10.1559/152304095782540546

Geography Division, S. C. (2009, February 16). GeoSearch 2011 - Statistics Canada. Retrieved December 2, 2017, from http://geodepot.statcan.ca/GeoSearch2011-GeoRecherche2011/GeoSearch2011-GeoRecherche2011.jsp?placeRadio=begins&searchLocalityName=Chilliwack&cmdSearchEntered=Search&searchTheme=Locality&searchPass=2&MinX=1878964.7430212735&MinY=460028.473404256&MaxX=9729226.258978726&MaxY=5238448.52659575&LastImage=.%2FImages%2FFirstImage_e.gif&lang=E&FormTool=&sZoomLevel=10&boundaryType=province&boundaryType2=&boundaryDefault=N#searchResults

Department Reports - City of Chilliwack. (n.d.). Retrieved December 2, 2017, from http://www.chilliwack.ca/main/page.cfm?id=2279

B.C. forests more fire-prone than in the past. (2017, July 10). Retrieved December 2, 2017, from http://www.theprogress.com/news/b-c-forests-more-fire-prone-than-in-the-past/

Fire Department - City of Chilliwack. (n.d.). Retrieved December 2, 2017, from http://www.chilliwack.ca/main/page.cfm?id=20

GIS Code of Ethics. (n.d.). Retrieved December 2, 2017, from http://www.urisa.org/about-us/gis-code-of-ethics/

Government of Canada, S. C. (2017, February 8). Census Profile, 2016 Census - Chilliwack [Population centre], British Columbia and Alberta [Province]. Retrieved December 2, 2017, from http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=POPC&Code1=0177&Geo2=PR&Code2=48&Data=Count&SearchText=Chilliwack&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=0177&TABID=1

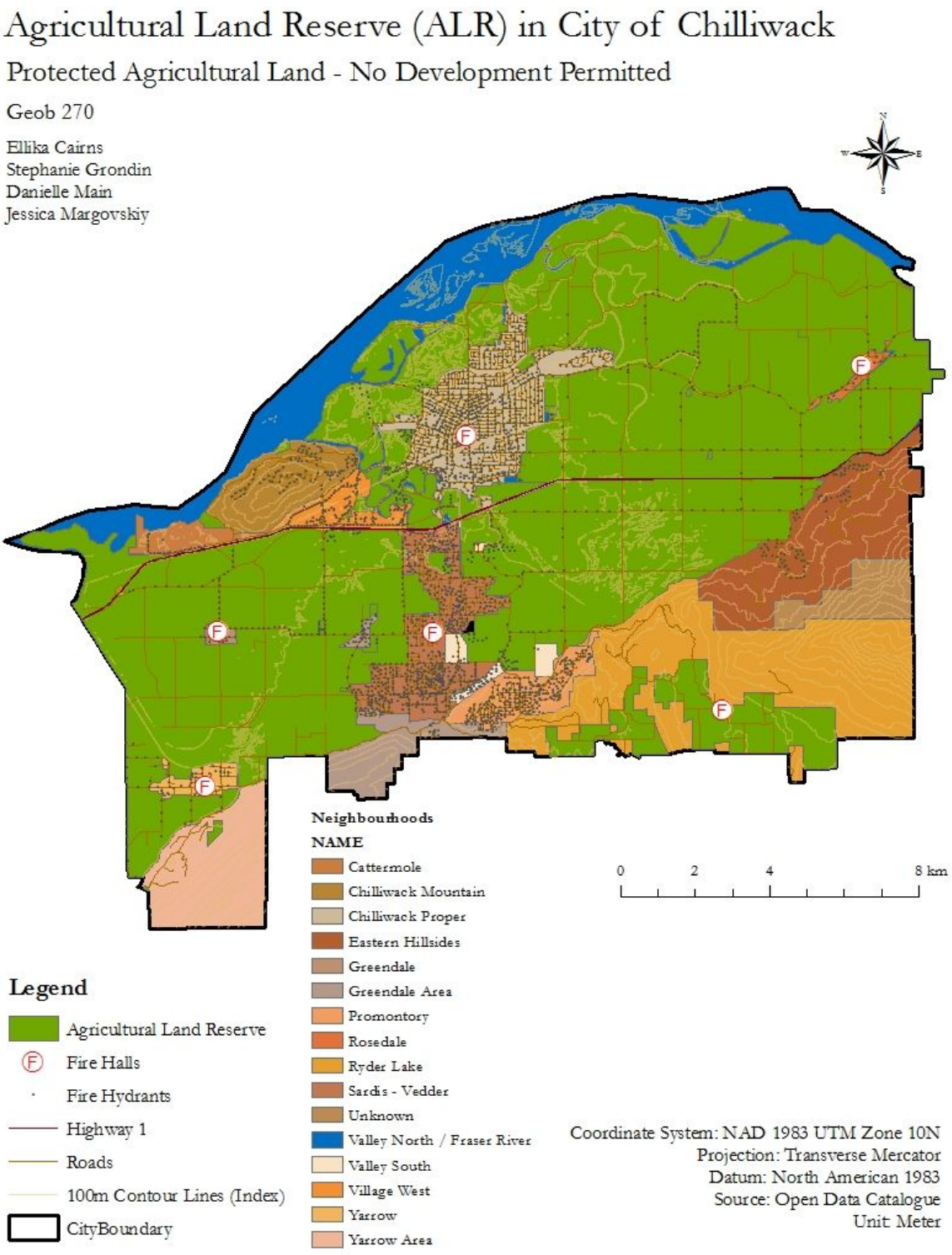
Sells, P. (2012). Proper protection.. Retrieved December 2, 2017, from https://www.firefightingincanada.com/response/proper-protection-10994

Fire Dept Incident Reporting - City of Chilliwack. (n.d.). Retrieved December 2, 2017, from http://www.chilliwack.ca/main/page.cfm?id=2682

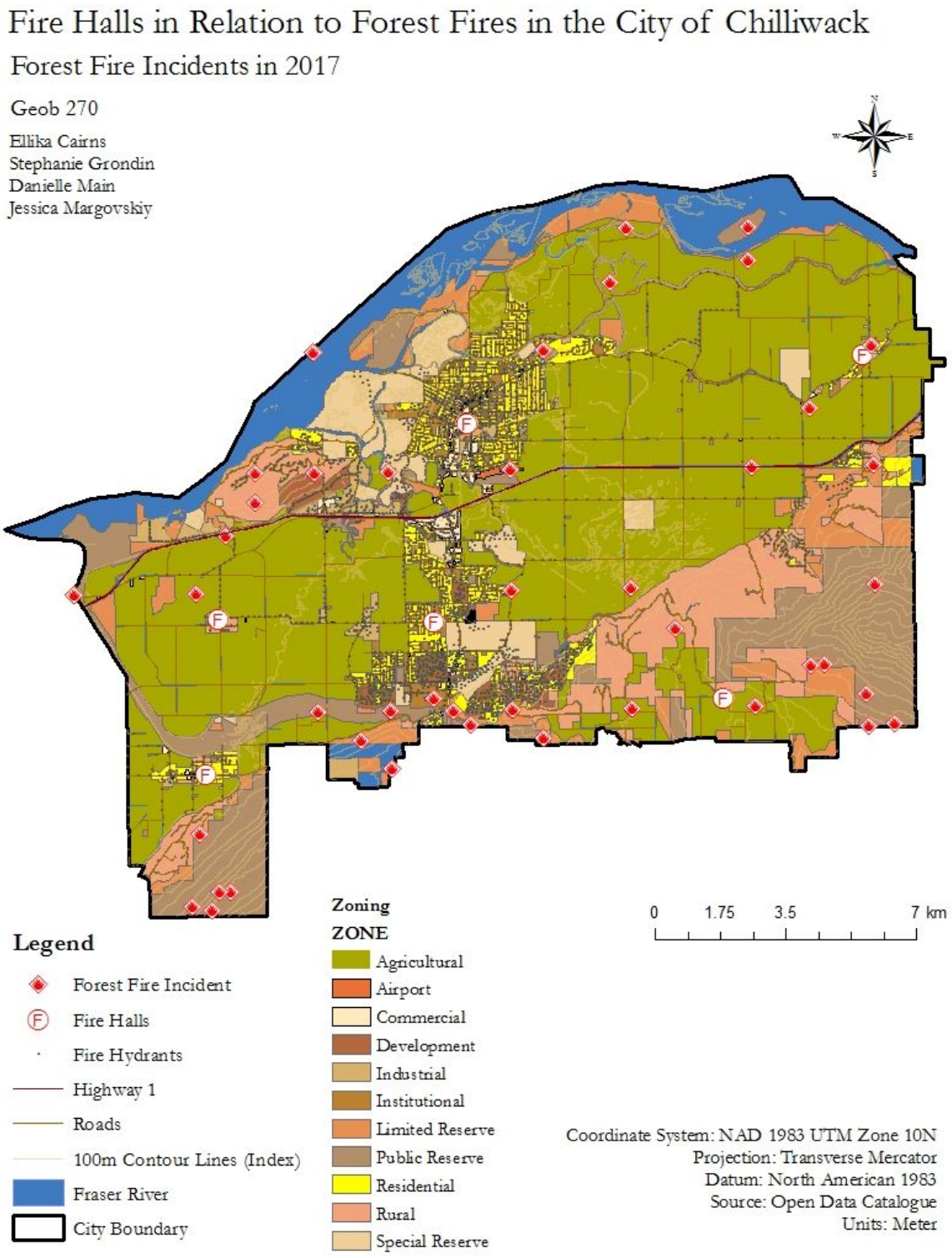
What does a Firefighter do? (n.d.). Retrieved December 2, 2017, from https://www.sokanu.com/careers/firefighter/#what-does-a-firefighter-do

Cartography, Ethics and Socail Theory - J.B. Haley | Cartography | Map. (1990.). Retrieved December 2, 2017, from https://www.scribd.com/document/252069913/Cartography-Ethics-and-Socail-Theory-J-B-Haley

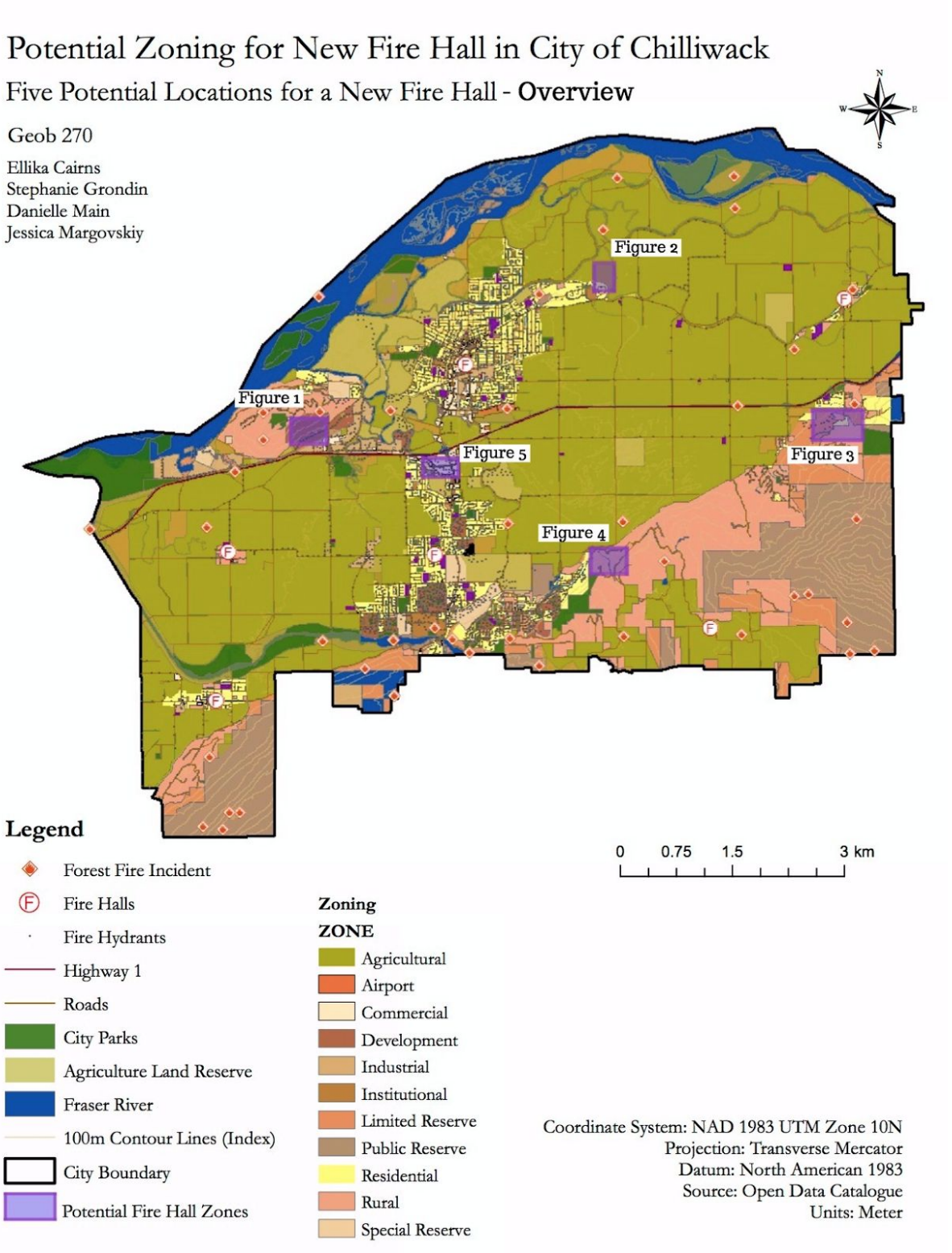
APPENDIX II - MAPS & FIGURES



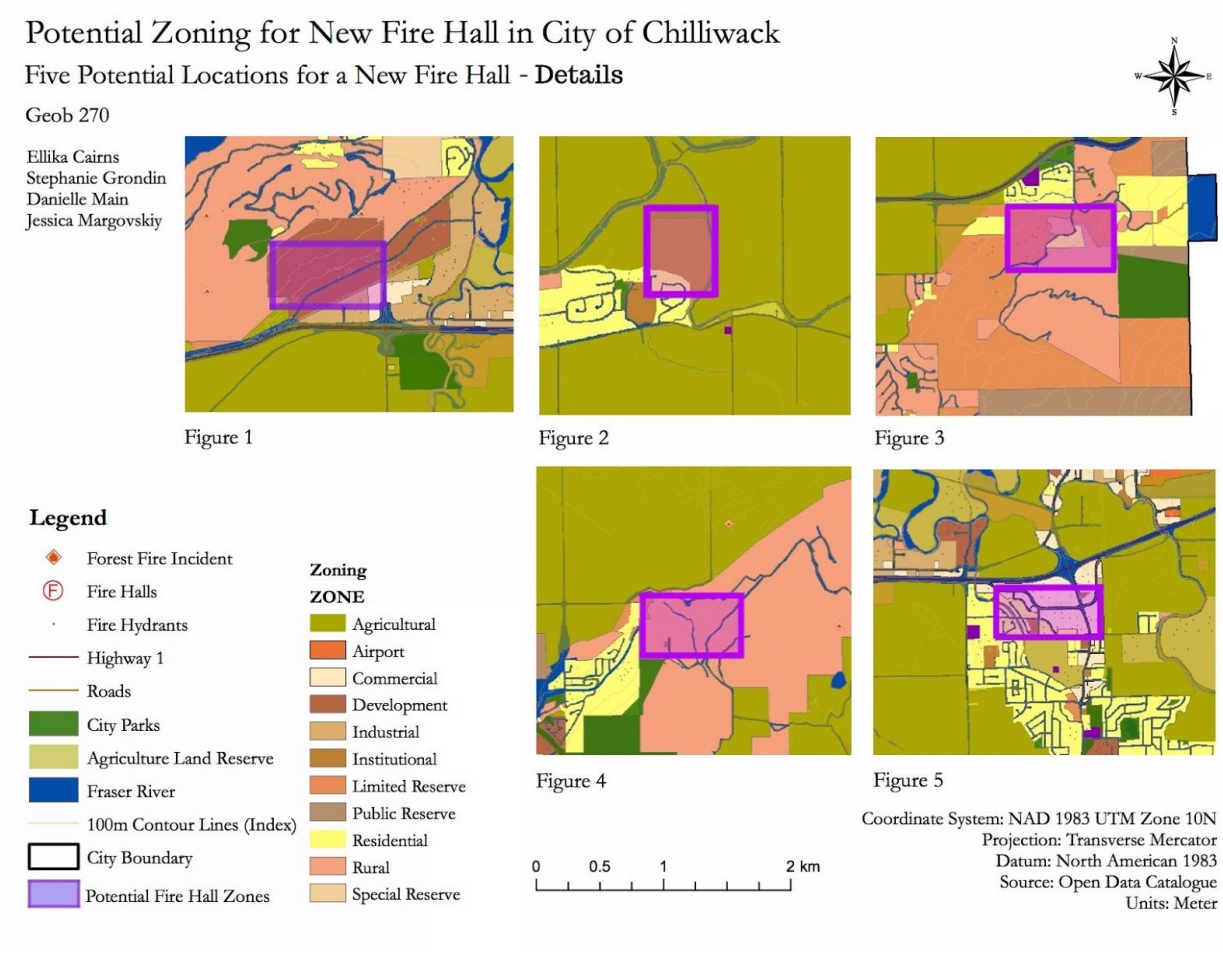
Map 1: Agricultural Land Reserve (Student generated)



Map 2: Fire Halls in Relation to Forest Fires (Student generated)



Map 3: Five Potential Zoning Locations for a Fire Hall - Overview (Student generated)



Map 4:. Five Potential Zoning for New Fire Hall - Details (Student generated)

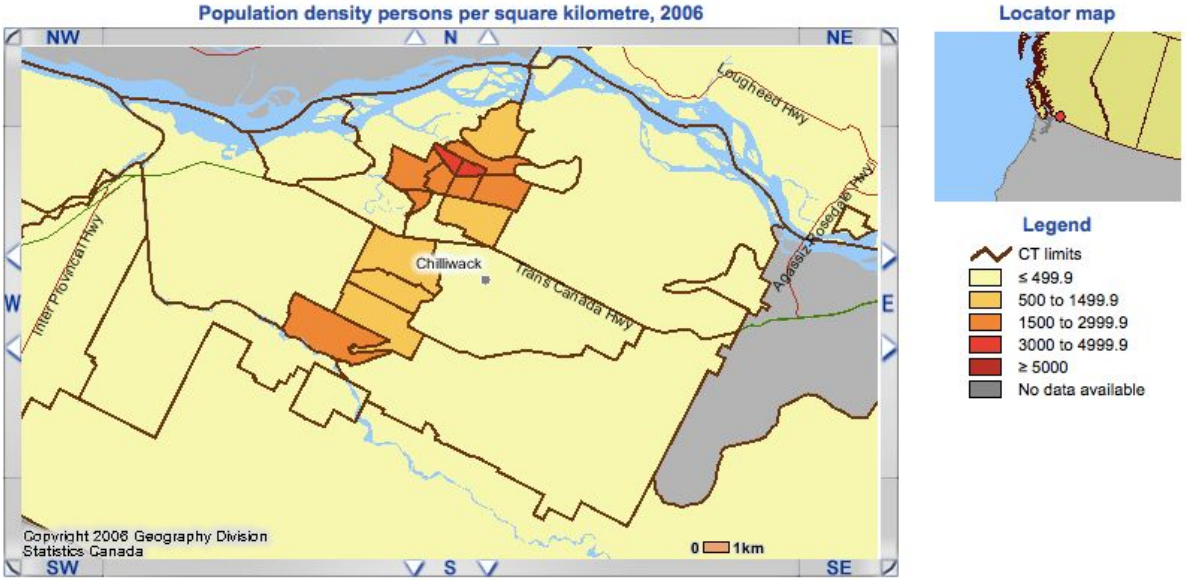


Image 1: Census Tract Density for City of Chilliwack 2006 (Government of Canada, 2017)

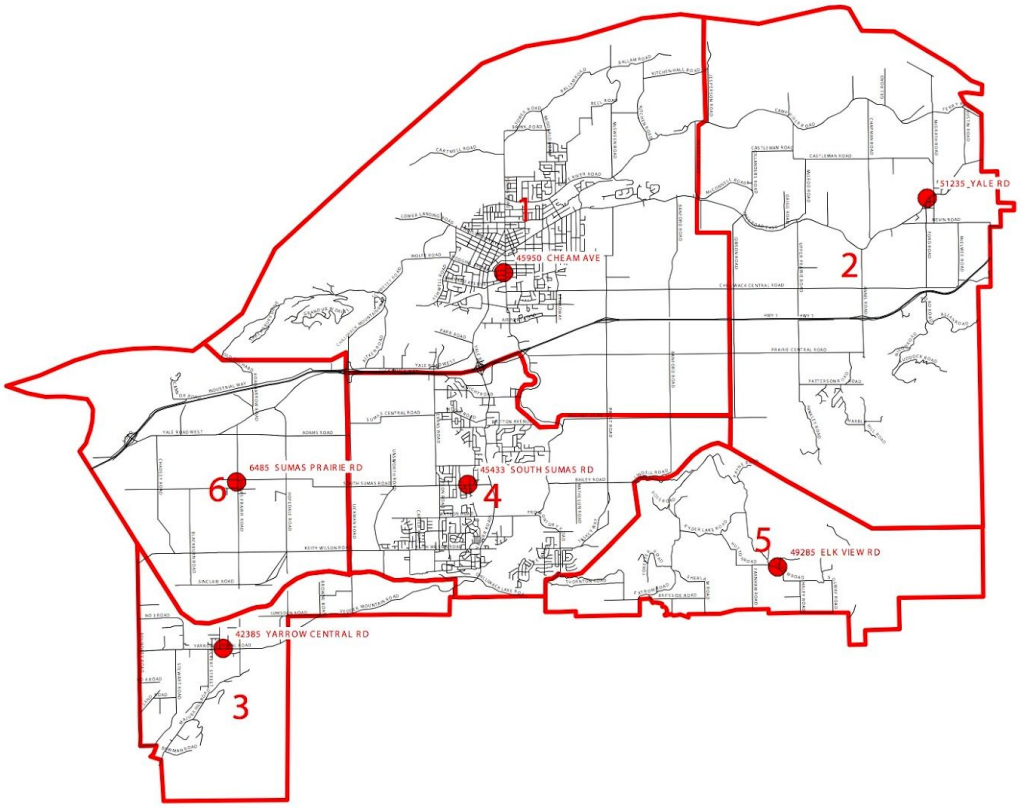
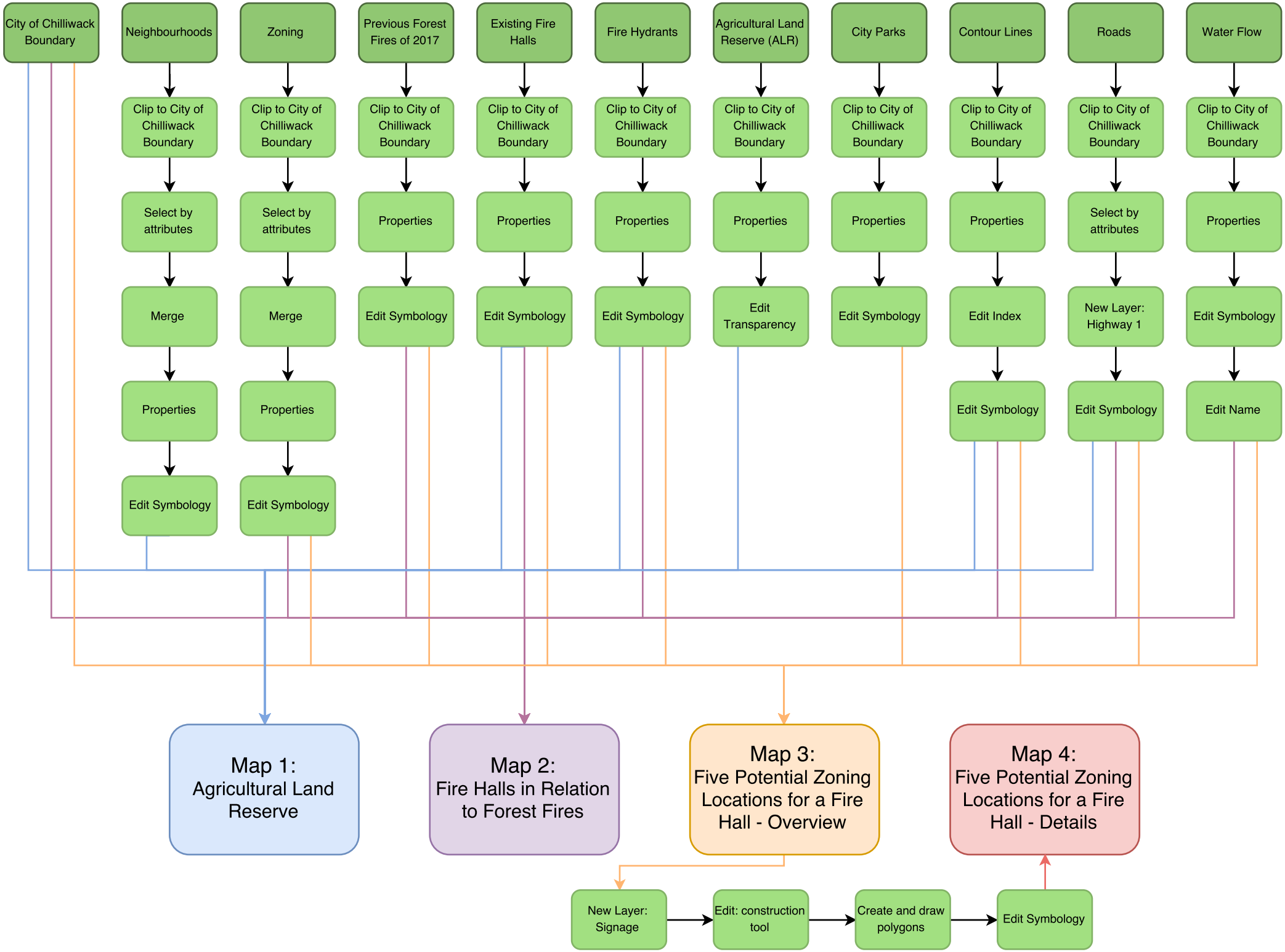


Image 2: Current Fire Hall Response Areas (Fire Department - City of Chilliwack, 2017)


City of Chilliwack Boundary
Neighbourhoods
Zoning
Previous Forest Fires of 2017
Existing Fire Halls
Fire Hydrants
Agricultural Land Reserve (ALR)
City Parks
Contour Lines
Roads
Water Flow
Clip to City of Chilliwack Boundary
Select by attributes
Properties
Merge
Edit Symbology
Edit Transparency
Edit Index
New Layer: Highway 1
Edit Name
Map 1: Agricultural Land Reserve
Map 2: Fire Halls in Relation to Forest Fires
Map 3: Five Potential Zoning Locations for a Fire Hall - Overview
Map 4: Five Potential Zoning Locations for a Fire Hall - Details
New Layer: Signage
Edit: construction tool
Create and draw polygons