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A R C H A E O L O G I C A L A N D H E R I T A G E C O N S U L T I N G

March 26, 2007

Emilie Adin, MCIP
Deputy City Planner
Planning and Zoning
City of Langford
2nd Floor, 877 Goldstream Avenue
Langford, BC, V9B 2X8

Dear Ms. Adin:

Re: City of Langford Archaeological Overview Assessment – Phase 1 Baseline Mapping

Millennia Research Limited (Millennia) was contracted by the City of Langford to create a predictive model to identify potential archaeological site locations. This first phase of work was part of a larger initiative by the City of Langford to identify priority areas for heritage management within the city (Figure 1).

Work on developing the model included background research, refining of an existing predictive archaeological model which had been created for the Hul'qumi'num Treaty Group (HTG) in 2006, and mapping of that model for the Langford area. Additional layers of information were gathered and analyzed, and then incorporated into the model.

Background Research

Background investigation included sea-level research, geological research, searching for other sources of relevant data, downloading information on known archaeological sites and collecting archaeological reports for past work done in Langford. Refining the existing HTG model included using a higher resolution Digital Elevation Model (DEM) provided by the City of Langford in order to refine the DEM variables used in the model, and incorporating other data from the background research that was found to be relevant and beneficial to the model.

Sea-level research was drawn primarily from Eldridge and Steffen (in press), which summarizes several other papers. These research papers indicate that sea levels were as high as 75m above present day levels in the late Pleistocene /early Holocene (Figure 2), and as low as 50m below present day levels in the early to mid Holocene (Mosher and Hewitt 2004). However, there have been no dated archaeological sites found in or around Langford with dates corresponding to the time of the high sea level, which was approximately 12500 radiocarbon years before present (BP). We concluded that changing sea levels are of minimal significance in the mainly upland City of Langford.

Geological data was acquired digitally from the BC Ministry of Energy and Mines (Massey, et al. 2005). This data was at a fairly coarse scale, and did not include surficial geology, making it of limited use for this project. A downloaded surficial geology map (Monahan and Levson 2000) was rectified, and the areas identified as peat were digitized for use in the modelling as described below.

Garry Oak data, from 1997 and circa 1800, was acquired from the CRD Natural Areas Atlas and from http://www.goert.ca/resources/oak_map.htm. This dataset was found to be highly significant in the correlation with the locations of recorded archaeology sites (Chi-square PL0.001). However, this correlation could be due partly to survey bias (Garry Oak meadows being generally easier to survey, and sites being more visible). The areas of Garry Oak (past and present) were digitized, based on the CRD Natural Areas Atlas mapping (Figure 3).

Additional archaeological data was acquired by conducting a search for any archaeological studies undertaken within the study area, including those without positive results (sites found). A search of the Archaeology Branch Remote Access to Archaeological Data (RAAD) website for recorded sites was supplemented by visits to the Archaeology Branch, where staff was able to search the provincial database for any archaeological permits issued for the area. From the identified reports, the areas surveyed for archaeological impact assessment were digitized and then added to the data used to build the model.

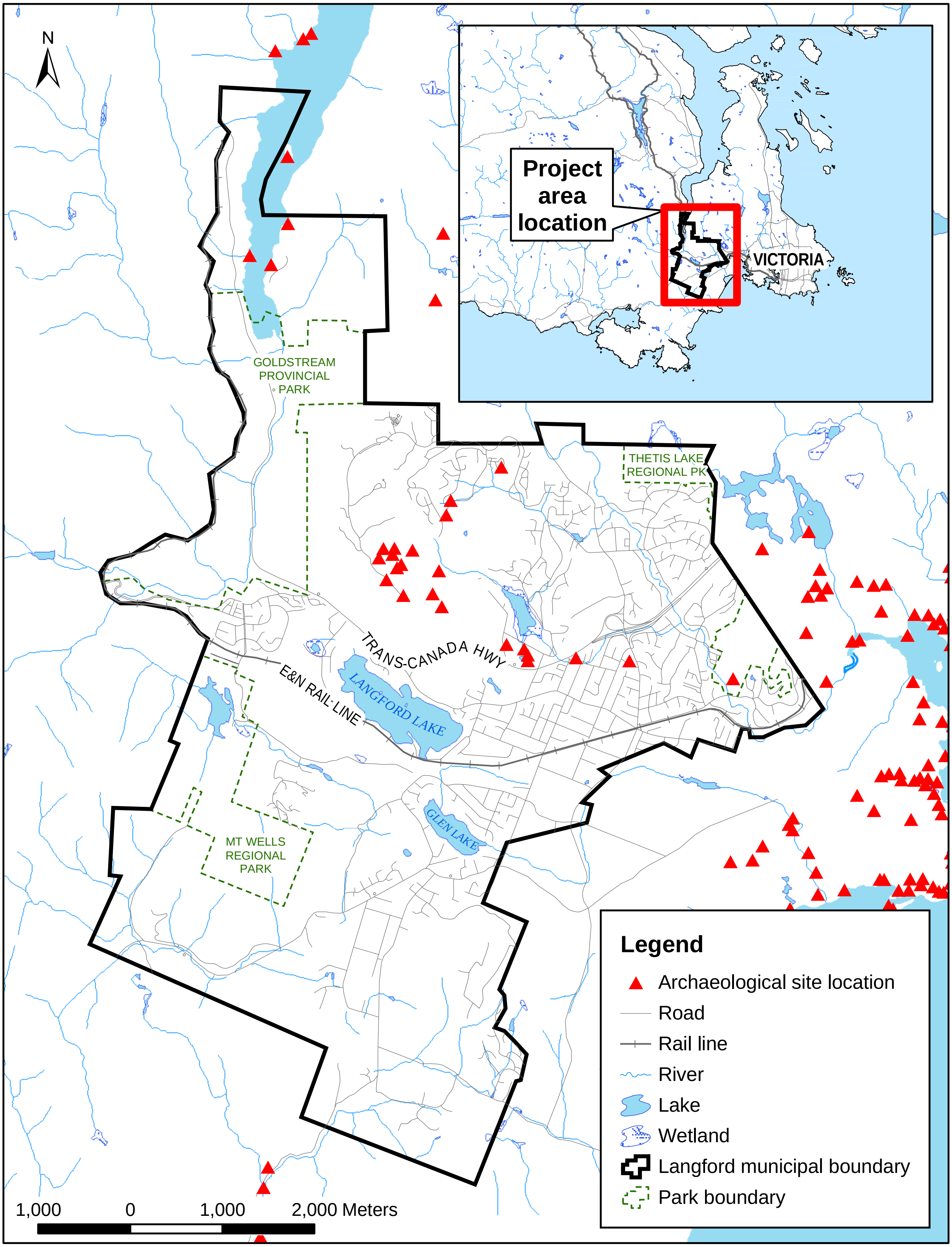

Figure 1. Overview of Langford.

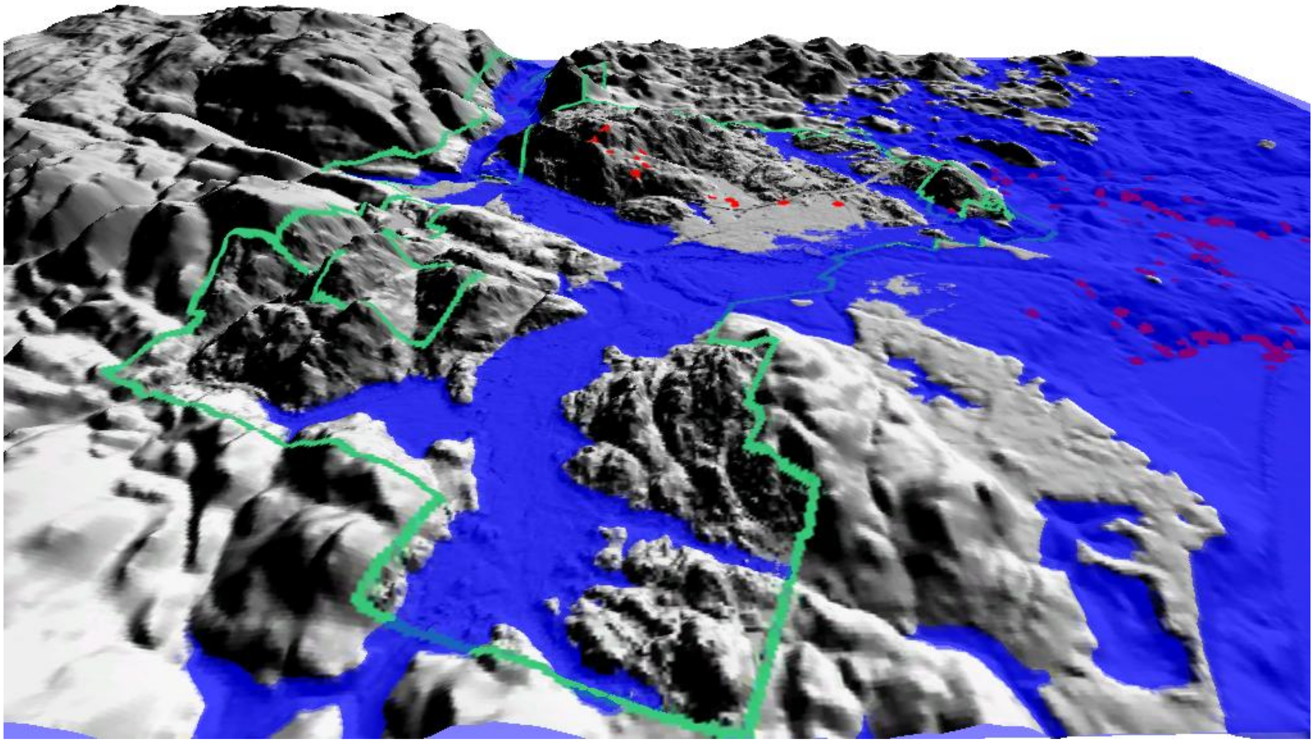

Figure 2. 3D view of Langford (looking North) with 75m sea level. Green lines indicate the boundary of Langford, while red dots indicate recorded archaeology sites in and surrounding Langford. The blue area indicates the area that would be underwater if sea levels were 75m higher than present-day.

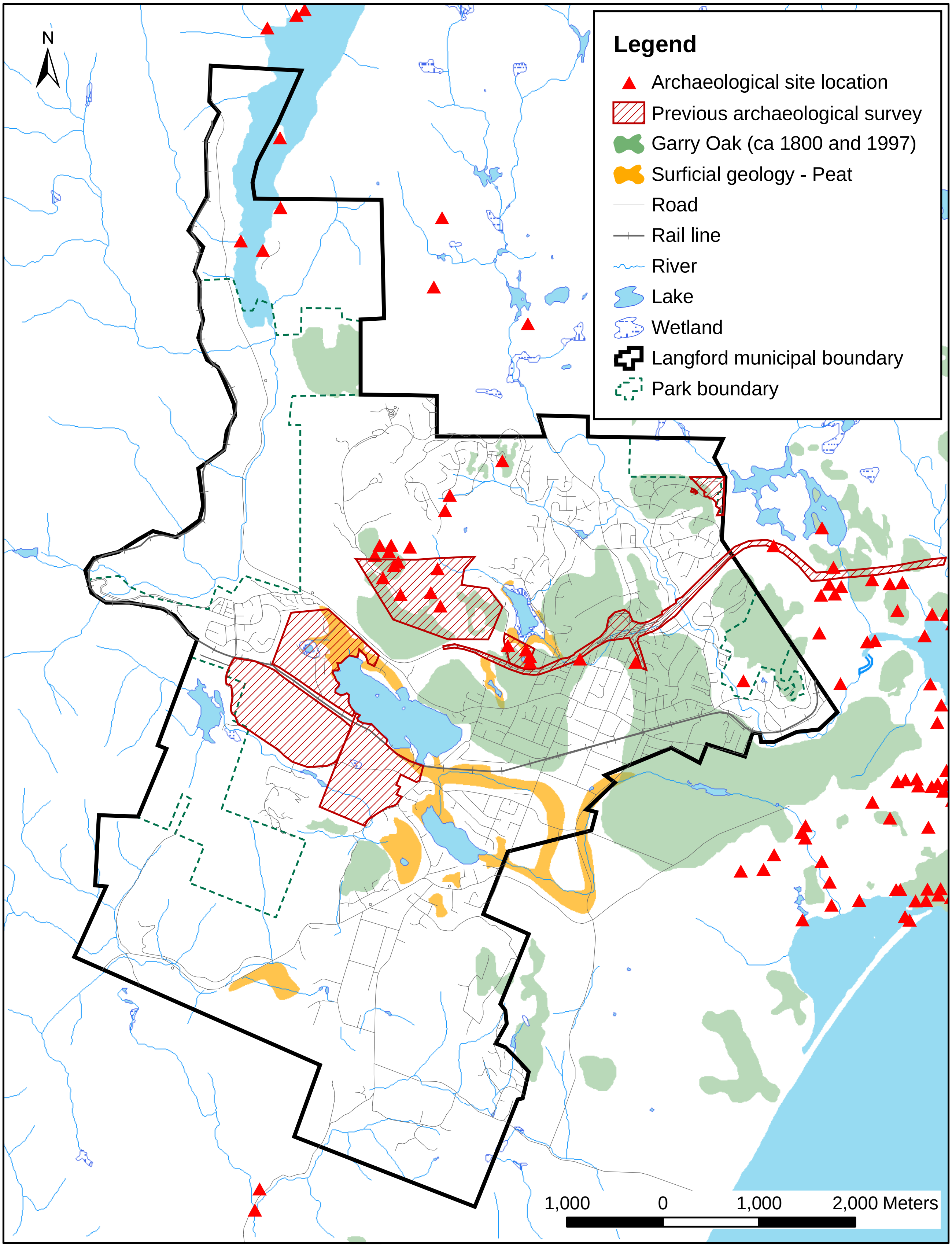

Figure 3. Results of background research and addiitonal data used in modelling.

Model building

As the initial model was acquired from the Hul'qumi'num Treaty Group, work was focussed on refining and "tweaking" the model in order to make it more applicable to Langford specifically. A DEM of much higher resolution than the one used in the HTG model was provided by the City Langford, and it was used to fine-tune the model. In order to supplement the database of recorded sites in Langford (of which there are relatively few), areas within Langford which were noted to be of high potential in recent fieldwork by Millennia staff were digitized, and the distribution of the DEM variables for these areas was compared with the distribution for the overall land area by means of histograms. While several of the variables did not show any significant differences, some of the variables appeared to be skewed in one direction or another, suggesting the importance of that variable for potential archaeology site locations.

Landform features were identified using the higher resolution DEM provided by Langford. Timberline Natural Resources Group ran a custom AML script (Arc Macro Language), developed for earlier modelling projects by Millennia and Timberline, on the improved DEM. The AML script uses a rectangular moving window to identify topographic variables from the DEM by evaluating the cells surrounding a central cell (the cell size being 5m). Moving windows used for this evaluation were a 9 by 9 cell rectangle, a 25 by 1 cell horizontal rectangle, and a 1 by 25 cell vertical rectangle. The statistics calculated for each cell include the sum of all cells with relative elevation values lower than the central cell ("positive"), the sum of all cells with relative elevation values lower than the central cell ("negative"), and the number of cells with relative elevation values higher than the central cell ("positive count"). The positive and negative were calculated using both the 25 by 1 horizontal and vertical windows, while the 9 by 9 square window was used to calculate positive and positive count. The 25 by 1 results were combined by taking the maximum value of the horizontal or vertical for each cell.

The DEM variables were then combined to model for landform features which would have high potential for archaeological sites. The relatively flat tops of knolls, ridges and terrace edges were modelled for, as were small, unmapped wetlands and streambeds. The relatively flat areas at the tops and bottoms of steep slopes were also identified as features. The combination of these features appeared to accurately represent the areas we had identified as high potential, as well as the locations of recorded sites. Additional archaeological site data acquired after this modelling was complete was also tested against model predictions and was suitably captured by the model.

The elevation ranges were also calculated for each cell using a number of different sizes of rectangular windows. In combination the AML results described above, and the standard DEM derivatives including slope and aspect, terrain features with high archaeological potential were identified. These features and the variables used to identify them are shown in.

Landform feature	DEM variables used to identify the feature
Tops and bases of steep slopes (rockshelters and lookouts)	Areas with a slope less than or equal to 15 degrees, which were within 25m of a slope greater than or equal to 30 degrees
Knolls and ridge tops	A positive count greater than or equal to 45 was combined with areas where the 9 by 9 elevation range was between (inclusively) 3 and 9 (the region where sites and areas of high potential appeared to be more skewed than the overall range distribution), and also combined with slopes less than or equal to 6 degrees
Small wetlands	A positive count of less than or equal to 15 was combined with a 50 by 50 elevation range >= 20. This identified also streams, wetlands, and small water bodies etc., not all of which appear in TRIM map features.

Table 1. Landform features and the DEM variables used for identification

In addition to these landform features, water features which were used in the HTG model were also used in this model, although some of the buffer distances were modified to better reflect the scale of this particular project. Rivers (TRIM "definite") were buffered to 20m; FISS (Fisheries Information Summary Systems) streams were buffered to 100m; lakes and TRIM-mapped wetlands were buffered to 50m; geology peat "wetlands" were buffered to 50m; and small wetlands derived from the DEM were buffered to 20m. FISS streams in Langford include Goldstream River, which is home to coho and chum salmon, and Millstream River, home to cutthroat trout. The HTG modelling identified proximity to FISS, river, lake, or wetland features as being significant to the locations of archaeological sites.

The areas of Garry Oak (past and present) were also incorporated into the model. Analysis was done to determine whether these were significant in the location of archaeology sites, and it was found that Garry Oak meadows were highly significant – there were there were more than twice as many archaeology sites found in Garry Oak meadows than a random distribution would suggest.

One limitation of the DEM however, is that it was created recently and includes many man-made features such as road cuts, quarries, and built-up areas. This created a large amount of spurious "high potential" land area, where a road embankment or quarry pit appeared to be high potential in the model. This was compensated for by removing the areas that were obviously incorrectly identified as having potential. Combining DEM 'Break lines' with buffered layers captured most of these areas (roads could not be used since the layer included roads as yet unbuilt). Manual digitizing finished the clean up.

Another limitation is the large amount of landscape alteration that has taken place in Langford over the last century. The overall changes have made it more difficult to predict archaeological site locations in the altered areas. An example of this would be the change in flow direction of Langford Lake, from flowing south through Glen Lake to Esquimalt Lagoon, to flowing north through drainage culverts to Goldstream River. The railway embankment on the southwest side of Langford Lake is the main cause of this change, and as a result, the lands between these two lakes will have been quite altered from their original natural environment (http://www.bclss.org/docs/Langford%20Lake.pdf).

This was at least partially accounted for by the addition of the digitized geology areas where the surficial geology was identified as peat. These areas of peat were likely once wetlands (Monahan and Levson 2000), and have therefore been treated the same as wetlands in the modelling. This also helps at the south end of Florence Lake, where there is an area that in-field survey as well the orthophoto suggests was at one time wetland (though diverting of drainage, construction etc. have caused it to dry up). In order to account for DEM inaccuracies due to landscape modification, some clipping of the model was done. Creation of a clip layer included:

- Cleaning up of road center lines (removal of roads that were not existent at the time of the DEM creation; moving roads that were digitized in the wrong place);
- Buffering road center lines – in residential streets to 5m (on each side of line), highways (wide sections) to 15m, and narrow highway sections to10m. This seemed to capture the majority of roads. (a few sections may not have been captured due to fluctuations in road width);
- Digitizing areas which were modelled but where landscape modification prevented accurate use of the DEM – e.g. quarries, large industrial areas, golf courses etc.;
- Combining these attributes into a layer to clip the model layers.

Scoring classification for the archaeological potential was set as following:

Feature	**Point score**
Ridge/knoll **or** Top/base slope	2 points
20m to river **or** 50m to lake	1 point
20m to river **or** 50m to lake **or** 50m to wetland **or** 50m to peat-wetland **or** 20m to DEM wetland **or** 100m to FISS stream	1 point
20m to DEM wetland	1 point
Garry Oak	1 point
Total points possible	**6 points**

Table 2. Scoring classification for features identified by baseline model

Based on the scoring system a preliminary classification for areas of archaeological potential was established: 0-1 points = low potential, 2 points = moderate potential, 3-6 points = high potential

Results

The modelling provided the following results:

- Approximately 60% of known archaeological sites are located in high potential areas;
- Approximately 25% of known archaeological sites are located in moderate potential areas;
- Approximately 15% of known archaeological sites are located in low potential areas;
- Areas identified in the field as high potential are well captured by the model;
- Sites recorded but not yet entered into the archaeological site registry, and not used in the model definition are well captured and so provided a good check of the model;

- Approximately 3.5% of the Langford land area is captured in the high potential;
- Approximately 11% of the Langford land area is captured in the moderate potential;
- As a result of the modelling, approximately 85% of the known archaeological sites have been captured in 15% of the land area. This is a Kvamme's Gain of 0.82 overall, and a Kvamme's Gain of 0.94 for high potential lands, a quite good result.

Kvamme's (KV) Gain is a statistic used to measure the accuracy and precision of a model (Brandt, et al. 1992).

Conclusions

As can be seen from the results, the draft model is performing well. The improved DEM provided by Langford was able to greatly improve the model from the starting HTG model, and the additional data gained from our background research was also useful in improving the model and making it more specific to Langford. Future field work will help to test and fine-tune the model. Eventually the model may be replaced with PFR (provisional field reconnaissance) ground assessments of archaeological potential.

Should you have any questions about this report or the model, please don't hesitate to contact us.

We look forward to continuing working with you on the other phases of the Langford Heritage project.

Yours sincerely,

Morley Eldridge, M.A.

Alyssa Parker, B.Sc.

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