QUATERNARY GEOLOGY OF FORT NELSON (NTS 094J/SE) AND FONTAS RIVER (NTS 094I/SW), NORTHEASTERN BRITISH COLUMBIA

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ABSTRACT

During the summer of 2004, Quaternary geology studies were conducted within the Fort Nelson and Fontas River map areas (NTS 094J/SE and 094I/SW, respectively), in northeast British Columbia. The study area is situated within the Interior Plain physiographic region, encompassing parts of the Alberta Plateau and the Fort Nelson Lowland. The plateau is dominated by Cretaceous Dunvegan sandstone while the more recessive Fort St. John group shales underlie the lowland. Objectives of this study include delineation of the surficial geology, compilation of stratigraphy and aggregate potential studies within the map area. As the study area is located near the western extent of the Laurentide Ice Sheet and the eastern extent of the Cordilleran Ice Sheet possible ice sheet interactions will be addressed. Preliminary icnvestigations of river sections suggest the Prophet River valley is a re-incised paleovalley that provides new pre-glacial to Holocene stratigraphy, including a pre-Late Wisconsinan site. One site provided radiocarbon dates of > 44 730 and > 45 100 years BP from peat and wood within a massive to laminated clay unit with gradational pods of diamict.

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1.0 INTRODUCTION

Northeastern British Columbia is an important region for natural resource development, including forestry and petroleum. Given the increase in oil and gas development, the British Columbia Ministry of Energy and Mines recognizes the need for regional-scale Quaternary geologic studies to address such issues as the recent increase in demand for construction aggregates (Ferbey *et al.*, this volume). This study focuses on the southeast quadrant of the Fort Nelson map area and the south-west quadrant of the Fontas River map area (NTS 094J/SE and 094I/SW; Figure 1) for detailed surficial geology and stratigraphy investigations. Accessibility to the regions is good and potential for large Quaternary exposures exists along major rivers. The region has received minimal Quaternary study and the objective of this investigation is to fill this data gap as it relates to several areas of research. Specific goals include the following:

- map the surficial geology of the region, and two 1:100 000 maps,
- compile the stratigraphy and document the character of glacial and preglacial sediments in paleovalleys and at plateau level, and
- investigate the interactions of the Laurentide Ice Sheet, Rocky Mountain glaciers and the Cordilleran Ice Sheet, addressing the eastern extent of Early or Late Wisconsinan Cordilleran ice.

These objectives will be addressed through aerial photograph interpretation, fieldwork (regional mapping, stratigraphy, sampling) and laboratory work (pebble lithology, grain size, geochemistry) in 2004 and 2005 as a contribution to a Master's thesis through the University of Victoria.

2.0 LOCATION

The study area is within the Fort Nelson and Fontas River map areas and is situated in northeast British Columbia between 58˚-58˚ 30' N and 121˚-123˚ E (Figure 1). Specifically, the map area includes the 1:50 000 map regions of Niteal Creek (94I/03), Dehacho Creek (94I/04), Fontas (94I/05), Elleh Lake (94I/06), Klua Lakes (94J/01), Prophet River (94J/02), Big Beaver Creek (94J/07), Klua Creek (94J/08) and Clarke Lake (94J/09). The region is about 60 km south of Fort Nelson, and includes Prophet River, a community of the Dene Tsaa Tse K'Nai First Nation. The Alaska Highway (Highway 97) transects NTS 094J/2, 7 with additional road access via active and inactive resource and petroleum development roads. The Canadian National rail line transects NTS 094J/8 and 094I/5, 4, 3 and provides access into road-inaccessible areas.

3.0 PHYSIOGRAPHY

The map region is part of the Interior Plain physiographic region, encompassing parts of the Alberta

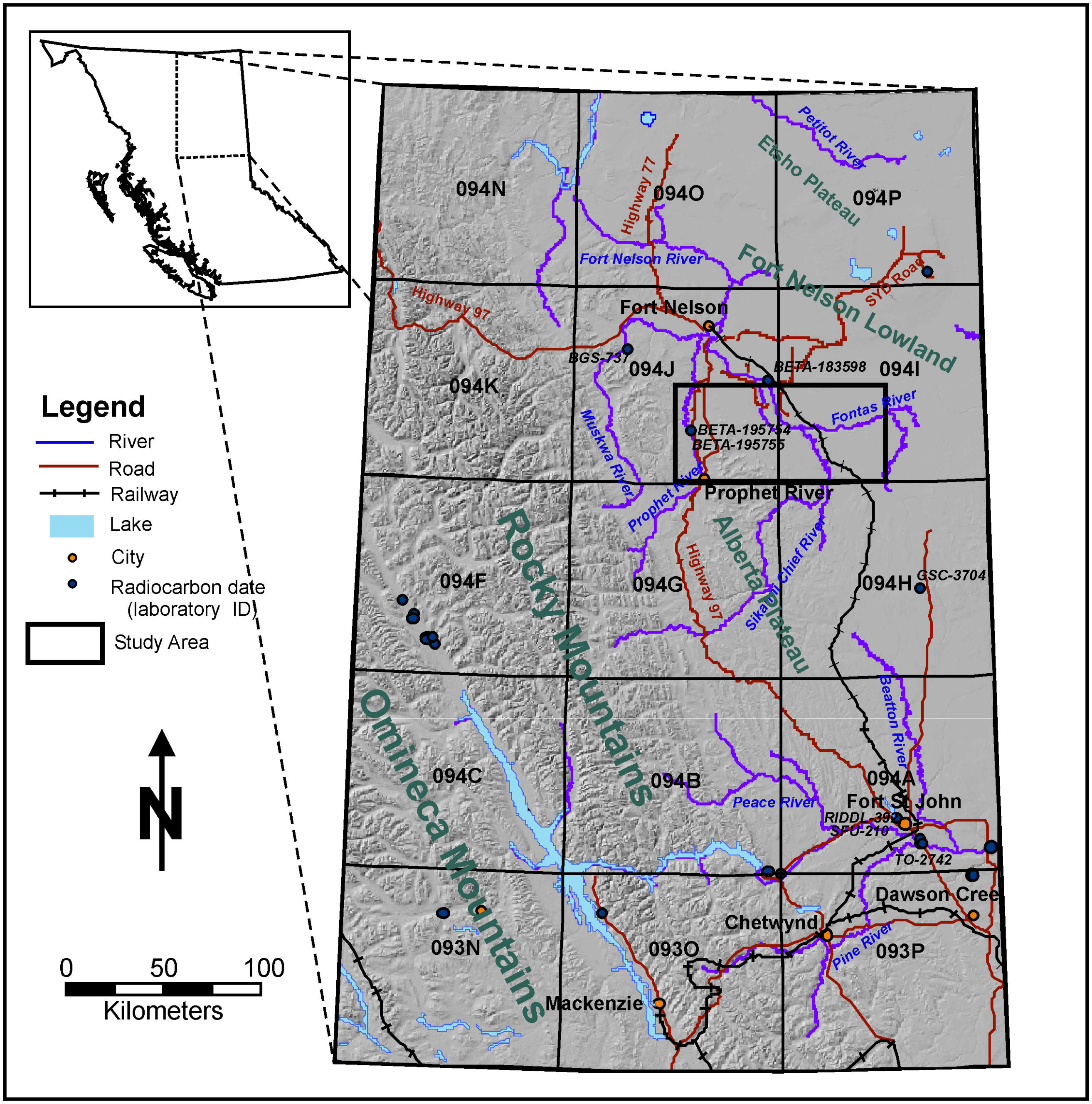

Figure 1. Location of the study area within the Fort Nelson and Fontas River map sheets (NTS 094J/SE and 094I/SW), northeastern British Columbia.

Plateau and the Fort Nelson Lowland (Holland, 1976; Figure 1). The Alberta Plateau is a predominately flat upland that lies east of the Rocky Mountain Foothills with elevations between 915 and 1220 m (Holland, 1976). In northeastern BC, rivers have incised the Alberta Plateau resulting in remnant flat-topped cuestas caused by resistive sandstone and conglomerate beds overlying recessive shales. These cuestas can be found in the southwestern part of the map area exhibiting elevations up to 1070 m above sea level (a.s.l.). Arbitrarily designated below the 668 m (2000 ft) contour, the Fort Nelson Lowland exhibits elevations as low as 450 m a.s.l. Dominating the map area, the Fort Nelson Lowland is an area of low relief, with poor drainage resulting in abundant bogs and fens (Holland, 1976). Further incision into the lowland by the Sikanni Chief, Fort Nelson and Prophet rivers results in valley bottom elevations from 330-520 m a.s.l., with the Fort Nelson incised the deepest. The general relief in the area can be attributed to bedrock topography. Locally, however, the bedrock can be masked by up to 200 m of Quaternary (and possibly Late Tertiary) deposits. Quaternary landforms typically exhibit positive relief of less than ten metres relative to the surrounding area. The Elleh Creek gravel deposit, situated just north of the map area in NTS 094J/9, is anomalous in that its local relief due to Quaternary sediments varies from 20-65 m.

4.0 BEDROCK GEOLOGY

The study area is situated near the western edge of the Western Canadian Sedimentary Basin and is underlain by Cretaceous shale, sandstone and conglomerate. Bedrock topography is variable as seen in river cuts. Bedrock outcrops are rare in the map area, except along river valleys and cuesta scarps where there is little or no Quaternary cover. Outcrops are predominately Lower Cretaceous Fort St. John Group, with the uplands capped by Upper Cretaceous Dunvegan Formation (Figure 2) (Taylor and Stott, 1968; Thompson, 1977). The Fort St. John Group is mainly a marine shale succession with minor siltstone and sandstone and commonly contains ironstone concretions, sulphur staining and selenite crystals (Thompson, 1977). Within the Fort St. John Group are the Buckinghorse Formation, Sikanni Formation, and Sully Formations. The Buckinghorse Formation consists of silty shales with minor sandstone. The Sikanni Formation overlies the Buckinghorse Fm and consists of four to eleven units of sandstone separated by silty shales. Overlying the Sikanni Fm is the Sully Formation, which consists of recessive shales. Stratigraphically overlying the Sully Fm is the Upper Cretaceous Dunvegan Formation. This upper formation is a deltaic and pro-deltaic sandstone, conglomerate and mudstone succession (Thompson, 1977). Sandstone is dominant and chert-quartz conglomerate outcrop only at the highest elevations in the map area. This study has identified a new outcrop of Dunvegan conglomerate, previously not reported within the map area (Figure 2). This rock type may be suitable for crushed rock aggregate.

5.0 PREVIOUS WORK

Previous Quaternary geologic work in the region is limited. During original construction of the Alaska Highway several road surveys were published, providing information on the general geology (Hage, 1944; Denny, 1952). Specific Quaternary research in the map area is limited to a large-scale geomorphology and ice flow study of northeastern British Columbia and northwestern Alberta complied by Mathews (1980). In regions near to the study area, surficial geology maps and reports have been completed for Charlie Lake (NTS 094A) and Trutch (094G) map areas (Mathews, 1978 and Bednarski, 1999 respectively). Aggregate potential has been mapped for Trutch (east half, NTS 094G) and Beatton River (NTS 094H) (Savinkoff, 2004). As part of the previously mentioned British Columbia Ministry of Energy and Mines / Geological Survey of Canada initiative, surficial geology and bedrock topography studies are in progress for Petitot River (NTS 094P) and Fontas River (NTS 094I) respectively (Ferbey *et al.*, this volume; Hickin *et al.*, this volume).

6.0 BACKGROUND: REGIONAL GLACIAL GEOLOGY

Previous work, within and adjacent to the map area, indicates the study area is near the western extent of the Laurentide Ice Sheet and eastern extent of the Cordilleran Ice Sheet. As such, most authors assume both ice sheets, at some point in the Quaternary, covered the area. More specifically, Mathews (1980) recognizes that there were

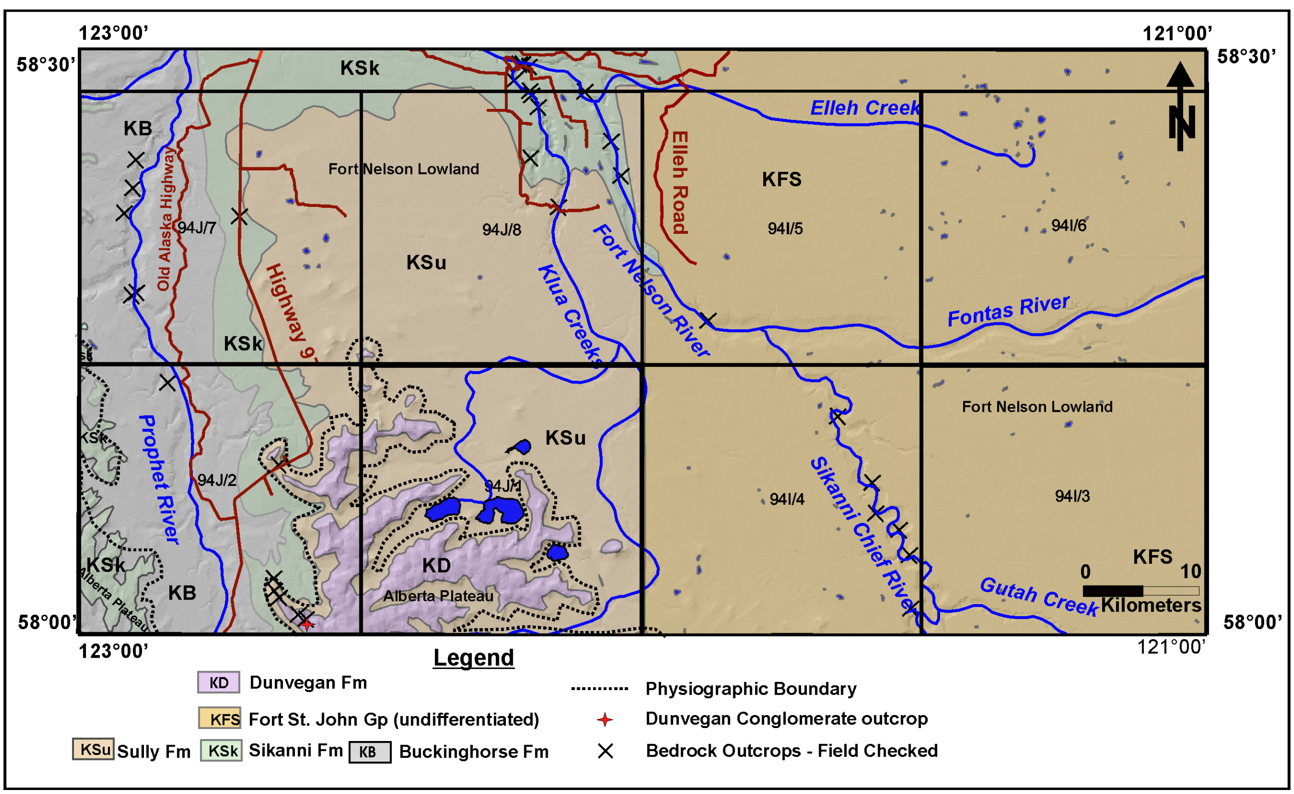

Figure 2. Cretaceous bedrock geology of the study area and observed bedrock outcrops in river sections, stream cuts and road cuts. The Fort St. John Group is equivalent to the Buckinghorse Formation, Sikanni Formation and Sully Formation; thus the straight-line boundary between 94I/SW and 94J/SE represents mapping divisions and not an actual geologic division.

likely three glacier systems present in northeast British Columbia during the last glacial maximum - the Laurentide Ice Sheet, the Cordilleran Ice Sheet and coalescent valley glaciers (local montane) from the northern Rocky Mountains. The words montane and Cordilleran are often used interchangeably in the literature, but should not be confused as they are spatially and lithologically distinct. Cordilleran refers to an ice mass that covered much of British Columbia, which at one time extended locally west over the Coast Mountains and east to, or over, the Rocky Mountains. Contrastingly, montane refers to the development of local cirque and valley glaciers. The confusion arises because the Cordilleran Ice Sheet grew primarily by assimilating local Montane glaciers and did not become a true Late Wisconsinan 'Cordilleran Ice Sheet' until about 19-13 ka (Ryder *et al.* 1991). During retreat, the Cordilleran Ice Sheet melted and once again took form of local Rocky Mountain (montane) glaciers.

In order to interpret the presence and behavior of the three glacier systems, criteria are required to separately distinguish the sediments. The easiest method to use, especially in the field, is identification of distinct clast lithologies sourced from one specific area. This allows tracing of dispersal trains and determination of ice flow and thus ice sheet provenance. However, it may not be possible to determine one or two distinct lithologies diagnostic of one source area. Common practice is to identify an assemblage of lithologies from the source region of each glacier system. For example, red to pink felsic igneous and metamorphic clasts are commonly derived from outcrops of the Canadian Shield. These outcrops occur in northern Alberta, Saskatchewan and the Northwest Territories. As such, these clasts are most likely brought to the study area by the Laurentide Ice Sheet. Similarly, Mathews (1980) notes, grey granitic fragments and low-grade schist and slate are derived from plutons and the metasedimentary Hadrynian beds within or west of the Rocky Mountain Trench. Thus, these clasts are most likely brought to the study area by the Cordilleran Ice Sheet. The schist and slate weather fairly easily and it is thought that they would be mostly eradicated if the deposit had been reworked. Lithologies local to the area include ironstone, shale, siltstone, and sandstone clasts derived from the underlying Cretaceous bedrock. Outcrops of Dunvegan conglomerate provide a local source for black chert, tan chert, red chert and quartz pebbles. The presence of these clasts may not be useful in determining specific provenance. In addition, sediments from all three source areas contain quartzite that may have been reworked from Tertiary River systems draining onto the plains of Alberta and British Columbia from the Rocky Mountains. Likewise, while certain fossils or types of fossiliferous limestone may indicate provenance, the presence of limestone itself does not. Platformal Devonian limestone rocks outcrop in northeastern Alberta and the Northwest Territories and could have been brought to the study area by the Laurentide Ice Sheet. However, Devonian limestone also occurs in the Rocky Mountains of southern Alberta and northern British Columbia. Thus, limestone could also have been transported to the study area by the Cordilleran Ice Sheet or Rocky Mountain glaciers.

Work within or adjacent to the study area, has resulted in a general and somewhat debated glacial history. It is known that Laurentide ice advanced into the study area after 24 400 ± 150 C^{14} BP (BETA-183598), indicated by a radiocarbon date on wood found in gravel underlying till at Elleh Creek (Levson *et al.,* 2004; Figure 1). Whether another ice sheet was present in the region before this period is unknown. In the Trutch sheet (NTS 094G, Figure 1), just south of the map area, the presence of eastward pointing striae at elevations of 1860 m a.s.l (Bednarski, 1999) suggests Cordilleran ice overtopped the Rocky Mountains and entered the foothills. It is not known if the ice front extended onto the plains and into the field area. Shield-derived clasts are found extending west into the mountain valleys in the Trutch map area and thus the Laurentide Ice Sheet reached the Rocky Mountain front, in this region, during a past glaciation (Bednarski, 1999). However, it is unknown whether the Cordilleran Ice Sheet had retreated west of the Rocky Mountain front when the Laurentide Ice Sheet was there or whether a period of coalescence occurred (Bednarski, 1999). The western limit of the Laurentide Ice Sheet has been mapped west of the study area, "where counts of red granite or gneiss drop off abruptly" (Mathews, 1980, page 4) His study suggests that coalescence of ice sheets did not occur in the map area but may have occurred on the plains east of the Rocky Mountain Front.

Coalescence between the Laurentide and Cordilleran Ice Sheets is believed to have occurred in southwestern Alberta in the Late Wisconsinan (Bobrowsky and Rutter, 1992) South of the map area (NTS 094A, Figure 1), Mathews (1978) suggested a region of coalescence in the plains east of the mountains, indicated by a continuous surficial till sheet with Cordilleran lithologies in the west and Laurentide lithologies in the east. In the Grand Prairie-Peace River region, Catto *et al.* (1996) contest coalescence, suggesting instead that a pre-Late Wisconsinan Cordilleran advance (>51 ka BP) was the most extensive glaciation, followed by a smaller Late Wisconsinan Laurentide advance (~22 ka BP).

Ice recession began around 14 ka for the northwest, southwest and south margins of the Laurentide ice sheet (Dyke *et al.*, 2002). Although very few radiocarbon dates exist in northeast BC, dates ranging from 10 100±210 C^{14} ka BP (RIDDL-392) to 13 970±170 C^{14} BP (TO-2742) near Fort St John indicate retreat of the Laurentide Ice Sheet southeast of the map area by this time (Bobrowsky *et al.*, 1991; Driver, 1988;Catto *et al.* 1996; Figure 1). Further north, though still southeast of the area, a 10 400±140 C^{14} BP (GSC-3704) date from Snowshoe Lake (MacDonald, 1987; Figure 1) suggests retreat by about 10.5 ka. Closer to the study area, Rampton (1986) identified three stages of a glacial lake occupying the Muskwa River valley and dated a terrace 27 m above modern river level at 8 930±230 C^{14} BP (BGS-737) representing a minimum deglacial date (Figure 1). Rampton suggests that the ice margins he mapped are comparable to ice margins mapped for the Clayhurst stage of Glacial Lake Peace (Mathews, 1978; 1980). Using this analogy, he suggests that deglaciation of the Fort Nelson area occurred between 11,500 and 12,200 C^{14}years BP.

7.0 FIELD METHODS

Black and white aerial photograph (1:60 000 scale) interpretation was completed to obtain a detailed preliminary map of the surficial geology. Accessible areas were ground checked during the 2004 field season along roads, rail, seismic lines, pipeline routes and well sites using a truck, foot traverses, rail truck and all terrain vehicles (Figure 3). Surficial materials were studied in various exposures including borrow pits (created during road and well site construction), newly cut ditches, road cuts and river/stream cuts. In areas where exposures were not available, surficial materials were determined using an Oakfield soil probe or a Dutch auger to a depth of at least one metre. Care was taken to ensure stations near well sites and roads were placed away from areas of human disturbance. Major river sections along the Fort Nelson and Prophet River systems were reached by jet boat. Sections were measured and sampled, noting stratigraphy, color, density, lithology and sedimentary structure. Additional sections on the Prophet River and other remote areas are scheduled for investigation in 2005.

8.0 LABORATORY METHODS

A total of 32 samples were collected during the 2004 field season to be used for characterization of surficial sediments in the map area (Figure 3). Samples of sand and gravel were taken from representative glaciofluvial sites (n=10). One half to one kilogram of each sample was wet-sieved into > 4 mm, 2-4 mm and 1-2 mm size fractions. Lithologic pebble counts were completed for the > 10 mm and 4-10 mm size fractions and will be used to identify different meltwater source regions. Wood was collected from two units in a section along the Prophet River. This wood was sent to the BETA Laboratory for conventional radiocarbon dating.

Samples of diamict were also collected throughout the map area (n=14). Select samples will be wet sieved and pebble counts will be completed on the larger size fractions. This data will be used to investigate till provenance. Lastly, diamict and gravel samples collected from units within four sections on the Prophet River (n=8) will be used for correlation between sections.

9.0 SURFICIAL GEOLOGY

Ground checking in the field area has resulted in the identification of the surficial sediment type at 203 field sites. This has led to the recognition of two diamict units, several sand and gravel units and two silt and clay units. These deposits are found at surface throughout the map area and overlie other stratigraphic units (see section 10.0). As such, these units likely record the last glacial events in the region. Examples of each surficial geology unit are described below.

9.1 Glacial

Dense, clast-poor silty clay diamict is the dominant surficial material in the study area, encountered at approximately 90 field sites. Thickness of this unit is usually 1-10 m but can be up to 170 m (Hickin and Kerr, this volume). The clast content ranges from 1-5% and includes subangular to subrounded, granule to cobble sized clasts with occasional boulders. Clast lithologies include potassium feldspar-rich granite and gneiss, limestone (some fossiliferous), oil-impregnated dolostone, minor mafic and volcanic clasts, siltstone, quartz, quartz sandstone, quartzite, black chert, tan chert, sandstone, shale and ironstone. This diamict is primarily interpreted to be a basal till, identified by the presence of numerous local and striated clasts, high density and a fine-grained matrix derived from local Cretaceous shales or advance glaciolacustrine sediment. Englacial and supraglacial tills likely exist in the study area but have not been specifically identified. One exception is a diamict exposed in a stream-cut at plateau level near the Fort Nelson River. The diamict is poorly stratified, has 5-15% clast content with a cobble-sized average clast diametre, and contains occasional metre-wide coarse gravel lenses. Due to these characteristics, the diamict at this site is interpreted as a meltout till.

The presence of abundant felsic granitic clasts at all till sites studied suggests that the till is of Laurentide provenance (see section 6.0). This till occurs at the surface throughout the map area and is only overlain by thin and geographically restricted glaciofluvial and glaciolacustrine sediments. As such, the till likely records the last glacial event and is Late Wisconsinan in age. Although the study area is near the margins of the Laurentide Ice Sheet, the ice was thick enough to overtop the Alberta Plateau uplands, as evidenced by felsic igneous and metamorphic clasts at the highest elevation in the map region (1050 m a.s.l.).

Preliminary field studies have found few grey granitiod, schist or slate clasts within the till (see section 6.0). This, combined with the abundance of Shield-derived clasts, suggests deposits of Cordilleran provenance have not yet been found in the map area. However, it is recognized that ice interaction can cause dilution of clast provenance, and the presence of Cordilleran till in the map region cannot be ruled out.

Till deposits in the region generally occur in low relief till plains. However, there are numerous small-scale ridges concentrated in a corridor between Klua Creek and the Fort Nelson River, but also occurring locally throughout the map area. These ridges are identifiable on aerial photographs and LiDAR DEM imaging, and trend southeasterly (Figure 3B). The ridges are continuous for 1000's of metres with occasional gaps. Ground checking at three sites indicates the ridges are one to two metres tall (e.g. Figure 4). Relief is highlighted by the vegetative transition of stunted black spruce in the lows, to poplar trees on the ridges with higher relief and better drainage. Lithologically, the ridges consist of silty clay diamict with ~5% subangular to subrounded clasts (granule to cobble sized), including granitic lithologies. The ridges are interpreted to be recessional moraines, related to retreat of the Laurentide Ice Sheet. Combined with the initiation points of meltwater channels, these ridges delimit ice-margins in the corridor between Klua Creek and the Fort Nelson River.

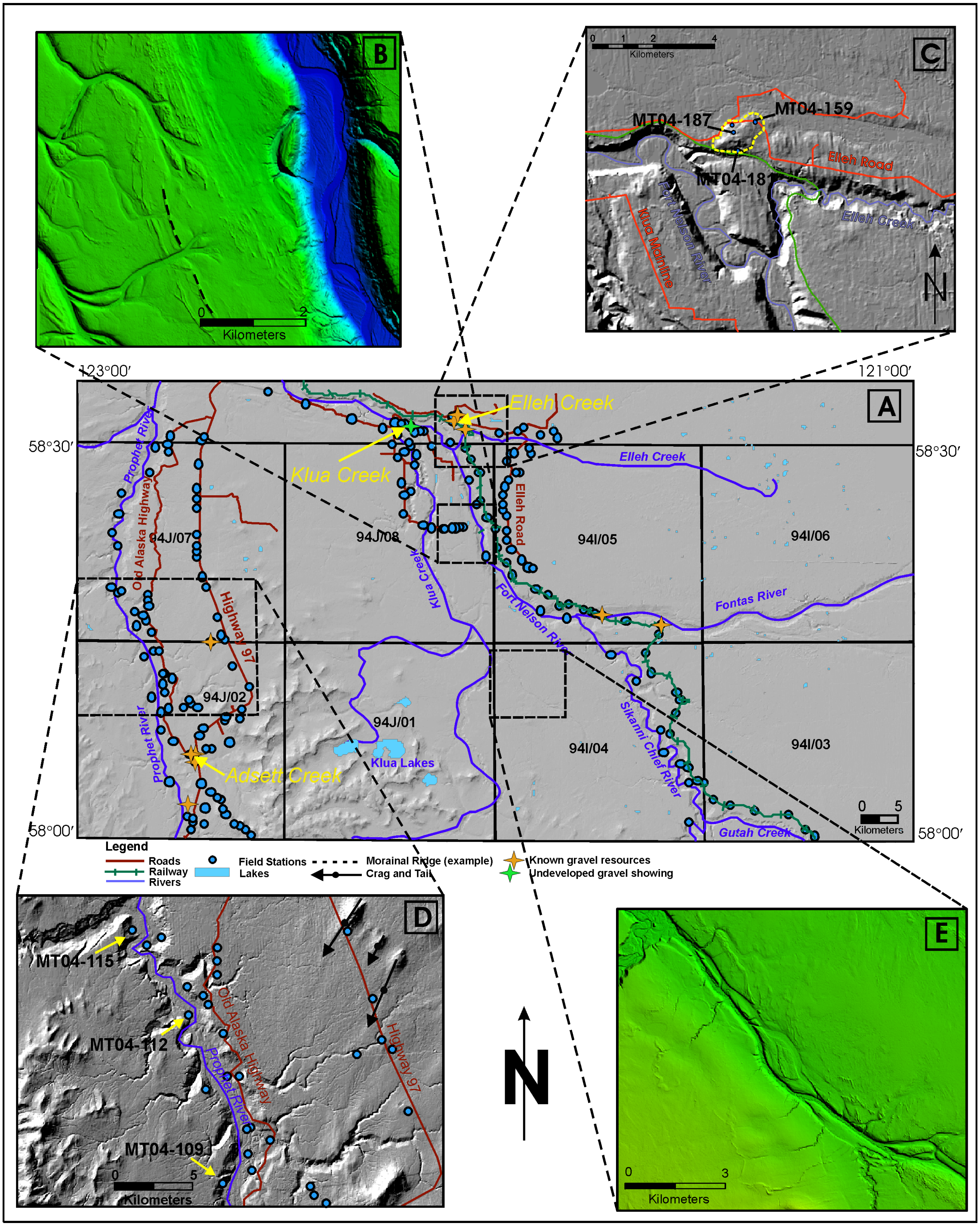

Figure 3. A. Location of field stations, aggregate occurrences and areas of geomorphic interest within and just outside of the map area. B. LiDAR hillshade (2 m resolution) showing morainal ridges and meltwater channels situated between Klua Creek and the Fort Nelson River. One ridge has been outlined with a dashed line C. Hillshade (30 m resolution) of the Elleh Creek gravel deposit (dashed polygon) and surrounding regions. D. Close-up hillshade (30 m resolution) image along a section of the Prophet River. The locations of sections discussed in the text are demarcated, as are several crag and tail features on the plateau. E. LiDAR hillshade (10 m resolution) showing an abandoned river system with meandering to braided channels. This channel system is thought to be an ice-marginal meltwater channel (see text).

Figure 4. A morainal ridge found in the region between Klua Creek and the Fort Nelson River.Ridge is ~two metres high. Relief of the ridge is highlighted by the growth of poplar trees on the high, better drained, ridge and spruce bog and/or fen in the regions of lower relief with poorer drainage.

9.2 Glaciofluvial

Glacial meltwater activity is indicated throughout the map area by the presence of meltwater channels at various elevations. These channels incise into till and bedrock, contain under-fit rivers and are commonly occupied by lakes and Holocene organic deposits. A northwest-trending braided channel system up to 30 m deep, 8 km wide and >50 km long transects the study area through NTS 094I/04, just west of the Fort Nelson-Sikanni Chief River system (Figure 3E). The braided behavior and orientation of the parallel to the recessional moraines suggest these channels are the result of ice-marginal drainage. Also significant, a 1.5 km wide and 90 m deep, steep-walled, channel system with occasional terrace deposits transects the map area, cross-cuts other systems (see below) and extends over 150 km. With its headwaters at Ekwan Lake, this channel is occupied by the Fontas and Fort Nelson Rivers, and has been related to late-stage meltwater drainage from Glacial Lake Peace (Mathews 1980). However, this feature may have first formed as an incised subglacial channel. According to regional deglaciation estimates, this meltwater channel was active from 11.5-11 C^{14} ka BP (see Dyke *et al.* 2003 and Mathews, 1980). Many of the smaller channel systems were largely erosional and generally lack glaciofluvial sediments.

There are also depositional systems, notably the Klua Creek deposit. This sand and gravel outwash extends approximately 1 km by 0.5 km and is situated just below plateau level near the confluence of Klua Creek and the Fort Nelson River (Figure 5). Southward extent of the deposit is unknown. At site MT04-139, cobble gravel is exposed at the edges of a meltwater channel (Figure 5A). This gravel contains 50-70% clasts in silt to coarse sand matrix and is matrix to clast supported, poorly sorted and poorly to moderately stratified. To the north, the outwash plain is exposed in a six-metre section at site MT04-141 (Figure 5B). This section occurs on the edge of the Fort Nelson River valley, and from this crosscutting relationship it is interpreted that the Klua Creek gravels were deposited at an earlier stage than the formation of the steep-walled channel system occupied by the modern Fort Nelson and Fontas Rivers. The cobble/pebble gravel here contains 40-60% clasts in clay to coarse sand matrix and is poorly sorted and matrix to clast-supported. Pebble lithology data (n=256) indicate 27% limestone, 20% quartzite, 18% red granite, 14% ironstone, 12% chert, 7% sandstone (Dunvegan), and minor red gneiss, amphibolite, phyllite and metaconglomerate (Figure 6). The geomorphic expression as a plain, surficial nature of this deposit and granitic pebble lithology suggests that Klua Creek is an outwash plain (fan?), deposited marginally to the Laurentide Ice Sheet.

Another region of interest is a 25 m high gravel hill dissected by the modern Adsett Creek, near the community of Prophet River (Figure 7). This gravel deposit covers an area of two square metres and has been excavated for aggregate at several sites. At site MT04-011, the hill is five to six metres high and consists of cobble/pebble gravel in a matrix to clast-supported medium to fine sand. The gravel structure varies from massive to bedded and matrix content varies from 30% to 80%. Pebble lithology data (n=580) indicate 28% sandstone (Dunvegan), 19% limestone, 16% red granite, 5.5% quartz, 5% quartz sandstone, 4% white granite, 2% red sandstone, and minor amphibolite, chert, shale, quartzite and ironstone. A larger, active, gravel excavation occurs at site MT04-055. This pit is roughly 150 by 200 m, excavated into the gravel hill that varies from 10-25 m high. In some regions, a weak imbrication is apparent in the gravel, indicating a paleoflow direction

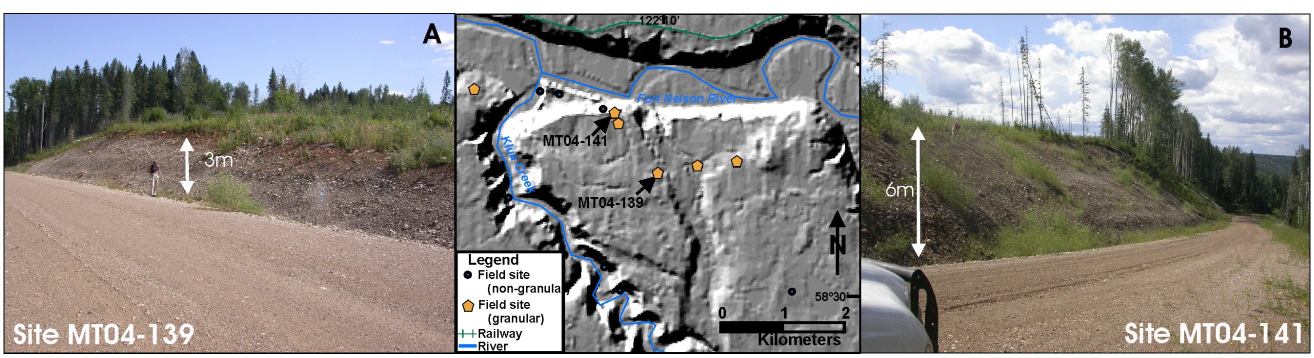

Figure 5. Location of the Klua Creek outwash plain situated in a region of coalescing meltwater channels. A. Gravel exposed in a road-cut at the edge of a meltwater channel at site MT04-139. B. Gravel exposed in section at the edge of the Fort Nelson River valley at site MT04-141.

Figure 6. Clasts exposed at surface along section MT04-141 (see Figure 4 for site location). A. Larger clast is a phyllite. B. Pink gneiss. C. Largest clast is a metaconglomerate. Also present are ironstone, limestone, quartzite and red granite.

to the west. Clast and matrix description are similar to site MT04-011. The lithology data is very diverse and the mixture of local and Shield-derived clasts suggests Laurentide deposition. This deposit is interpreted as a kame or rapid deposition at the end of a meltwater channel), supported by the variable structure, matrix percentage, and geomorphic expression as a hill.

Of geomorphic interest, a two metre high, six metre long ridge (Figure 8) was found at one site consisting of coarse sand to silt with 10-15% pebble to boulder content. The silt, sand and gravel are poorly sorted, and matrix-supported. Though this may be called a diamict, the high sand and gravel percentages differentiate this deposit from the regional diamict (interpreted as a till). The clasts within the ridge are subangular to subrounded and lithologies include shale, chert and granitiods (pink and white). This deposit was interpreted to be a crevasse fill ridge, of which several are found throughout the map area.

Lastly, several crag and tail features exist within the Big Beaver Creek map area (NTS 094J/07) (Figure 3D). These features are hills with a tapering end, approximately 100 m high and 1.5 - 5 km long and azimuths ranging from 195°-200°. The northernmost tail on Figure 3D is exposed in a road cut. The outcrop is 10 m high on the northeast side of the road, 6 m high on the southwest side of the road, and 200 m wide. The section exposes poorly sorted fine to coarse sand with beds that are dominantly clay and silt. Contacts within the beds are sharp, and most beds contain clay pellets or rip-up clasts. 1% clasts are weathered out on the slumped surface, and several subangular clasts were located within the section.

9.3 Glaciolacustrine

Well-sorted, massive clay to fine sand was encountered at 19 field sites along the plateau adjacent to the Prophet River valley in the south half of the map area and 6 field sites at plateau level near the confluence of the Fontas and Fort Nelson Rivers. These sediments are exposed in tributary stream cuts and borrow pits and exhibit thicknesses greater than 3 m. Near the confluence of the Fontas and Fort Nelson Rivers, active borrow pit excavation reveals greater than seven metres of grey clay (Figure 9). The clay contains rare pebbles including one granitic clast that indicates Laurentide provenance or reworking of Laurentide-derived deposits. As the deposits are well-sorted and contain only rare (<< 1% clasts) these sediments can be interpreted as glaciolacustrine in origin. This is substantiated by the flat topographic expression in areas where these sediments are found. These deposits occur at the surface and contain felsic granitic clasts, suggesting the sediments were deposited in the latest event and are related to Laurentide-derived deposits. The modern Prophet and Fort Nelson Rivers flow to the north. As such, it is likely that these deposits represent an episode of ponding due to the presence of northward retreating Laurentide ice that temporarily blocked river drainage.

Though generally flat, at a local scale some regions along the plateau level of the modern Prophet and Fort Nelson Rivers exhibit extensive regions of 'hummocks.' These features are identified on aerial photograph and LiDAR hillshade images (Figure 10). Ground checking at five sites indicates that they exhibit one to two metres of relief with diameters of 100-600 m. The relief is barely

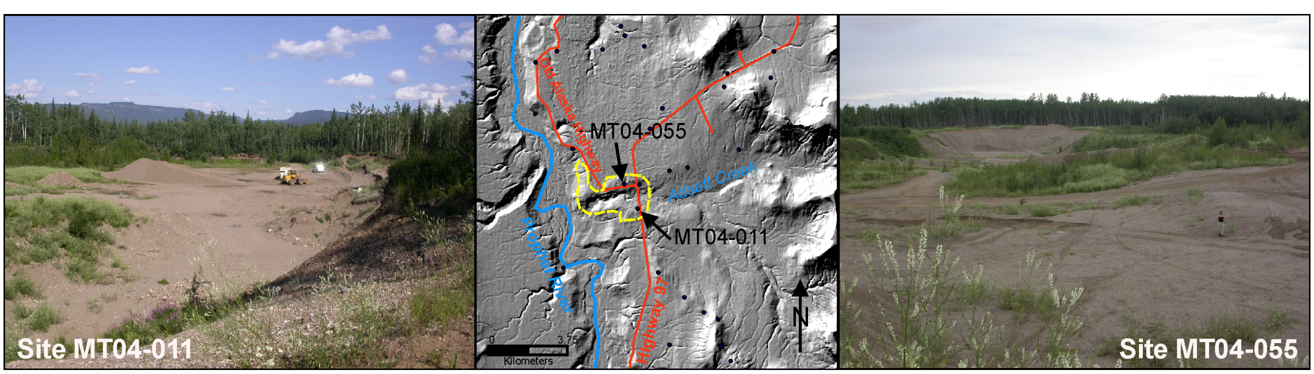

Figure 7. A 20 m high (dashed polygon) gravel hill dissected by the modern Adsett Creek near the community of Prophet River. This gravel deposit is interpreted to be part of a subglacial or englacial glaciofluvial system draining east from the uplands (see text).

Figure 8. An example of a crevasse fill ridge, of which several are found throughout the map area.

perceptible on the ground, but is somewhat highlighted by vegetative species change related to differences in drainage caused by the higher relief. Sites investigated have determined that the lithology, both within the hummocks and in surrounding areas, is clay. Further study is required to determine the origin and geomorphic significance of these features.

10.0 QUATERNARY STRATIGRAPHY

Reconnaissance stratigraphic investigations were conducted at 34 sites along the Fort Nelson and Prophet Rivers in addition to several sites at plateau level. Most river sections expose a thin diamict over bedrock, but some sections expose 5-50 m of Quaternary sediment. Four key sites, three on the Prophet River and one at plateau level adjacent to Elleh Creek, are described below.

Figure 9. Massive grey clay seen in active borrow pits along Elleh Road near the confluence of the Fontas and Fort Nelson Rivers. The clay contains rare pebbles, in particular, granites of Canadian Shield provenance are present. Trowel blade is 20 cm long.

10.1 Elleh Creek

The deposit of interest at Elleh Creek is a large hill, 2.25 km long, 1 km wide and 20-50 m high, situated at plateau level near the confluence of Elleh Creek and the Fort Nelson River (Figure 3C). Four field sites were located at this deposit, three of which will be discussed here.

A BC Rail gravel pit excavation into the south hillside, site MT04-181 (Figure 3C), exposes >18 m of sand and gravel overlain by one metre of diamict. The gravel matrix is silt to very coarse sand. The gravel is dominantly matrix-supported but locally clast-supported. Clast sizes range from granule to medium cobble, with an average two centimeter diametre. Clasts are mainly

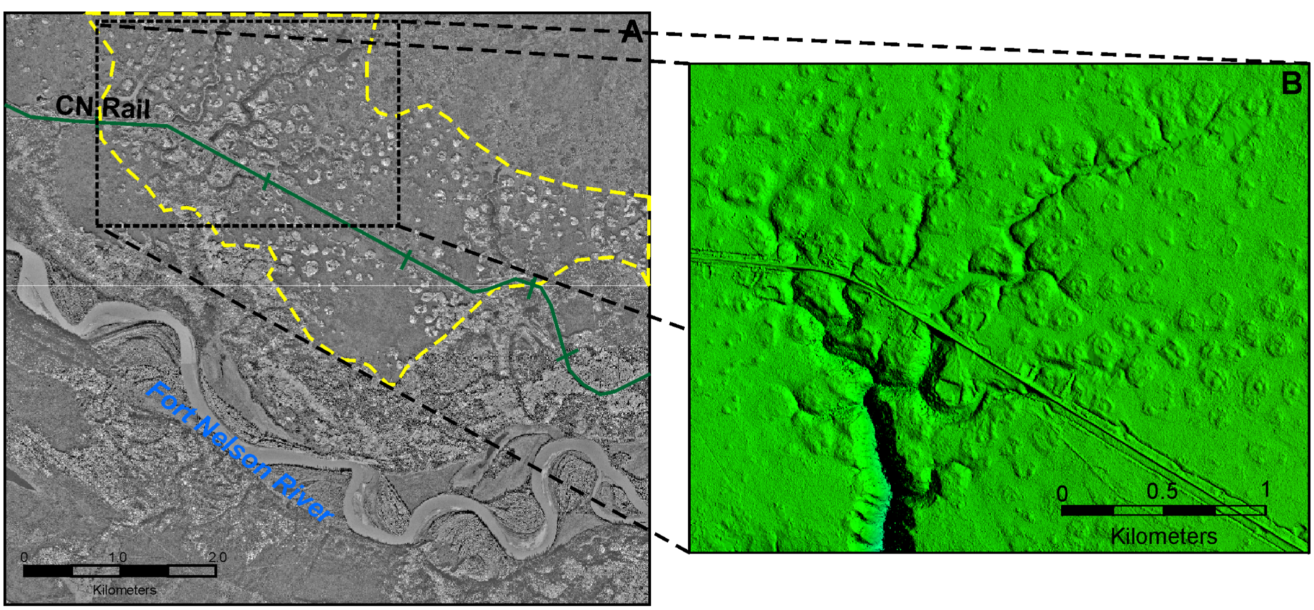

Figure 10. Orthophotograph (A) and Light Detection And Ranging (LiDAR, two-metre resolution) hillshade (B) image examples of 'hummocks' in glaciolacustrine clay at plateau level near the confluence of the Fort Nelson and Fontas Rivers. The 'hummocks' exhibit one to two metres of relief over 100-600 m.

subangular to rounded. A piece of wood from within this gravel was dated at 24 400 ±150 C^{14} years BP (BETA-183598) (Levson *et al.*, 2004; Figure 1). Pebble lithology data (n=805) indicate that the gravels consist of red granite (29%), quartzite (25%), angular ironstone (17%), limestone (6%), sandstone (6%), black chert (5%), and minor white granite, amphibolite, siltstone, quartz, and rounded ironstone. Pebble counts were completed to aid in correlation with other gravel deposits. The angular ironstone likely was locally derived and disaggregated during transport and is thus not indicative of any particular fluvial source. The gravels grade upwards into a thin sandy silt diamict containing abundant gravel lenses and centimeter-thick oxidized sand lenses. Further study is required to determine the origin of the diamict (colluvium, subglacial debris flow, till, etc).

A second exposure into the Elleh Creek hill occurs near the top of the hill at a wellsite (site MT04-187, Figure 3C). The section consists of an upper 0.9 m thick unit of sandy silt diamict with 15-30% clasts. This unit is cemented with carbonate and many clasts are highly weathered. This diamict is interpreted to be a till, based on lithology, structure and stratigraphic position. Underlying the till is a 3.1 m thick sand and pebble/cobble gravel unit. Well log data at this site (gamma) suggests that there is approximately 50 m of gravel here. This unit is variably bedded to massive, with bed thickness ranging from 1 to 15 cm. Sorting is generally poor, and support varies from matrix to clast supported. Clasts are pebble to small cobble sized and most are subrounded to rounded. Pebble lithology data (n=345) indicate that the gravels consist of red granite (30%), quartzite (26%), chert (10%), white granite (10%), limestone (9%), sandstone (9%), red gneiss (2%), siltstone (2%), quartz (1%), and minor amphibolite and oil-bearing dolomite.

Lastly, an active gravel excavation at the LEDCOR pit was observed at the northwest side of the Elleh Creek hill; site MT04-159 (Figure 3C). Exposures here show a 50-80 cm thick upper unit of sandy silt diamict overlying a 5-15 m unit of sand and gravel. The gravels vary from pebble to boulder gravel and are matrix to clast supported. Sorting is generally poor, but some sections are well sorted. Vertical sections show several shears (metres long) and minor deformed bedding.

The 24.4 ka BP wood date suggests that the gravels at site MT04-181 are likely glacial advance-phase gravels. The high proportion of Shield-derived felsic clasts and stratigraphic position below a diamict, inferred to be a till, substantiates this interpretation. Both sites MT04-159 and MT05-187 are lithologically (Figure 11) and texturally similar to site MT04-181 (except higher ironstone content) and may be part of the same glaciofluvial system. Alternatively, they may represent various stages of deposition within or aligned with a pre-existing channel system. The stratigraphic position of the gravel under till, in conjunction with observations of sheared and deformed (overturned) beds, indicates that the Elleh Creek deposit formed pro-glacially and was then overridden and/or formed subglacially. It is unknown what directly underlies the gravel deposits.

10.2 Prophet River Sections

Three key sections observed along the Prophet River expose very dense clay, silt, sand, gravel, stratified diamict and massive diamict. Based on preliminary lithology, texture, sedimentary structures and stratigraphic position, these sections have been separated into six units as described below. For the location and a stratigraphic section of each site discussed, the reader is referred to Figures 3D and 12, respectively.

10.21 UNIT 6

The lowest exposed unit in the Prophet River sections is unit 6, a two-metre thick cobble gravel. This unit occurs only at site MT04-115 (Figure 12), where it is laterally continuous for approximately 30 m. At this site, the cobble gravel is unconformably overlain by massive silt and the lower contact is obscured by modern river level (Figure 13). The gravel is clast-supported with a variable matrix ranging from coarse sand to poorly sorted fine-medium sand. Matrix content increases up-section. Pebble lithologies (n=610) include black chert (43%), sandstone (34%), quartz (11%), tan chert (8%) and minor ironstone and quartzite. Clast size varies from granule to cobble, averaging about 10 cm. The cobbles are dominantly rounded, tabular and imbricated sandstone clasts. In places within these gravels, deformed lenses of grey silt with small pebbles occur (Figure 14). The lenses are 10-40 cm thick and are laterally continuous for one to three metres. Compact and dense, the silt beds exhibit open folding with 10-15 cm amplitude.

As this gravel is situated within a modern river valley, overlain by 53 m of sediment and contains only clasts of local provenance, it is likely pre-glacial and may represent deposition in a paleovalley river system.

10.22 UNIT 5

Unit 5, also exposed at river level, is a nine-metre thick massive to horizontally laminated black clay. This unit only outcrops in section MT04-112 (Figure 12), where it is laterally continuous for approximately 500 m. At this site, the clay is unconformably overlain by cobble gravel and the lower contact is below modern river level. Very locally, the black clay grades laterally and vertically into a massive clast-poor diamict. Clasts in the diamict (n=289, 4-10 mm size fraction) are rounded to subrounded Dunvegan sandstone, shale, black chert, quartzite, and minor tan chert (one small cobble) and volcanics. Organics are abundant in the clays. A sample of wood occurring six metres above the section base was dated at >44 730 C^{14} years BP (BETA-195754) (Figures 1 and 15). Additionally, a 20 cm thick peat layer, laterally exposed for approximately 20 m, occurs 1-3 m above the section base (Figure 16). The peat layer was dated at >45 100 C^{14} years BP (BETA-195755) (Figure 1).

This clay with interbedded organics is interpreted as lacustrine sediment deposited in an interglacial pond. The discontinuous diamict beds within this unit may represent debris flows.

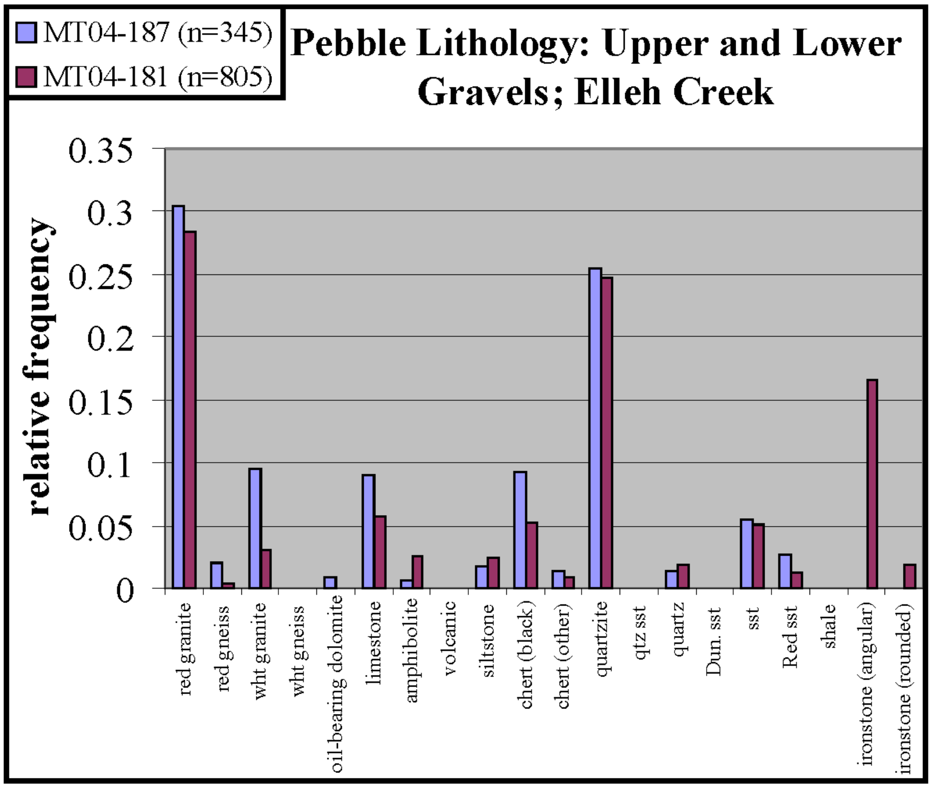

Figure 11. Relative frequency bar graph providing a comparison of pebble lithology for lower MT04-181 (sample 421 m a.s.l.) and upper MT04-187 (sample 461 m a.s.l.) gravels at the Elleh creek deposit in NTS 094J/09, near the confluence of Elleh Creek and the Fort Nelson River (see Figure 3 for locations). Numbers associated with pebble counts in this report are a summation of size fractions >10 mm and 4-10 mm with no clast larger than 80 mm.

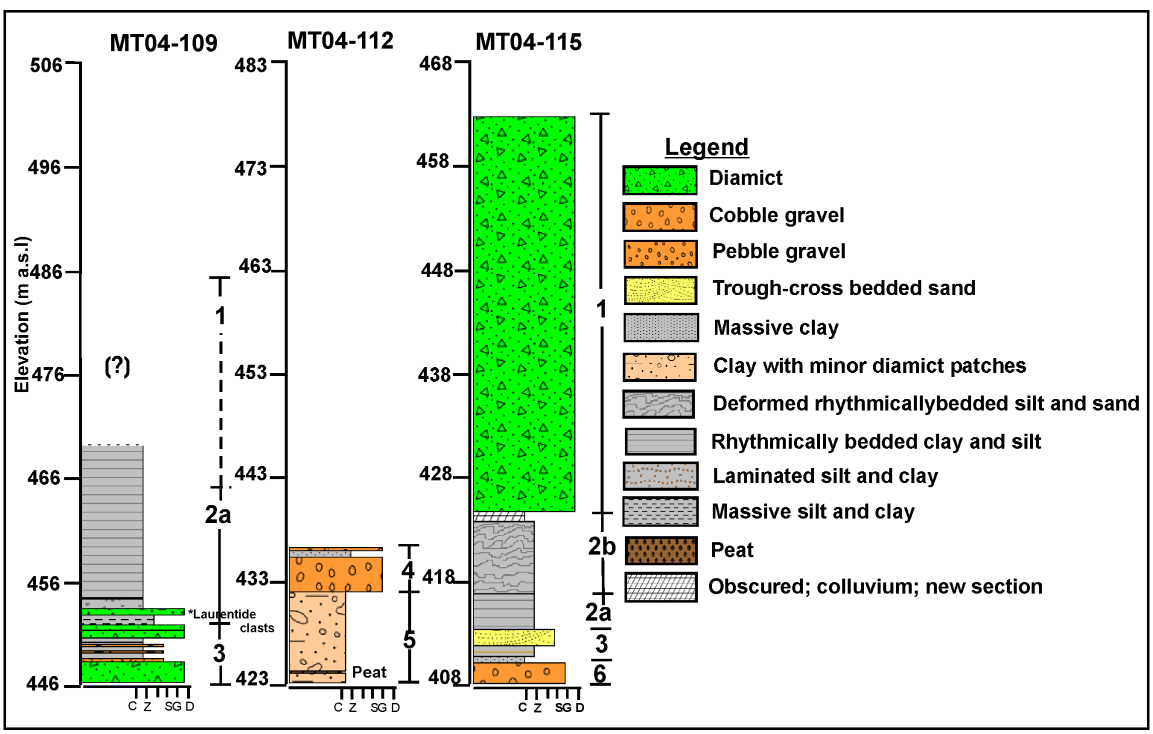

Figure 12. Lithologs of described sections MT04-109, MT04-112 and MT04-115 on the Prophet River (see Figure 3 for locations). 10.3 km separates the first two sections and 7.35 km separates the last two, with MT04-109 the most southerly section. Numbers one though six refer to general units correlative between sections (see text.).

Figure 13. Oxidized pre-glacial gravel at modern river level on the Prophet River (site MT04-115). The gravel is overlain by massive grey silt interpreted to be lacustrine deposits.

10.23 UNIT 4

Unit 4 is a cobble gravel that can be found at several sections along the Prophet River valley. It varies from 0.5 to 3.5 m thick and is flat-lying and laterally continuous at most sites. Described in detail at site MT04-112, the unit occurs at the surface and unconformably overlies unit 5. It also overlies bedrock in some sections along the river. The gravel is matrix to clast-supported with a medium sand matrix. Clasts are rounded to subrounded and field lithology data indicates the presence of quartzite, chert, ironstone, pink granite, white granite and limestone. Sorting is well to moderate and there are a few pebble gravel beds that contain tabular shale clasts in addition to other lithologies. There is a cobble lag at the lower contact. Within the unit, there occurs a 20-30 cm thick organic-rich clayey silt bed that is laterally continuous across the section.

As this gravel is flat-lying, unconformably overlies a number of different units at the top of sections along the river and contains Shield-derived clasts, it is likely a post-glacial fluvial terrace gravel. The organic-rich clayey silt bed is interpreted as a paleosol.

10.24 UNIT 3

Unit 3 varies from 2-8 m thick and contains beds of dense silt, clay, sand, gravel and clast-poor stratified diamict. It outcrops at two key sections, MT04-109 and MT04-115 (Figure 12), along the Prophet River and is laterally continuous for 50 to 100 m at these sections. The unit is overlain (conformably?) by rhythmically bedded clay and silt and unconformably overlies unit 6 at section MT04-115. The unit base is not exposed at section MT04-109. At the latter section, the unit consists of 8 m of dense silt, clay, sand and horizontally stratified diamict. The thickness of the beds varies laterally and vertically. Gravel occurs as horizontal beds to u-shaped lenses with erosional lower contacts. There are < 1% clasts within the lower diamict and lithologies in both the diamict and gravels are shale, sandstone, quartz and chert. At section MT04-115, unit 3 is a three-metre thick sequence consisting of coarsening up clay, silt and sand. The silts and clays are laminated to rhythmically bedded and the sand contains horizontal laminations and small-scale climbing ripples (amplitude ~ 0.5 cm). Within the unit, the clay-silt contact is likely conformable, while the sand has a lower erosional contact with the silt and a sharp upper contact with the rhythmically bedded silt and clay.

These sediments are probably interglacial or pre-glacial due to the over-consolidated nature, lack of erratic clasts and stratigraphic position underlying Laurentide till (see section 10.26, Figure 12). They may relate to damming of drainage during the advance of the glaciation, represent pre-glacial valley fill or a transition from valley fill to advance glacial deposits.

10.25 UNIT 2

Unit 2 is a rhythmically bedded clay and silt sequence that varies from nine to at least 15 m thick. The unit outcrops at MT04-109 and MT04-115, and is laterally continuous for approximately 50 to 100 m at these sections. The clay and silt is unconformably overlain by diamict and underlain (conformably?) by unit 3. The clays and silts are nine metres thick at MT04-115 with a basal silt/clay elevation of 413 m a.s.l. At MT04-109, further upstream, correlative deposits are >15 m thick with a basal silt/clay elevation of 454 m a.s.l. The unit is of unknown thickness at this site because a large slump rupture surface occurs within the unit and the amount of displaced or overlying material is unknown.

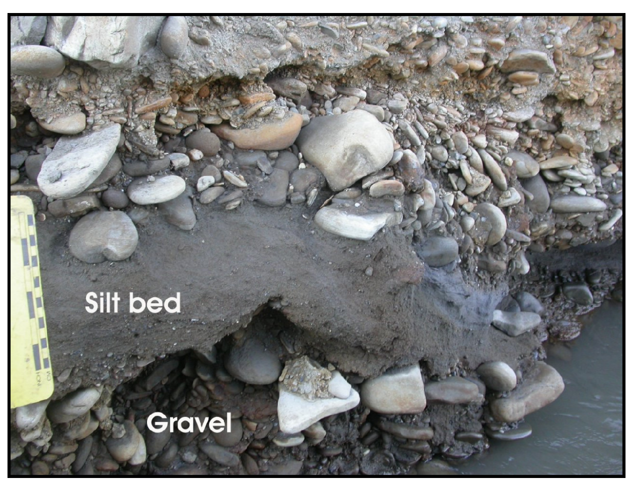

Figure 14: Deformed silt and fine sand bed within the lower gravel at site MT04-115.

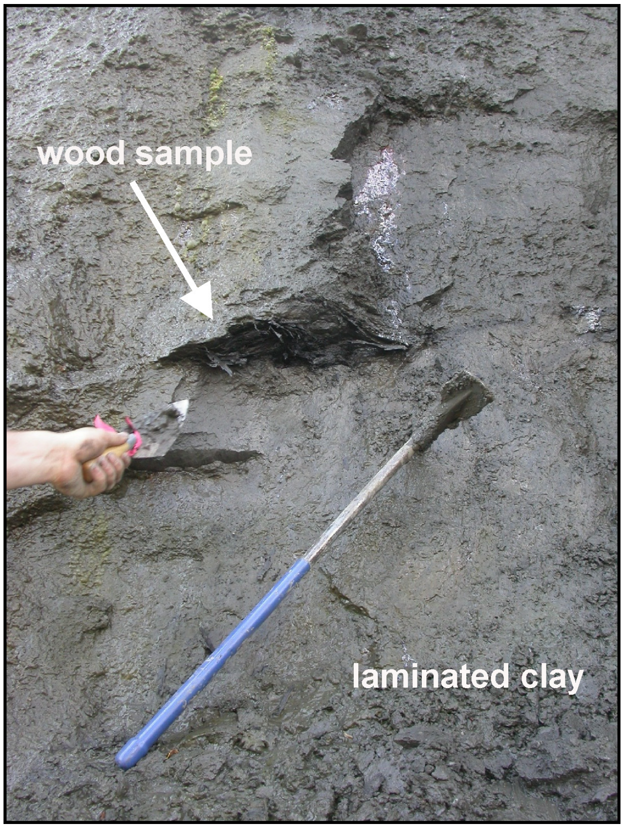

Figure 15. Wood sampled within grey-black, finely laminated clay, six metres above the base of section MT04-112. This wood yielded a date of > 44 730 radiocarbon years BP (BETA-195754).

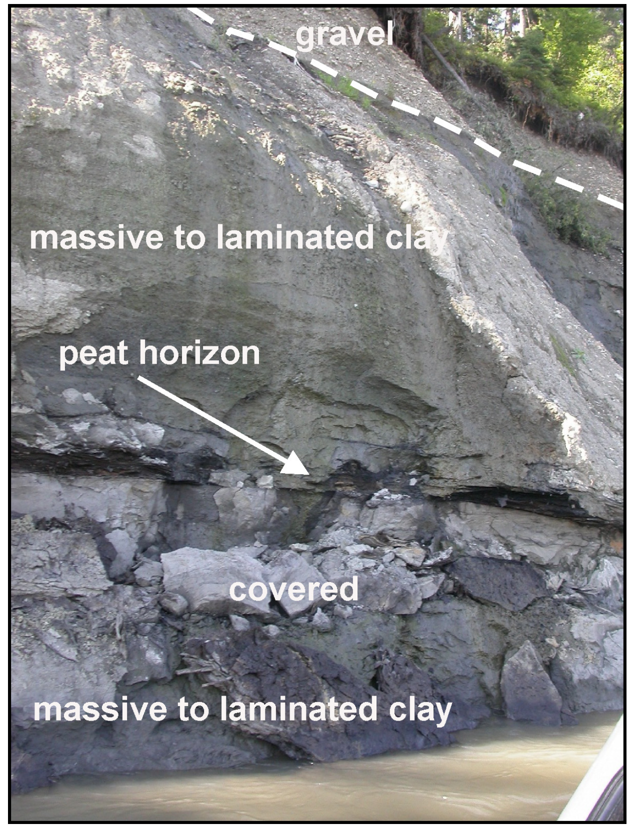

Figure 16. Peat horizon sampled one metre above the base of section MT04-112, within a massive to laminated grey-black clay. This peat yielded a date of > 45 100 radiocarbon years BP (BETA-195755).

At both sites, the overconsolidated silt and clay exhibits horizontal rhythmic stratification (1-15 mm thick) with small-scale ripples (unit 2a, Figure 12 and Figure 17). Beds are well sorted and clasts could not be found. The upper seven metres of the unit at site MT04-115 exhibit soft sediment deformation (unit 2b, Figure 12 and Figure 18).

As the silts and clays of unit 2 are overconsolidated and occur stratigraphically below a diamict, these sediments may be part of an advance-phase glaciolacustrine depositional system. The fine-grained well-sorted silts and clays, rhythmic bedding and thickness of deposits indicate glaciolacustrine deposition over a considerable time period. As such, these sediments were likely deposited when ice moved southwards into the Prophet River valley and blocked northward-flowing pre-glacial drainage. This advance-phase interpretation is supported by the sheared and faulted upper silt and clay sediments (unit 2b) within section MT04-115, which may have been deformed by overriding ice. The first appearance of felsic red granites (Shield-derived) in a stratified silty clay diamict just underlying the rhythmically bedded silts and clays at site MT04-109 may be a glaciogenic debris flow and further substantiates this interpretation.

10.26 UNIT 1

Unit 1 is a massive diamict that varies from < 1 to > 40 m thick and is laterally continuous at most sections. The unit outcrops at sections along the Prophet, Fort Nelson and Fontas rivers and Klua and Elleh creeks. Described in detail at section MT04-115 along the Prophet River, the diamict is brown with a silty clay matrix, and is matrix-supported with only 2-3% granule to cobble sized clasts. Clast lithology includes felsic granitic rocks derived from the Canadian Shield. At site MT04-109, a diamict overlying unit 2a is inferred from the presence of abundant felsic granitic and gneissic boulders in a stream cut found above the described section.

As the clasts in both sections include granitiods and gneiss of Shield provenance, the presence of these requires a Shield-derived source. Therefore the till is likely of Laurentide provenance. As this unit occurs at surface (at plateau level), it is likely a record of the last Late Wisconsinan glacial event and can be correlated to the diamict found at many other plateau level sites (see section 9.1).

11.0 GLACIAL HISTORY

From preliminary studies of surficial field sites and stratigraphic sections, the following glacial history is

Figure 17. A bedding plane from the rhythmically bedded silt and clay (unit 2a, Figure 12) at site MT04-109 exhibiting small-scale ripples with amplitudes of one to fivemillimetres. Two-dollar coin for scale.

outlined for the Fort Nelson (NTS 094J/SE) and Fontas River (NTS 094I/SW) map areas.

Quaternary sections on the Prophet River indicate that the modern valley is a re-incision of a paleovalley, at least for a stretch located within the field area between sites 109 and 115 (Figure 3D). This paleovalley contains pebble to cobble gravel consisting of locally derived sandstone, shale, quartz and chert. The presence of minor fluctuating channel positions and water levels within the valley are suggested by deposits of massive clay, massive silt, bedded sand, gravel beds or pods and stratified diamict. The stratified diamicts likely represent subaqueous debris flow deposits. Perhaps also within this paleovalley, similar to modern-day conditions, ponds developed in the valley bottom due to slumping of the valley walls. This ponding could result in the local deposition of massive to laminated clays. Organics occurring in these clays along the Prophet River have yielded radiocarbon ages of > 40 000 years BP.

As ice entered the paleovalley, sourced from the Laurentide Ice sheet (from the east), or the Rocky Mountains (from the west), the northward-flowing river was blocked and deposition of a thick, rhythmically bedded, silt and clay glaciolacustrine sequence occurred. Minor shears and faults in the upper 7 m of a 9 m outcrop of bedded silts and clays suggest that this unit was overridden by ice as the glaciers continued to expand. At plateau level to the east of the Prophet River, in the Elleh Creek area, sands and gravels were deposited either subglacially or ice-marginally. A radiocarbon date of wood found in these sands and gravels (24.4 C^{14} ka BP) indicates that at least the lower portions were deposited during the advance phase of Late Wisconsinan glaciation. The presence of shears and overlying diamict at the Elleh Creek site suggest ice overrode this deposit as well.

The ubiquitous distribution of till throughout the study area, at surface, suggests there was at least one glacial advance into the region during the Late Wisconsinan. The abundance of Shield-derived clasts suggests that this till was deposited by Laurentide ice. Possible reasons for a lack of distinct Cordilleran Ice Sheet tills in the region include distance from the Rocky Mountains, the lack of a pass that would allow Cordilleran ice to flow east into the region (such as the Pine pass, Peace River or Athabasca pass to the south) and relative timing of Cordilleran and Laurentide glacier advances.

As ice retreated from the region, flutes and crag and tail features were exposed. Moraines were deposited along ice margins and meltwater created minor glaciofluvial ridges (eskers). Major and minor meltwater channels were formed including the 150 km long steep-walled channel that contains the modern Fontas and Fort Nelson Rivers. This large meltwater channel may have been reoccupied by meltwater several times as Glacial Lake Hay (east of the study area) drained (Mathews, 1980). Within, or near the end of some channels, large hills or plains of glaciofluvial gravel were deposited (*e.g.* Adsett Creek or Klua Creek deposits).

Regional drainage is northward and an accumulation of meltwater resulted from short-term ponding due to the presence of northeastward retreating Laurentide ice. In the stratigraphic record, this is evidenced by

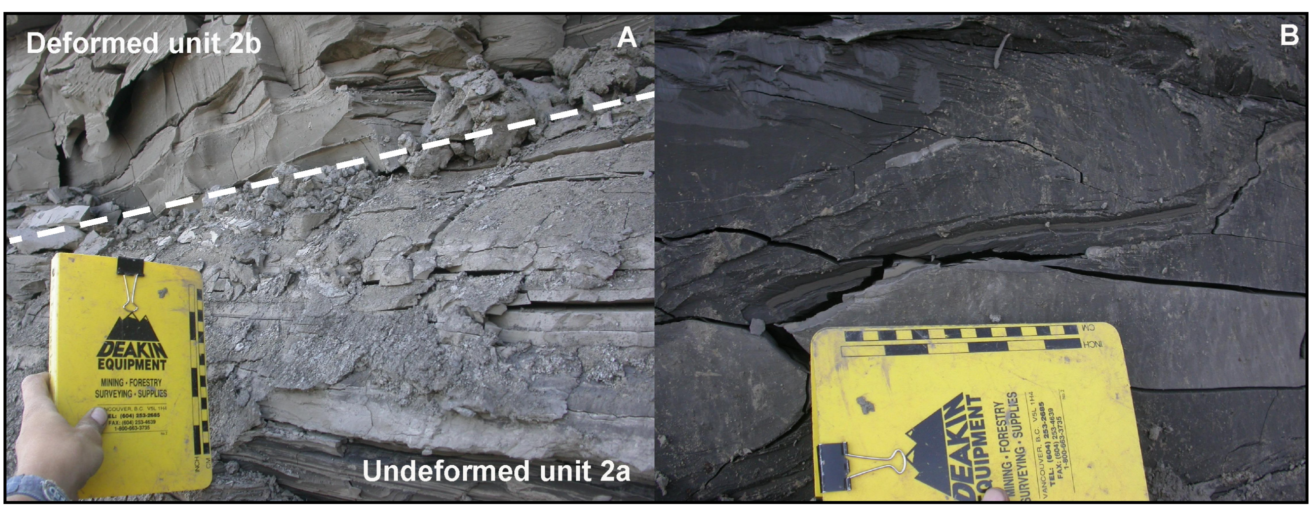

Figure 18. Rhythmically bedded silt and clay at site MT05-115. A: Sheared and faulted unit 2b over undeformed unit 2a. B: Example of folded deformed beds in unit 2b, approximately 11 m above the section base.

geographically restricted massive clay to fine sand deposits situated at plateau level along modern river valleys.

As a result of base level adjustment, incision of valleys and terrace development occurred. Both processes have continued though the Holocene, resulting in deep river valleys with terraces.

12.0 AGGREGATE POTENTIAL

The map region is dominated by the presence of clast-poor diamictons and massive clays and silts unsuited for aggregate use. A very extensive mantle of organics throughout the study area adds difficulty in identifying aggregate resources. Possible aggregate sources include pre-glacial, glaciofluvial and fluvial gravels as well as Cretaceous pebble conglomerate (Figure 2 for location). Ten gravel pits occur in the study area (Figure 3), including two significantly large ones at Elleh Creek (Figure 3C; section 10.1) and Adsett Creek (Figure 7; section 9.2).

The Elleh Creek deposit is a pebble to cobble gravel covering approximately 2.25 km^2 and ranges in height from 25-50 m. It has recently become a critical aggregate resource for the Sierra-Yoyo-Desan (SYD) road east of Fort Nelson. Through test pitting, the hill has been separated into regions of predominately gravel, predominately sand and gravel and predominately sand (Dewar, 2003). Tests completed in the predominately gravel section indicate 6% fines (< 75 µm), 40% sand (<4.75 mm to < 75 µm), 34% fine gravel (<25 to 4.75 mm), 18% coarse gravel (75 to 25 mm), and 2% oversize (>75 mm). This detailed investigation identified a preliminary granular resource of >1 700 000 m^3. The reader is directed to Dewar (2003) for the details of this investigation including test pit logs, laboratory results, and a map of test pit locations. During the winter of 2003, LEDCOR CMI Limited extracted and processed 165 000 m^3 of sand and gravel from the northeast corner of the reserve (site MT04-159, Figure 3C) for use in construction of the Clarke Lake Bypass Road and upgrading of SYD. Blue Canyon Concrete Limited has also opened a smaller pit in the reserve, approximately one kilometre west of the LEDCOR CMI Limited pit.

The Adsett Creek deposit is smaller, with an approximate extent of two square kilometres and height range from 5-25 m. The deposit is dissected by the modern Adsett Creek, and several small active gravel pits are located on the south side of the creek. A larger active pit is located on the north side of the creek (MT04-055, Figure 7). Clast sizes within the deposit range from pebble to cobble. The gravels are matrix to clast-supported, in a medium to fine sand matrix. The gravel structure varies from massive to bedded and matrix content varies from 30% to 80%. Clast lithology is variable, but the dominant lithologies are hard and resistant to weathering (with the exception of Dunvegan sandstone).

By studying the provenance and depositional history of these known aggregate reserves, it is possible to predict where new resources may be found. A new aggregate prospect in the map area is the glaciofluvial outwash deposit at Klua Creek (Figures 5 and 6; section 9.2). This gravel extends approximately 1 km by 0.5 km and known thickness at one site is greater than six metres. Several road construction borrow pits and eight hand-dug pits are located on the deposit. These exposures indicate that the deposit is variable, from pebble gravel to boulder gravel in a fine sand to silt matrix. The deposit varies from matrix to clast-supported and is generally poorly sorted. Clast lithology is variable, but the dominant lithologies are hard and resistant to weathering. There is however a significant (~14% at site MT04-141) ironstone component, which is friable and easily breaks down.

When working near the uplands of the Alberta Plateau (Figure 2), Dunvegan pebble conglomerate may provide a source of aggregate and requires further attention. It consists of well-rounded, pebble-sized clasts of resistant lithologies (chert and quartz) in a sandy matrix. Other showings, as yet uninvestigated, for aggregate potential include terraces on the Prophet River, terraces on the Fontas River, small-scale glaciofluvial deposits (eskers, kames and outwash) and pre-glacial gravel deposits along the Prophet River (see section 10.21).

13.0 CONCLUSIONS

In this paper we present an initial interpretation of the Quaternary history, stratigraphy and geomorphology of the Fort Nelson (SE) and Fontas River (SW) map areas (NTS 094J/SE and 094I/SW respectively), in northeast British Columbia. From preliminary work several conclusions can be made.

- Surficial material in the region is predominately silty clay, clast-poor diamict overlain in some areas by massive to rhythmically bedded silt and clay. Bedrock topography defines most of the relief in the region, and Quaternary landforms typically exhibit positive relief of less than ten metres relative to the surrounding area.
- Field investigations of stratigraphy and surficial material suggest at least one episode of glaciation for the map area, during the Late Wisconsinan.
- Gravel and diamict pebble lithologies include red felsic granites and gneiss, limestone, oil-impregnated dolostone, and minor mafic and volcanic clasts in addition to local (Cretaceous) sandstone, shale, chert and quartz. The red igneous and metamorphic rocks are inferred to be Shield-derived, and their abundance within the gravels and diamicts suggests these deposits are of Laurentide provenance.
- The abundance of Shield-derived clasts possibly indicates that the Cordilleran Ice Sheet did not extend into the region, though dilution of Cordilleran-derived clasts by reworking cannot be ruled out. Additionally, inconclusive evidence exists that Rocky Mountain glaciers extended into the map area.

- The Prophet River valley is a re-incised paleovalley, providing valuable pre-glacial to Holocene stratigraphy including a new pre-Late Wisconsinan interglacial site. Site MT04-112 provided radiocarbon dates of > 44 000 and > 41 000 years BP from peat and wood within a massive to laminated clay unit with gradational pods of diamict. The depositional environment is an interglacial pond, possibly formed by slumping of the paleovalley walls, with minor debris flows.
- The map area contains an important aggregate resource for the Sierra-Yoyo-Desan (SYD) road, east of Fort Nelson. This deposit, Elleh Creek, is 2.25 km^2 and is thought to be the result of subglacial or ice marginal depositional glaciofluvial systems. Several new aggregate showings (economic potential unknown) include outwash surrounding Klua Creek, Prophet River terraces, Fontas River terraces, glaciofluvial deposition, pre-glacial gravel and outcrops of pebbly Dunvegan conglomerate.

Further field study in 2005 will ground check potential aggregate resources and surficial map units within remote areas. Detailed work will focus on stratigraphic studies in paleovalley sequences exposed along the Prophet River and delineation of ice sheet limits within or near the field area.

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