Lithologic unit	Description and distribution	Soils and their vegetation	Topography	Drainage	Workability	Engineering uses and service record
Alluvium	Postglacial fluviatile deposits of plastic clay, sand, gravel, and other detrital material. Forms the surface of the flood plains of most of the major valleys as well as the floors of many of the larger undrained depressions. In general, 10 to 100 feet thick in the valley bottoms, much less elsewhere. Particle sizes range from clay to pebbles as much as 1½ inches in diameter.	Thin clayey soil with sparse grass. In many places a thin saline veneer, possibly sodium sulfate, is at the surface.	Very low relief on the flat to gently sloping valley floor of Big Muddy Creek and other valleys.	Surface drainage poor, with marshes and stagnant lakes common. Gravels below alluvium, however, afford good subsurface drainage.	Poor foundation material. Hand tools relatively ineffective in clay and silty material. Power tools recommended. Unconsolidated sand and gravel below alluvium easily worked.	No use reported.
Colluvium	Forms gentle slopes below steep escarpments. Normally composed of materials forming the escarpment. In most localities, a heterogeneous mixture of reworked till, fragments of Fort Union formation, and varying amounts of loose sand and gravel. Thickness ranges from 2 to 5 ft.	Thin silty soil with sparse grass. Slopes generally unsuitable for farming.	Very low relief, with grade steepening toward escarpments.	Surface drainage poor.	Difficult digging with hand tools but easily worked with power equipment. Scattered large boulders may require special handling.	No use reported.
Dune sand	Large irregular areas of unconsolidated sand of eolian origin. Most dune areas are southeast of the sand- and gravel-filled outwash channels. Sand grains consist predominantly of quartz, feldspar, pyriboles, and mica. Probably ranges in thickness from 1 ft to over 20 ft.	Unconsolidated sand supports a thin grass cover.	Irregular hummocky relief.	Loosely compacted and pervious. Has good subsurface drainage, with no surface drainage lines.	Easily worked with both hand and power equipment. Loose compaction of the material prohibits vehicular movement.	No constructional use reported. Roads traversing this area would be difficult to construct and maintain owing to the constant shifting of the sand. Extensive cut and fill, at least to the till subgrade, would be required. Present roads along the margins of this area are blocked during sand storms.
Terrace deposits	Small sand and gravel deposits flanking valleys of minor tributary streams. Most deposits are local and have little lateral extent. Texture of material ranges from fine sand to coarse gravel with pebbles 1½ inches in diameter. Gravel composed mainly of quartzite, with small amounts of igneous and other metamorphic rocks. Some limestone and dolomite fragments. Sand normally is in stringers or lenses and grades vertically into coarser material.	In most localities a thin layer of silt overlies the unweathered gravel. Generally a good grass cover is present.	Terrace surfaces are flat to gently sloping, with marginal slopes scalloped by ravines. Sides have average slope of about 30°.	Sand and gravel deposits are well drained.	Easily worked by either hand or power machinery.	Source of sand and gravel. May require washing. Locally used for road metal. In places used as concrete aggregate for small farm structures.
Outwash deposits	Extensive deposits of glaciofluvial sand and gravel that fill most of the broad valleys traversing this area. The thickness is variable and in larger valleys is as much as 185 ft. The size of included material ranges from silt to boulders 1½ ft in diameter. Average size of gravel is ¼ inch. Predominant materials are limestone and dolomite fragments; also included are pebbles of igneous and metamorphic rocks, varying amounts of quartz, quartzite, and chert and other cryptocrystalline fragments.	A layer of sand and silt about 2 ft thick overlies the gravel.	Very low relief on the flat to gently sloping valley floors of the outwash channels.	Drainage good; water table reported at varying depths below the surface in all valleys filled with outwash.	Easily worked by either hand or power machinery. In certain localities farmers report quicksand at depth.	Has been used with excellent results as concrete aggregate for bridges, culverts, and other small structures. Normally used for all road-surfacing purposes. Crushed gravel is mixed with bituminous material for all-weather road surfaces. Also used for railroad ballast. Gravelly layers form excellent subgrades. Silt and clay very poor subgrades.
Ice-contact deposits	Includes eskers, kames, kame terraces, crevasse fillings, most of which are in the east half of the area. Constituents include limestone, dolomite, igneous- and metamorphic-rock fragments, and varying amounts of quartz, quartzite, and chert. Texture ranges from fine sand forming the matrix to pebbles about 2 inches in diameter. Deposits normally poorly sorted with rapid textural changes vertically and laterally.	Thin silty soil supports sparse grass on most of the features. Several eskers have wedges of till on their flanks. Large surface concentrations of boulders common.	Eskers are sinuous ridges; kames are conical mounds; crevasse fillings are linear ridges, generally straighter than eskers.	All features well drained.	Both hand and power equipment can be used.	An excellent source of road metal. May be mixed with bituminous matter for all-weather road surfaces. If gravel is to be used as concrete aggregate, washing will be necessary. Most farmers use the gravel for construction purposes.
Till	Most of the area is covered by till which ranges in thickness from about 1 ft to a maximum of about 100 ft; average is about 20 ft Till is blue gray, clayey, and calcareous on fresh surfaces, although it oxidizes to light brown. Material is tough, well indurated. Embedded within the till and littering its surface are limestone, dolomite, igneous and metamorphic rocks, and varying amounts of quartz, quartzite, and chert. No sorting is evident. Rock sizes range from clay to boulders more than 10 ft in diameter.	A silty soil about 12 inches thick, with much clay, overlies most of the area. Included rock fragments are generally unweathered.	Surface flat to gently rolling in the west half of the area, with integrated drainage. Numerous undrained depressions, irregular hummocks, and unintegrated drainage in the east half of the area.	Surface drainage moderate to fair in the west half of the area, although poor to negligible in the east half, which is marked by small lakes, swamps, and other undrained depressions.	Worked with difficulty by both hand and power machinery due to extreme compaction. Cannot be worked during periods of wet weather when till becomes slippery and semiplastic as a result of high clay content. Presence of large boulders scattered irregularly throughout the mass may make special handling necessary.	Used primarily for fill. Unsurfaced roads would be impassible during periods of wet weather. Glacial boulders possible source of riprap. In east half of area much cut and fill would be needed; only minor amounts of similar work would be required in west half of area.
Gravels of early Quaternary(?) age	Superficially resembles the much older Flaxville gravel in general appearance. Differs lithologically in presence of minor amounts of limestone, dolomite, and igneous and metamorphic rocks all derived from the Canadian Shield. Predominant constituents, however, are quartz, quartzite, and chert. In general restricted to minor outcrops along lower levels of valley walls in the west half of area. Gravel is unconsolidated, bedding ranges from moderate to poor with considerable crossbedding present. Size range is from fine sand comprising the matrix to gravel containing pebbles about 2½ inches in diameter.	Thin silty soil supports sparse grass, overlies gravel.	Normally forms steep slopes.	Surface well drained.	Easily worked with hand and power machinery except for local lime-cemented zones.	Excellent source of road metal. Large amounts of cryptocrystalline quartz probably prohibits its use for major construction purposes, unless low-alkali cement used.
Flaxville gravel	Restricted to the westernmost edge of the area where it crops out between till and Fort Union formation. In places forms gravel-capped uplands. Consists of brown well-rounded fluvial sand and gravel of quartzite (66 percent), quartz (20 percent), and chert (14 percent). In general averages 10 ft in thickness, although has been reported to reach a maximum of 100 ft outside the area of this report. Size range is from fine sand forming the matrix to coarse gravel with pebbles about 3 inches in diameter.	Thin silty soil supports very sparse grass. Marked difference in grass cover between gravel and till areas where gravel emerges from beneath till.	In till-free areas it is flat to gently rolling. Where till has been removed forms elongate, even, gravel-capped surfaces.	Very well drained.	Easily worked with hand and power machinery.	Excellent source of road metal although screening and crushing would be needed to obtain uniform size. Tests by Bureau of Reclamation indicate that high percentage of included cryptocrystalline quartz fragments prohibits its use with high-alkali cement.
Fort Union formation	Forms bedrock for entire area. Light-tan to buff layers of sand, silt, and clay which alternate at irregular intervals with dark shales, carbonaceous seams, and lignite beds. Scattered irregularly throughout the formation are ferruginous limy concretions more resistant to weathering than the groundmass. These concretions weather out as rounded loglike or spheroidal masses. Where limonite beds have burned, the overlying clay beds have been baked and fused to a red clinker known locally as "scoria."	Poor soil.	Forms steep slopes along most valley walls. Where dissection has been active, extreme badlands topography results. Clinker tends to form more resistant ledges and ridges.	Drainage moderate to poor in silt and sand; impervious in clay. Lignite beds form aquifers carrying potable water.	Worked with difficulty by hand although easily excavated with power machinery, except for more resistant limy concretions.	Roads through this formation would require considerable cut and fill. Where large exposures of clinker are available, material may be used for road metal. No other uses reported.

460517 O - 59 (In pocket)