AIRPHOTO GRAVEL SEARCH ALONG THE LIARD HIGHWAY 7 BETWEEN THE MUSKEG AND BLACKSTONE RIVERS, NORTHWEST TERRITORIES

J D MOLLARD AND ASSOCIATES LIMITED

CONSULTING CIVIL ENGINEERS AND ENGINEERING GEOLOGISTS

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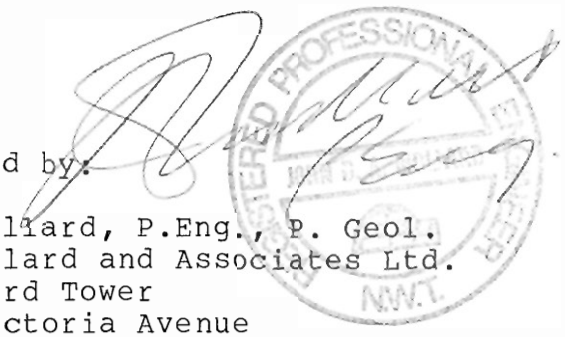

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1. TERMS OF REFERENCE

Terms of reference call for the location, outlining and description of granular material prospects on airphotos showing a band of terrain along Liard Highway 7 between the Muskeg and Blackstone rivers. As part of this undertaking, high altitude airphotos were purchased from NAPL in Ottawa. The Northwest Territories Department of Highways supplied a set of 1:20,000 scale airphotos, centred on Liard Highway 7 between the Muskeg and Blackstone Rivers.

2. MATERIALS STUDIED

Two sets of airphotos were studied in the Liard Highway area: 1:20,000 scale airphotos sent by the NWT Highway Department, and second set of National Air Photo Library (NAPL) airphotos at scale 1:50,000. Surficial geology maps, terrain classification maps, and bedrock geology maps were studied along with the airphotos.

3. ANNOTATED STRIP MOSAICS AND APPENDICES

Airphotos obtained for this study were assembled into single and/or double strip mosaics before they were studied stereoscopically -- and before any granular material prospects were identified and outlined.

Granular material prospects on the Liard Highway 7 search area are shown on seven low-altitude strip mosaic sheets labelled 1A to 7A, and on five high-altitude strip mosaic sheets labelled 1 to 5, respectively.

Descriptions of the various granular material prospects are given in Appendices A and B. Appendix C lists factors to consider in field checking, exploring and exploiting prospects in the Liard River area. Appendix D contains comments on potential rock quarry sites in the Liard Highway 7 area.

Key maps showing strip mosaic locations are shown on Figures 1 and 2.

4. BEDROCK GEOLOGY AND BEDROCK QUARRY SITES IN THE LIARD HIGHWAY 7 AREA -- MUSKEG RIVER TO BLACKSTONE RIVER

Terrain along the Liard Highway between the Muskeg and Blackstone rivers is underlain by shale, siltstone and sandstone of the Lower Cretaceous Fort St. John Group. These rock strata are often soft and easily weathered, especially shale and sandy shale. Where sandstone beds are well cemented, the bedrock tends to be much harder and more durable. Outcrops of the St. John Group are sparse and confined to a small area along and near the valley side north of the confluence of the Liard and Muskeg rivers. Here the sedimentary strata are gently dipping. Farther

west the bedrock types are harder and consist of Paleozoic shale, sandstone, limestone, and dolomite (Figure 4). Field checking is required to discover their precise location and the rock type.

Altogether five site areas (namely, A, B, C, D, E) have been marked for field reconnaissance checking using a helicopter (Figure 3, Appendix D, and mosaic sheets 1, 4 and 5). Four areas are located along the east side of the Liard River and one (Area B at Nahanni Butte) on the west side of the Liard. Local outcrop areas at A, C, D and E require careful ground search because they are not well expressed in the terrain. Most are expected to occur along the shoreline or riverbank. Quarry prospect A is shown on mosaic sheet 1, B on sheet 4 and quarry sites C, D and E on sheet 5.

Area B is different and consists of high steep cliffs, with piles of broken talus rock strung out along the base of Nahanni Butte. Whereas alluvial fans and cones tend to become finer downslope from their apexes, talus piles often become coarser at the toe of these coalescing piles. Moreover, Area B is more likely to contain hard carbonate rock fragments than other site areas that have been marked for field checking.

5. REGIONAL SURFACE MATERIALS AND GRANULAR MATERIAL PROSPECTS -- LIARD HIGHWAY 7 AREA

Figure 4 is a regional map showing surface geologic materials in the Liard Highway study area. There are very few outwash and ice-contact sand and gravel deposits in the region. The latter are a few crevasse filling fields and esker ridges; but in general granular material in them tends to be pockety. Contiguous deposits of till and sand or gravel are commonplace in the ice contact deposits.

Large sand and gravel deltas often form around the margins of glacial lakes, but they are absent along the shores of glacial Lake McConnell in the study area. Alluvial fans and cones occur where streams discharge from mountain ranges west of the Liard River (Figure 4). These granular deposits are remote, and also likely costly to develop.

The three most common mineral soil deposits in the study area are till; glacial-lake (lacustrine) clay, silt and fine sand; and alluvial floodplain and low terrace deposits along the Liard River, and lower Muskeg and Liard rivers. Fen and bog peats and their frozen counterparts are also common in poorly drained hollows.

The easiest granular prospects to assess from helicopter reconnaissance are exposed point bars in the active channels of large rivers. Exposed bars, on which one can readily land, should give one a good idea of the type of granular material to be expected below the finer-grained silt/clay/fine sand topstratum (or overburden layer). Where wooded islands in the river and channel-scarred floodplains are undercut by rivers, and where riverbanks are significantly higher and steeper, one can often get a good first impression of granular materials in the substratum without doing a lot of walking in heavy bush and without expensive backhoe exploration.

Strip mosaics should be used in the field for making comments about each prospect visited -- e.g., the height of a gravel surface above the water table, characteristic deposit gradation, estimated thickness of the overburden on average, access problems, envisaged environmental constraints, etc.

Many of the same deposits are shown on the low level and high level airphotos. I show 42 granular material prospects on the low level airphotos and 51 prospects on the high level airphotos.

6. SUMMARY AND CONCLUSIONS

1. There appears to be lots of granular material in Liard River exposed bars, below islands, and below the adjoining channel-scarred floodplains. But the water table may be high in these localities, especially so during spring and/or summer peak runoff. Also, environmental constraints may restrict gravel removal -- totally or just at certain times of the year. Close coordination and cooperation with environmental authorities may allow removal under certain specified conditions. The same things apply to granular deposits along the lower Muskeg and Blackstone rivers, and their larger tributaries. Alternative places to check in the field are marked by Xs.

2. Kames, eskers, and crevasse fillings in the Liard River study area are remote, pockety, heavily wooded, and are therefore difficult to assess from helicopter reconnaissance.

3. Because of potential environmental constraints to alluvial gravel removal, the possibility of quarry rock as an alternative source of aggregate should not be overlooked. I have marked five bedrock areas. All require careful field reconnaissance to identify their location and rock type. Rock samples should be collected from outcrops for laboratory testing of soundness and wearability before spending a lot of money on subsurface exploration -- especially if the quarry rock site is largely concealed beneath heavy overburden.

4. I believe the best method of checking road metal prospects is via a helicopter because many sites can be visited in a single day. In general, there are many good helicopter landing sites. Samples should be collected for grain-size analyses. Close-up ground snapshots should be taken of exposed rock faces and surface gravel appearance. Access and gravel recovery should be assessed and cost assigned to various items before detailed field subsurface investigation.

APPENDIX A

MUSKEG RIVER/BLACKSTONE RIVER SEARCH AREA ADJACENT LIARD HIGHWAY 7 GRAVEL PROSPECTS INTERPRETED FROM LOW LEVEL NORTHWEST TERRITORIES AIRPHOTOS

Mosaic sheet	Prospect number	Approximate kilometre post (km)	Description of prospects (Xs are suggested field reconnaissance check sites)
1A	1A,B,C,D,E	80-90	Liard River floodplain deposits. Overburden is probably ±1 m. Expect gravelly sand to sandy gravel substratum.
1A	2	92	May be kettled outwash. Heavily treed.
1A	3A to E	98	Exposed and masked (±1 m silt and trees) gravel bars formed by the Liard River.
2A	4A,B,C	108	Reworked gravel and sand deposits at the junction of the Blackstone and Liard rivers.
2A	5	113	A questionable prospect, but located near the highway.
3A	6A,B		Abandoned (raised) gravel bars. Expect high water table. Possibly summer stockpiling and winter haul if suitable material is discovered here.
3A	7	132	Questionable but close to highway. Probably oversanded, and a thick overburden. Poor prospect.

APPENDIX A (cont'd)

Mosaic sheet	Prospect number	Approximate kilometre post (km)	Description of prospects (Xs are suggested field reconnaissance check sites)
3A	8A-1,8A-2	140	Liard River scroll (point) bars. High water table likely. Check at Xs to determine overburden thickness and deposit gradation.
4A	8B,C	140	Small sand and silty sand point bar deposits. High water table. Generally poor prospects. Check exposed river bars.
5A	9A,B,C,D	151-157	Exposed side-channel bars. Roughly 50% gravel and 50% sand expected. Check environmental (fish habitat) controls. Large volume of material available.
5A	9E,F,G	Opposite Km 150 to 160	Similar to prospects 9A to D, but covered with 1 to 2 m silt, fine sand and trees.
5A	9H	Opposite Km 155 Across the Liard River	Many tens of millions of cubic metres of gravel. Expect deposit is coarser than 9A to G. Check undercut riverbanks, digging below sloughed debris.
5A	10	163	Overridden kame(?). Sand and gravel covered by till and lacustrine silt and clay. Poor prospect. Difficult to assess this prospect.

APPENDIX A (cont'd)

Mosaic sheet	Prospect number	Approximate kilometre post (km)	Description of prospects (Xs are suggested field reconnaissance check sites)
6A	11A,B,C	171	Exposed gravel bars and treed islands in Liard River. Large quantities of gravel. Inundated at high flows. High parts of islands are better prospects. High grades (slopes) from river deposits to highway (uphill when trucks are loaded).
6A	12	182	Gravel bar in Liard River. Steep haul out of Liard Valley.
7A	13A to E	188 - 193	Exposed gravel bars and treed flood plain with 1-2 m of silty to fine sandy overburden. Deposits easIly assessed by helicopter.
7A	14A,B		Gravel bars in Liard River.
7A	15	208 (Muskeg River crossing)	Large volume of alluvial sand and gravel below the floor of lower Muskeg River. The overburden is likely thin and the water table fairly high. Exposed point bars should reveal the quality of gravel in the adjoining treed floodplain and low terraces.

APPENDIX B

MUSKEG RIVER/BLACKSTONE RIVER SEARCH AREA
ADJACENT LIARD HIGHWAY 7
SUMMARY OF GRAVEL PROSPECTS INTERPRETED FROM HIGH LEVEL AIRPHOTOS

Note: Expect 1 to 2 m of silty to sandy overbank alluvial sediment over wooded flood plain deposits.

Strip mosaic sheet number	Prospect number	Description of prospect
Sheet 1	1	Alluvial terrace. Remote.
Sheet 1	2	Branching eskers and an esker-delta. Remote. Fair gravel prospect. Gravel in pockets in in ridges.
Sheet 1	3	Small esker.
Sheet 1	4 and 6	A large gravelly sand delta, deposited into a temporary glacial lake. Check at Xs.
Sheet 1	5	Reworked sand and gravel below low terraces and meander loops of the Blackstone River. Good prospect.
Sheet 1	7, 8	Gravel bars exposed at low flows in the Liard River.
Sheet 1	9,10,11,12	Sand and gravel at 1-2 m depth in side channel bars, floodplain and islands in Liard River. Large deposits (see, also, low level airphotos and Appendix A).

APPENDIX B (cont'd)

Strip mosaic sheet number	Prospect number	Description of prospect
Sheet 2	13	Braided, narrow, winding esker ridges. Remote. Fair to poor prospect.
Sheet 2	14	Crisscrossing crevasse fillings. Poor prospect. Remote.
Sheet 2	15	Row of kames. Best places to check are marked X.
Sheet 2	16	Expect sand and gravel along the floor of the tributary valley to the Blackstone River. Granular deposits may be shallow.
Sheet 2	17	Sand and gravel along the lower Blackstone River low terraces and floodplain.
Sheet 2	18	Extensive sand and gravel below the channel-scarred, wooded floodplain of the Liard River.
Sheet 2	19	Large area of interlacing eskers and crevasse fillings. Remote.
Sheet 2	20	Large deposits of sand and gravel in kames and eskers. Complexly stratified. Ridges and mounds.
Sheet 2	21	Kame. Poor prospect. Complexly stratified. Variable thickness of overburden.

APPENDIX B (cont'd)

Strip mosaic sheet number	Prospect number	Description of prospect
Sheet 2	22	Wooded bars on the flood plain of the Liard River. Check for gravel at depths of 1 to 2 m.
Sheet 3	23	Good prospect. Check higher terraces near the slide area. High water table and environmental constraints are main concerns.
Sheet 3	24	Similar to Prospect 23, only closer to the highway.
Sheet 3	25	Crevasse filling field. Small, narrow, criss-crossing ridges containing pockets of gravel and till. Poor prospect.
Sheet 3	26	Similar to Prospect 25.
Sheet 4	27	Extensive. Floodplain and point bar deposits. Generally thin. High water table. Check gradation of exposed point bars.
Sheet 4	28,29,30,31	Wooded point bars (meander scrolls) in the raised floodplain of the Liard River. The closest prospect is likely best. Water table position and environmental constraints are main concerns.

APPENDIX B (cont'd)

Strip mosaic sheet number	Prospect number	Description of prospect
Sheet 4	32,33,34,35,36	Similar to 28 to 31, with similar problems and constraints. Gradation is best checked at actively undercut river bank locations and at 1 to 2 m below surface on exposed sand and gravel bars.
Sheet 4	37,38,39	Similar to 32 to 36.
Sheet 5	40,41,42,43	Exposed gravel bars and wooded floodplain deposits.
Sheet 5	44,45,46,47, 48,49	Similar to 40 to 43.
Sheet 5	50,51	Crevasse filling fields and minor end moraines. Poor. Pockety. Small quantities expected.

APPENDIX C

SOME FACTORS TO CONSIDER IN GRANULAR MATERIAL LOCATION, FIELD EXPLORATION, AND DEPOSIT EXPLOITATION MUSKEG RIVER/BLACKSTONE RIVER SEGMENT LIARD HIGHWAY 7, NWT

1. Nearly all granular material prospects are alluvial rather than glaciofluvial in origin. They occur mainly as river bars, wooded meander-scrolled floodplains, and low wooded terraces.

2. Because of the origin and topographic position of these alluvial deposits, the fine-grained overburden, or topstratum, should be fairly thin (1 to 2 m). Also the water table is generally high (i.e. near the surface).

3. Gravel prospects located remote from the larger rivers tend to be small in volume, variable in gradation, pockety, and difficult to reconnoitre easily and confidently from a helicopter -- the best mode for checking identified prospects.

4. Granular deposits have been removed along the Liard, Muskeg, and Blackstone rivers for highway construction in the past. Hence precedent has been established. However, environmental controls may have changed since the time these deposits were removed. I visualize that there would be very little damage to fish habitat if gravel borrow were removed from wooded floodplain and low terrace areas.

5. Exposed sand and gravel bars in the Liard, Blackstone and Muskeg rivers are easily and quickly assessed by helicopter. Undercut riverbanks underlain by gravel are slightly less accessible. The whole study area may be reconnoitred in a couple of days by helicopter, and preferred deposits earmarked for follow-up subsurface exploration.

6. A hand spade is the best sample tool to use during helicopter reconnaissance. The gravel location person should clean off all sloughed material near the top of riverbanks, especially at actively undercut locations along the river. Gravel samples can be collected for grain size analyses in the laboratory.

APPENDIX C (cont'd)

7. Consideration should be given to winter versus summer recovery and stockpiling of gravel material.

8. Wherever existing cutlines occur -- seismic lines, old winter trails, etc. -- they offer possibilities for truck-haul roads to the highway right-of-way.

APPENDIX D

PROSPECTIVE ROCK QUARRY SITES NEAR LIARD HIGHWAY 7 MUSKEG RIVER TO BLACKSTONE RIVER AREA (see Figure 3)

Localities containing potentially economic sources of quarry rock require careful field inspection because they are (a) very few in number, (b) may be covered by excessive depths of overburden, and (c) may contain weak crumbly shale or other similar rock types that break down under traffic. The following 5 areas and comments are intended as a guide to field reconnaissance.

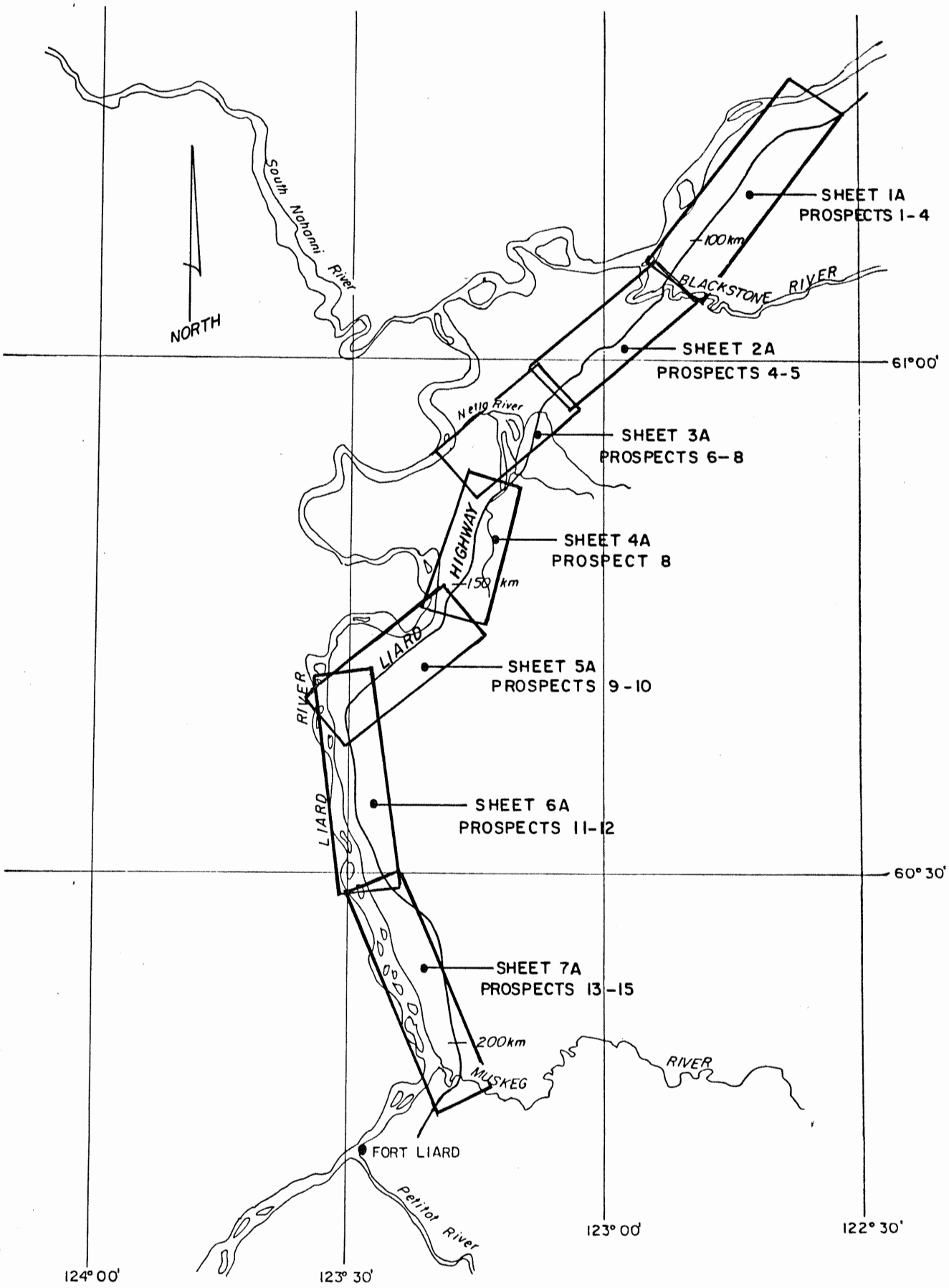
Area A — Check along shoreline and riverbank for exposures of Devonian shale and limestone. Check rock type, degree of weathering, and overburden depth.

Area B — Check piles of broken talus rock at the base of cliff. I expect to find a large variation in rock-fragment size. Also I expect mainly Silurian limestone and dolomite rock types, which are usually hard carbonate rock types suitable for crushing and road surfacing.

Area C — Check along shoreline and riverbank for exposures of Mississippian shale and/or limestone.

Area D — Check shoreline and riverbank for Mississippian shale and/or limestone.

Area E — Check for outcrops of soft Cretaceous shale, siltstone, and sandstone bedrock. These rock types may be too soft and too crumbly and easily weathered for use as road surfacing material.



KEY MAP SHOWING 1:20,000 STRIP MOSAIC SHEETS

LIARD HIGHWAY BETWEEN MUSKEG AND BLACKSTONE RIVERS

0 4 8 12 16 20 24km

0 5 10 15 miles

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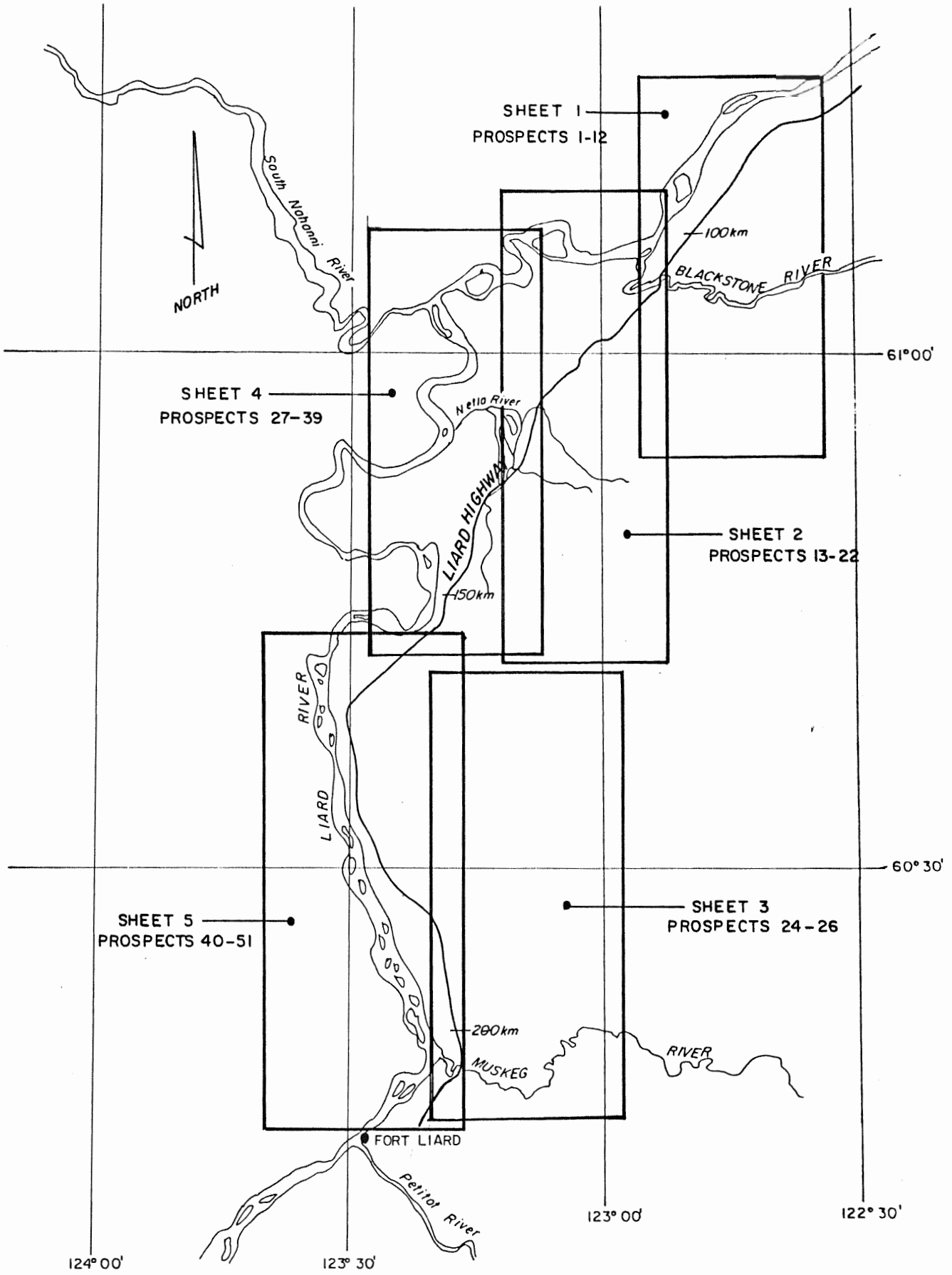
FIGURE 1



KEY MAP SHOWING 1:50,000 STRIP MOSAIC SHEETS

LIARD HIGHWAY BETWEEN MUSKEG AND BLACKSTONE RIVERS

0 4 8 12 16 20 24km

0 5 10 15 miles

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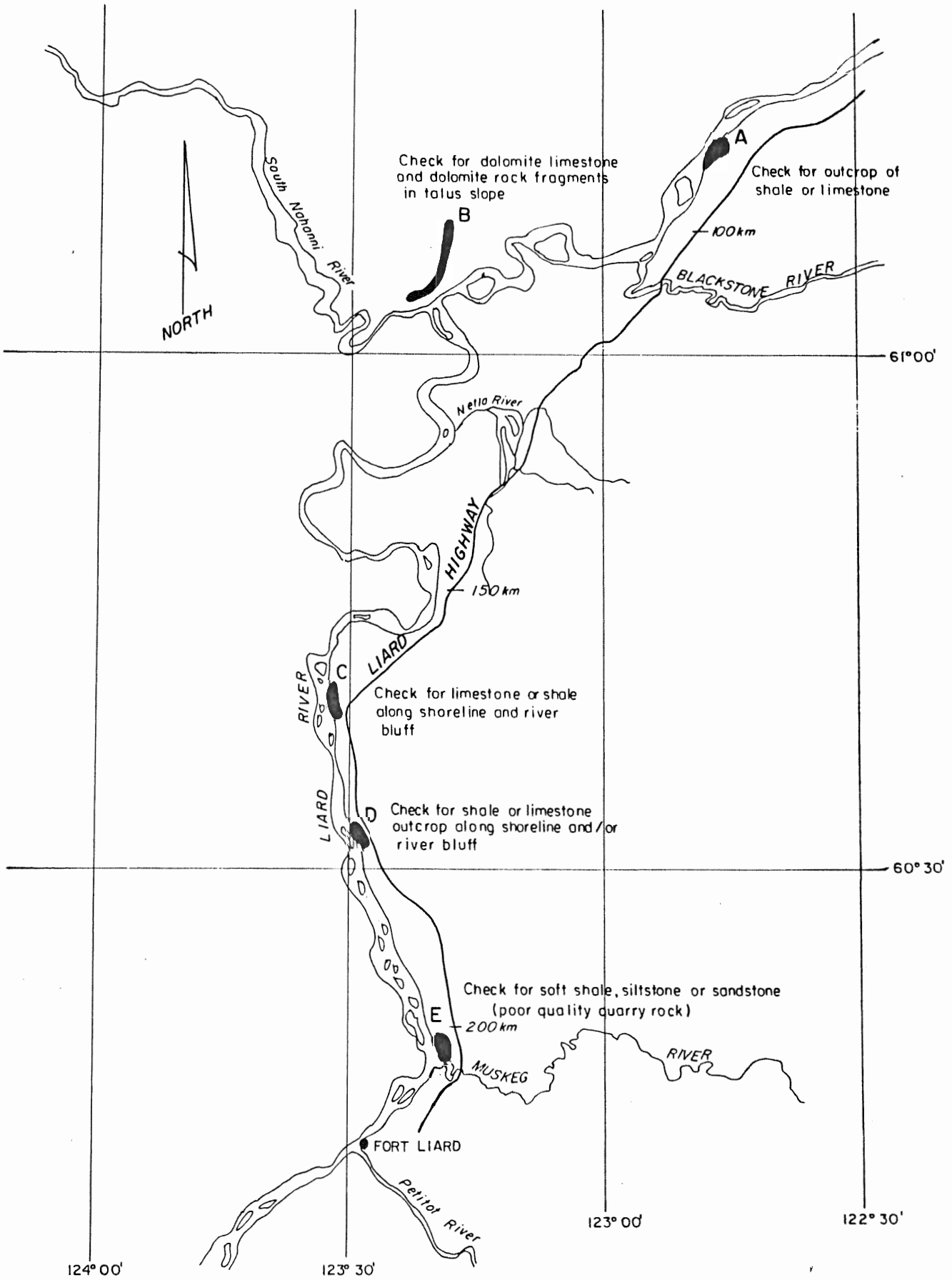
FIGURE 2



SITE LOCALITIES A to E TO CHECK FOR POSSIBLE QUARRY ROCK

MUSKEG RIVER TO BLACKSTONE RIVER AREA

0 4 8 12 16 20 24km

0 5 10 15 miles

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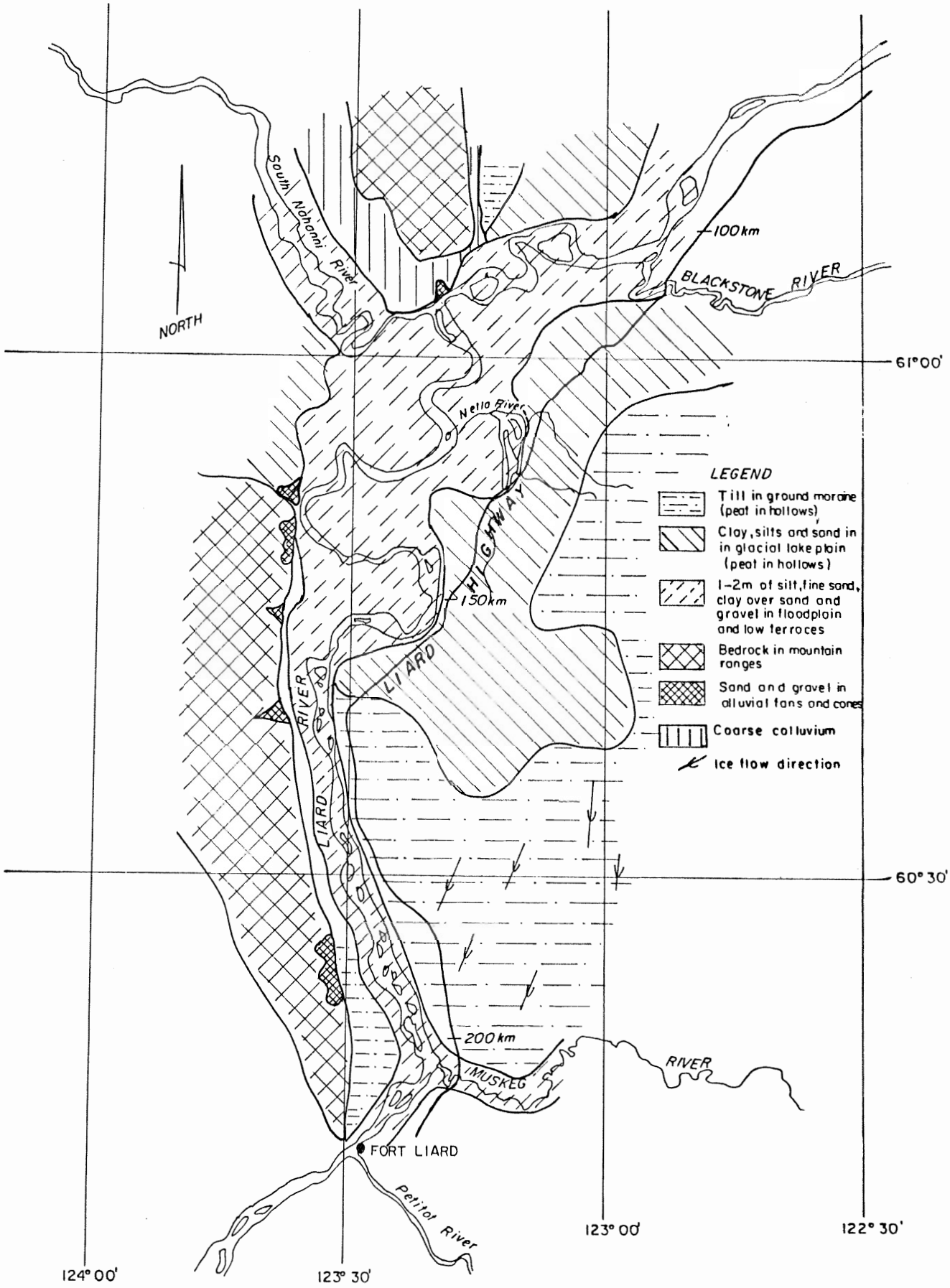
FIGURE 3



MAP SHOWING REGIONAL SURFACE MATERIALS
LIARD RIVER AREA FROM MUSKEG TO BLACKSTONE RIVERS

0 4 8 12 16 20 24km
0 5 10 15 miles

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FIGURE 4

AIRPHOTO MOSAIC SHOWING PROSPECTS

1 to 4

0 0.5 1.0 1.5 2.0 2.5 3.0km

0 0.5 1.0 1.5 miles

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SHEET 1A

AIRPHOTO MOSAIC SHOWING PROSPECTS

4 to 5

0 0.5 1.0 1.5 2.0 2.5 3.0km

0 0.5 1.0 1.5 miles

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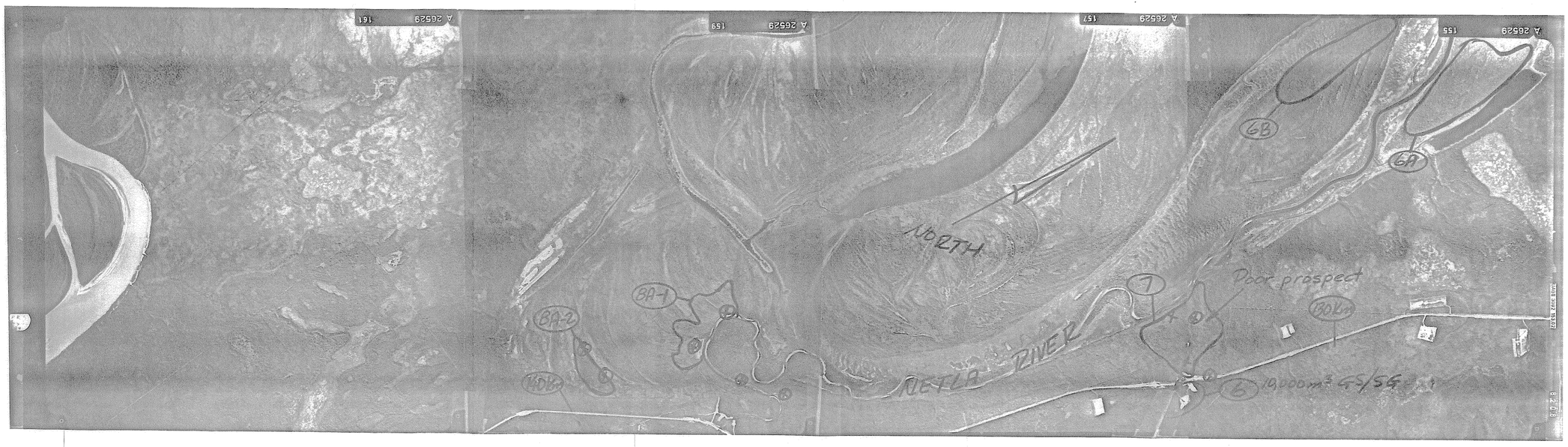
SHEET 2A



AIRPHOTO MOSAIC SHOWING PROSPECTS

6 to 8

0 0.5 1.0 1.5 2.0 2.5 3.0km

0 0.5 1.0 1.5 miles

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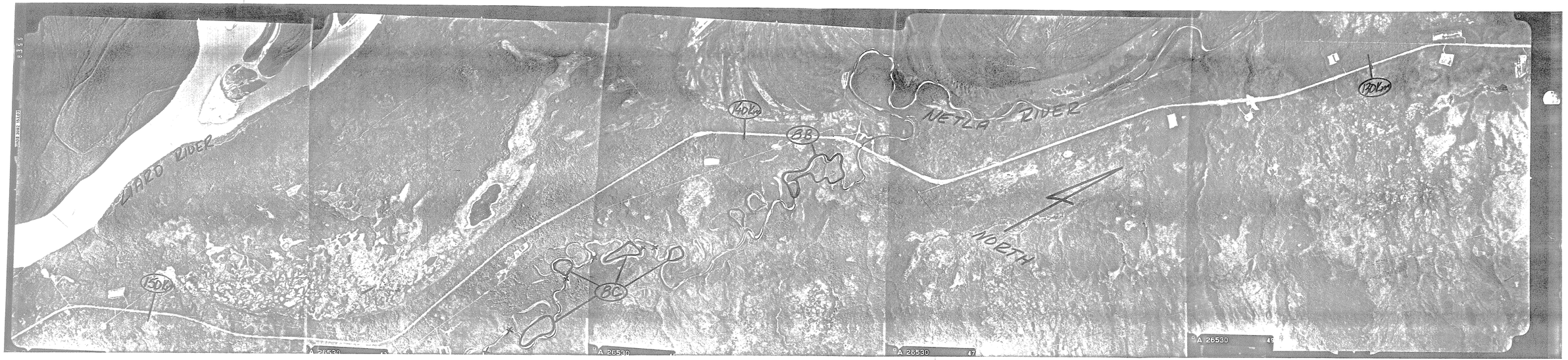
SHEET 3A



AIRPHOTO MOSAIC SHOWING PROSPECTS

8 to

0 0.5 1.0 1.5 2.0 2.5 3.0km

0 0.5 1.0 1.5 miles

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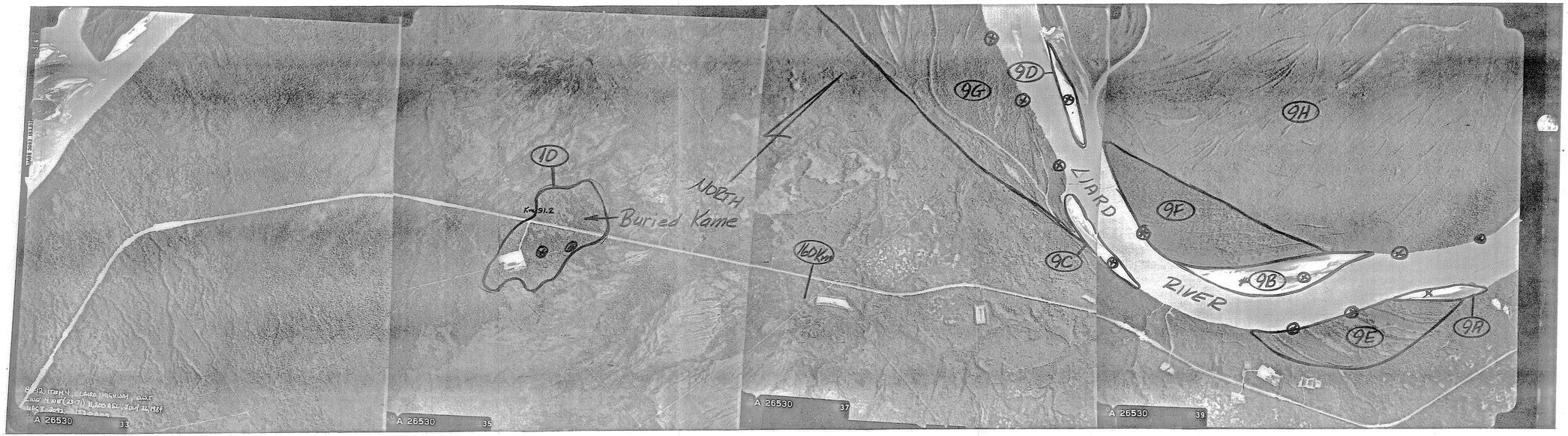
SHEET 4A



AIRPHOTO MOSAIC SHOWING PROSPECTS

9 to 10

0 0.5 1.0 1.5 2.0 2.5 3.0km

0 0.5 1.0 1.5 miles

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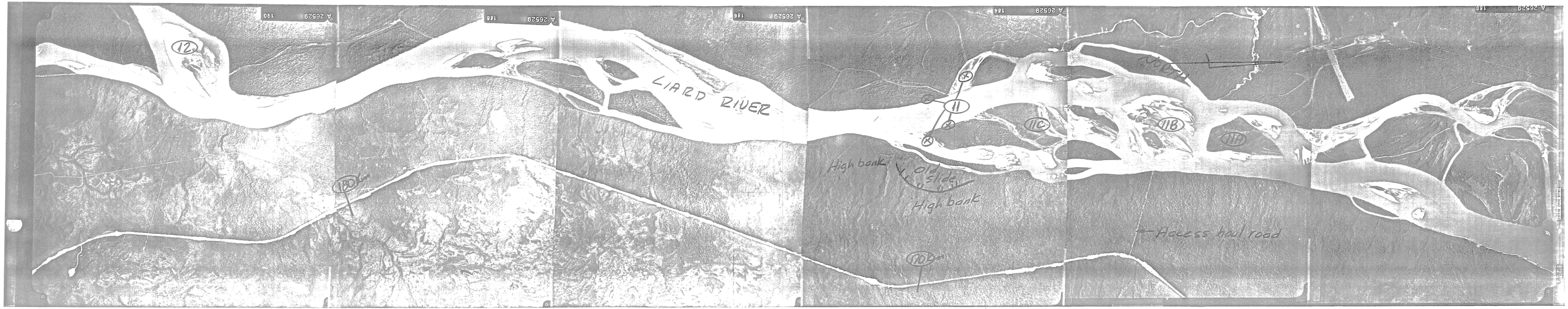
SHEET 5A



AIRPHOTO MOSAIC SHOWING PROSPECTS

11 to 12

0 0.5 1.0 1.5 2.0 2.5 3.0km

0 0.5 1.0 1.5 miles

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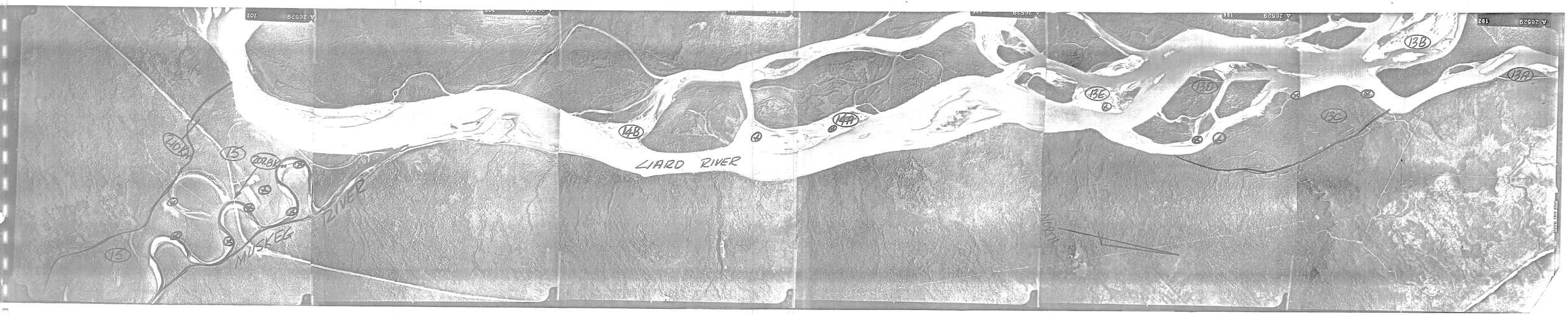
SHEET 6A



AIRPHOTO MOSAIC SHOWING PROSPECTS

13 to 15

0 0.5 1.0 1.5 2.0 2.5 3.0km

0 0.5 1.0 1.5 miles

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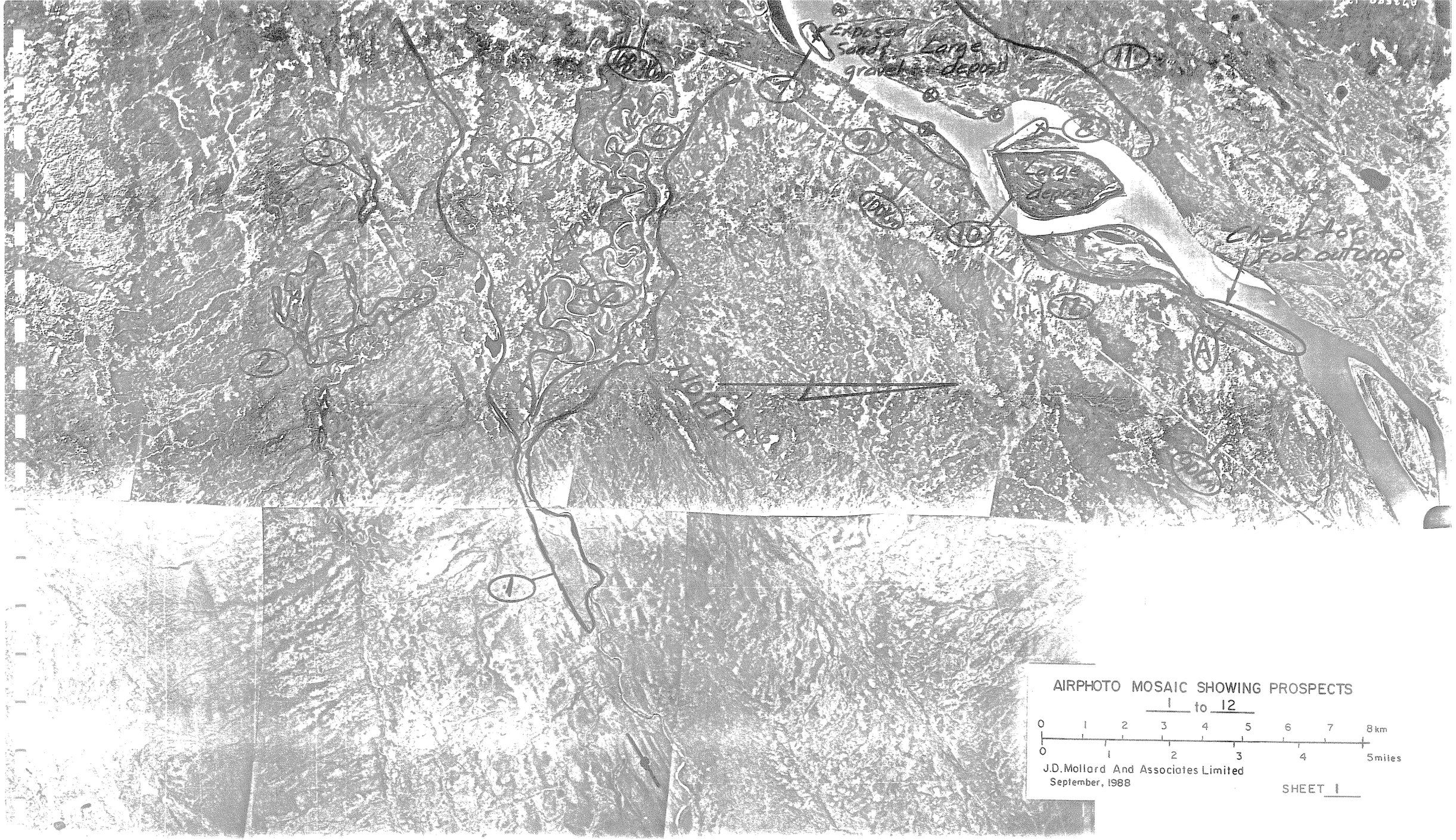
SHEET 7A



AIRPHOTO MOSAIC SHOWING PROSPECTS

1 to 12

0 1 2 3 4 5 6 7 8 km

0 1 2 3 4 5miles

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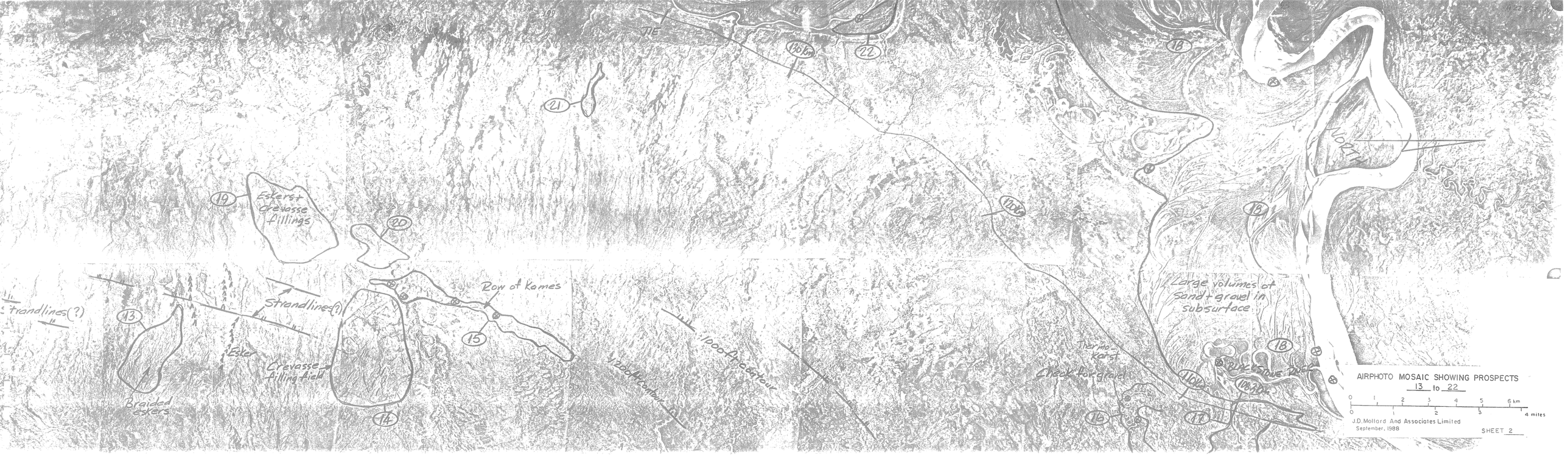
SHEET 1


Eskers Crevasse Fillings
Row of Kames
Strandlines(?)
Strandlines(?)
Esker
Crevasse Filling Field
Braided Eskers
1200 Ft contour
1200 Ft contour
Thermo karst
Check for gravel
Large volumes of sand + gravel in subsurface
AIRPHOTO MOSAIC SHOWING PROSPECTS
13 to 22
0 1 2 3 4 5 6 km
0 1 2 3 4 5 miles
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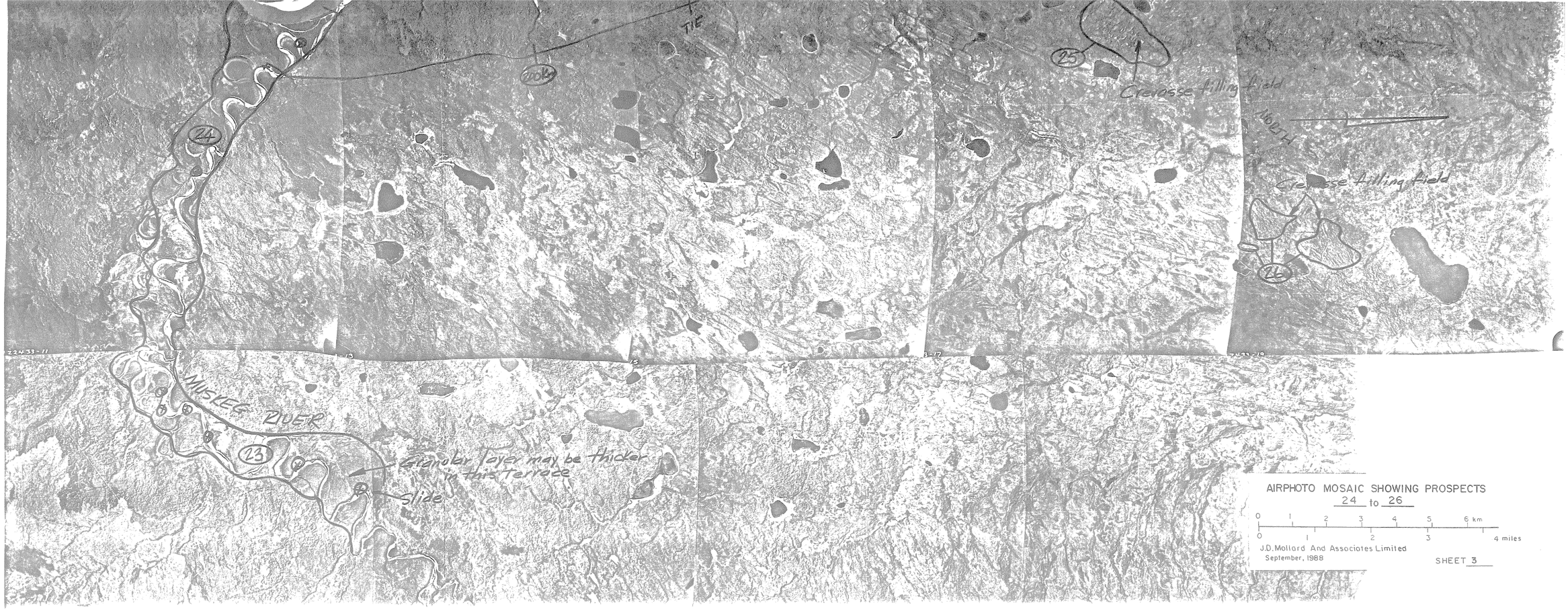
SHEET 2



AIRPHOTO MOSAIC SHOWING PROSPECTS
24 to 26

0 1 2 3 4 5 6 km
0 1 2 3 4 miles

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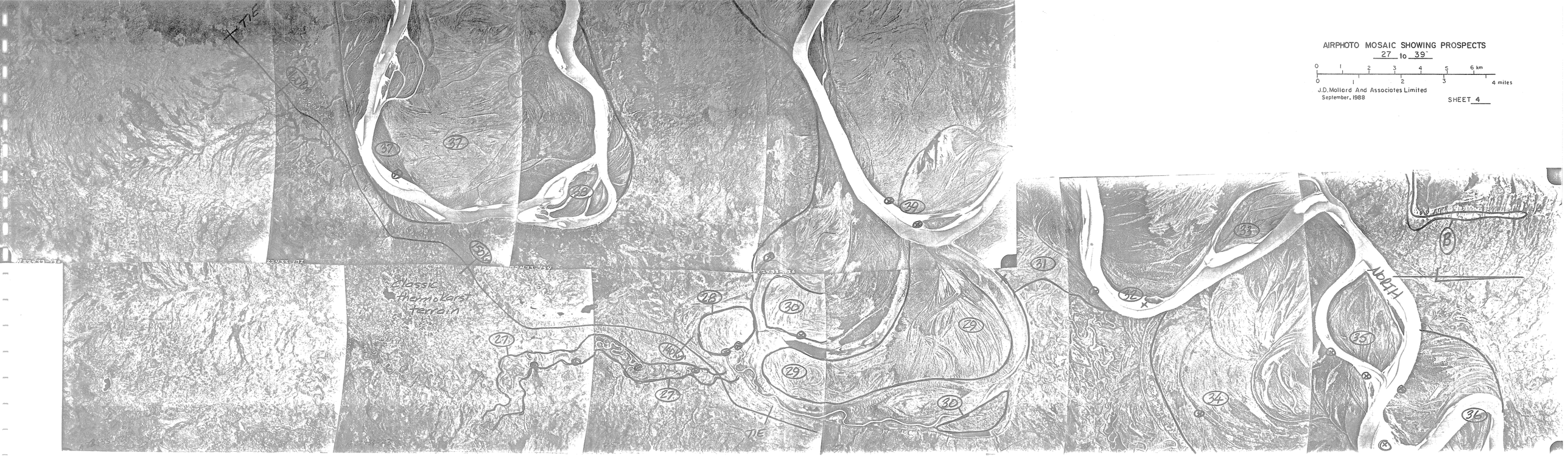
SHEET 3


AIRPHOTO MOSAIC SHOWING PROSPECTS
27 to 39
0 1 2 3 4 5 6 km
0 1 2 3 4 miles
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SHEET 4
TIE
Classic thermokarst terrain
ADLATH
TIE

AIRPHOTO MOSAIC SHOWING PROSPECTS
40 to 51

0 1 2 3 4 5 6 km
0 1 2 3 4 miles

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SHEET 5

END OF REPORT