REPORT

ON

PROPOSED CROSSING OF KATHERINE RIVER

AT

KATHERINE

(NOVEMBER, 1970)

1. INTRODUCTION.

We have been commissioned (Director's letter 70/2893(8) of 15th October, 1970) to investigate and report on a proposed crossing of the Katherine River at Katherine.

A site inspection was made on 27th October, 1970 by Messrs. Cameron and Bearkley and again on the 28th in company with Messrs Green, Darben and Duff of the Department. The river was in low stage and both banks and bed at the proposed site were inspected.

We have been supplied with a copy of a report "Katherine Investigation of Flooding from Katherine River - March, 1970", prepared by the Mines and Water Resources Branch and a level traverse across the river on the Katherine Terrace alignment.

We have also obtained photogrammetric contour and detail compilations C. & L. 665/D, 689/D and 690/D covering Katherine and the flood plains on both banks of the river. These are at a scale of 1" = 200', have two foot contour intervals and were compiled from 1963 photography.

The Commonwealth Railways have supplied us with prints of the main drawing of the Katherine River Railway Bridge.

A discussion has been held between Messrs. Cameron and Bearkley of this firm, Messrs. Green and Duff of the Department
1. INTRODUCTION (Cont'd)

and the acting town planner on aspects of the Katherine town plan.

1.1 DATUM.

All levels in this report are on Darwin Town Datum.

2. TOWN OF KATHERINE.

The town of Katherine is situated on the southern levee bank of the Katherine River. Figure 1 shows the relationship of Katherine to the highway network of the Northern Territory.

Although the present population of Katherine is small it is predicted to grow to a considerably larger town/city in the near future. It is at the junction of the Stuart (N-S) Highway and the Victoria (Western) Highway. It is on the railway line and is one of the main transhipment points from road to rail. The Daly Waters - Cape Crawford Road serving the Barkly Tableland and the Mataranka Roper Bar Road make access from Katherine to these major pastoral areas to the East easy.

Tindall Airport ten miles south of Katherine is capable of handling large jet aircraft and should develop as an aviation centre for this part of the Northern Territory. The area has considerable tourist potential.

Katherine is already established as a major meat producing centre and is situated close to the Tipperary land system in which occurs the main land in the Northern Territory with agricultural potential. It has an average annual rainfall of 36" and the Katherine River provides an excellent water supply.

All the factors point to a considerable growth in Katherine's population and the following figures have been supplied by the Acting Town Planner as the best estimate. He points out that the population growth rate of Katherine will be very sensitive to changes in the stimuli producing the growth.

Present population : 2,250 (3,000 within 30 mile radius).
2. TOWN OF KATHERINE (Cont'd)

Projected 1980 population: 8,000
Projected 1985 population: 15,000

Planning of transportation corridors near and through the town of Katherine should therefore be done on the basis of a town of at least 20,000 people with potential to grow further.

Unless a major water control scheme is built near the upper end of the Katherine Gorge flooding will be the main determining factor in the pattern of growth of Katherine. The Gorge already acts as a major throttle and appears to attenuate and limit the peak discharge at Katherine.

The existing business and residential districts of Katherine have been built along the South bank natural levee, most of which is immune to all but the most severe flooding. Some of the newer residential areas are however subject to flooding and if a flood at R.L. 360.0 ever occurred the whole of the existing town would be under 4 - 10 feet of water. A flood of this magnitude although a rare occurrence is considered by the Water Resources Branch to be possible.

It is fairly obvious that further residential development in Katherine will be on higher land either north or south of the flood plains.

The "Katherine Town Planning Scheme 1968 - 1988" shows the major subdivisional development south of the flood plain and east of the Stuart Highway. This town plan shows only industrial land and some motel sites north of the river although we understand that high ground north of the flood plain is under further consideration for residential development. This would only be feasible after the construction of a high level town bridge.

3. TRANSPORTATION CORRIDOR.

The North Australian railway has for many years crossed the Katherine River at Katherine. Until quite recently the whole town was situated East of the railway. There is now a fairly large residential area, the powerhouse and the meatworks west of the railway line. The present development in this area occupies
3. TRANSPORTATION CORRIDOR (Cont'd)

nearly all of the high levee bank and so little further development on the South bank can be expected West of the railway.

The Stuart Highway from the north parallels the railway until a point about one and a half miles north of the town is reached. It then diverts across the railway line to the low level crossing two miles west of Katherine and then returns along the South bank to recross the railway line near the northern end of the main street of Katherine (Katherine Terrace). The Stuart Highway then continues south parallel to and adjacent to the railway line through the central business district of Katherine.

The Railway/Stuart Highway corridor is therefore well established as a transportation corridor. Because it traverses low lying flooded country north and south of the present town it will be easy to maintain buffer zones between the road/railway and future residential areas.

Katherine is also the only town of any size in 600 miles of highway between Darwin and Tennant Creek. A large proportion of traffic travelling through Katherine will want to stop in the town. If a bypass road were built either a large proportion of traffic which might otherwise use the bypass would proceed into Katherine before travelling on or a satellite service area with motels, shops and service stations would form on the bypass. The former alternative would make a bypass unnecessary and the latter would tend to negate some of the advantages of the bypass and would make the development of a viable service industry more difficult as there would be two areas competing for limited business.

A bypass could only be considered to the East of Katherine where there would be conflict between road needs and residential requirements. Traffic on the Victoria Highway which is the main highway to Western Australia would also have to pass through Katherine's shopping centre to reach the bypass.

In our opinion there is a very sound case for the maintenance of the present transportation corridor as the permanent North - South corridor through Katherine.
Although our brief does not require us to concern ourselves with town planning problems we feel we should comment on two aspects of the Town Planning Scheme as published.

(a) It is very undesirable to have residential and business blocks fronting directly onto a main highway as has been shown for all areas south of Katherine. In figure 2 we have illustrated a possible road cross section for the future development of the Stuart Highway through Katherine outside the Central Business District. This would require a four chain reservation rather than the two chain reservation shown on the Town Plan.

We recommend that if the Stuart Highway is to remain parallel to the railway a four chain reserve be set aside for road purposes.

(b) In the Central Business District area there is a long narrow piece of land between the railway and Katherine Terrace which is zoned as Commercial B (Central Development). In our opinion it would be most unwise to allow continued development of this area as commercial blocks. The main shopping area will be on the Eastern side of Katherine Terrace and the presence of commercial development west of the highway will encourage more and more people to walk across an increasingly busy highway. Because of the large percentage of heavy trucks and road trains these will become a considerable hazard to pedestrians and local traffic.

If the line of commercial properties were resumed this would be the ideal location for the Stuart Highway leaving Katherine Terrace as a frontage/business road.

5. PROPOSED LOCATION OF STUART HIGHWAY THROUGH KATHERINE.

In figure 3 we have shown a possible cross section for the highway and frontage roads through the Katherine Central Business District.
5. PROPOSED LOCATION OF STUART HIGHWAY THROUGH KATHERINE. (Cont'd)

If this scheme were adopted there would be intersections at Giles Street and at the present level crossing. The north and south lanes of the highway and the frontage roads would have continuous barriers or plantings to prevent indiscriminate u-turns. We propose that part of the nature strip in the three Central Business District blocks be partly devoted to truck parking lanes so that trucks stopping for refreshment in Katherine would not have to enter the main town streets to park. Parking on the highway should be completely banned.

Figure 4 is a plan of the town area showing a possible layout for the Stuart Highway and Katherine Terrace which becomes a frontage road with provision for four lanes with parallel parking or two lanes with angle parking.

This development could easily be staged as follows:

1) Build Katherine River Bridge to suit the upstream (Eastern) carriageway of the future reconstructed Stuart Highway. Connect this to the existing Katherine Terrace on the Southern side of the river and the new Eastern carriageway of the Stuart Highway north of the river (figure 5).

2) Build the new eastern carriageway of the Stuart Highway south of the river to link up with existing highway south of Katherine Central Business District. Convert Katherine Terrace into a frontage (shopping) street (figure 6).

3) When Katherine grows to the stage that traffic between the various areas of the town requires the Stuart Highway to be converted to a four lane road through Katherine build the Western carriageway of the road and the downstream (Western) bridge.

It would be desirable to allocate space for a service station in Katherine Terrace between the railway level crossing and Giles Street. Petrol and distillate pumps could also be located opposite
5. PROPOSED LOCATION OF STUART HIGHWAY THROUGH KATHERINE. (Cont'd)

the service station in the nature strip between the truck parking bay and Katherine Terrace so that cars and trucks could be refuelled without manoeuvring in Katherine Terrace.

6. PROPOSED KATHERINE RIVER BRIDGE.

We recommend that a two lane bridge with footpath be built on the alignment of the proposed future eastern carriageway of the Stuart Highway.

The carriageway centreline of this bridge would be approximately 205° West of the eastern alignment of Katherine Terrace or 115° East of the railway track centreline. The location has been illustrated in figure 5. Although this involves an offset in the Katherine approach to the bridge until Stage 2 is built it is in the correct position for the final layout as recommended. In Stage 1 approach to the bridge from the North will be good and approach from Katherine will be adequate. As there will be 35 m.p.h. speed control in Katherine Terrace the reverse curves on the Katherine approach will present no problems. In Stages 2 and 3 approach to the bridge from both sides will be good.

6.1 BRIDGE WIDTH.

In conformity with recent policy decisions the Stuart Highway between Katherine and Darwin is being rebuilt to a 24° width of sealed pavement. The proposed bridge should cater for this and therefore is proposed with a 28° carriageway. As there is already some development north of the river and this bridge will stimulate further growth on the north side a footpath should be provided. A clear width of 8°-0° will provide adequate width for pedestrians to pass and still maintain adequate clearance to the kerb face and passing heavy vehicles. It will also provide reasonable space in the footpath cavity for the telephone, water and electrical services which may be required in the forseeable future.

6.2 BRIDGE PROFILE.

The proposed longitudinal profile incorporates a 65,000° Radius
6.2 **BRIDGE PROFILE (Cont'd)**

Vertical Curve. This will give more than adequate sight distance, will facilitate deck drainage and will lift the bridge superstructure above likely flood level. It will also facilitate the grading down of the approaches to minimise interference to the free flow of flood waters across the flood plain.

6.3 **DECK LEVEL.**

The proposed deck level at the crown of the V.C. is R.L. 358.0. This is about 2' above rail level on the adjacent railway bridge and will result in only minimum interference to flood flow by the bridge superstructure. Recent bridges on the Stuart Highway between Darwin and Katherine have openings which will pass the once in 20 year flood. The proposed deck level is consistent with this.

6.4 **SPAN LENGTHS.**

As the bridge carrying the second carriageway in Stage 3 of our proposal will only be 60' away from the railway bridge it will be important to line up the piers of the new bridge with those of the railway bridge. The railway bridge consists of seven 100' spans.

We propose that the new bridge have the same number and length of spans. Not only will these fit in with the railway bridge but they will be close to the most economical span arrangement for this height bridge. From our preliminary estimates it appears that a span of slightly greater than 100' would be the most economical. However the difference in cost would be marginal and the imposition of piers between the railway piers would be undesirable.

6.5 **SUPERSTRUCTURE TYPE.**

We would propose a composite steel girder and concrete deck bridge using unpainted weathering steel for the girders. As the girders will be above all but the most infrequent floods ($Q_{20}$ is just above bottom flange level) and the atmosphere in Katherine is not aggressive to steel this should be a very successful application of this steel. We would propose allowing alternative tenders employing prestressed concrete girders.
6.5 **SUPERSTRUCTURE TYPE.** (Cont'd).

Unless experienced contractors can be attracted to the site pre-stressed concrete appears to offer some problems in the Northern Territory.

6.6 **SUBSTRUCTURE TYPE.**

The recommended substructure will be similar to that of the Victoria River bridge being a reinforced concrete portal frame pier.

Because of the greater pier height and considerable flood pressures rectangular rather than the circular pier columns used at the Victoria River bridge will probably be required. Pier type and superstructure cross section are illustrated in figure 8.

The old railway bridge drawing shows that the railway bridge is founded in limestone 20 - 40 feet below bed level. It is most likely that the proposed bridge will be founded at similar levels. The deeper foundations will probably be steel piles and the shallower foundations will probably be cylinders similar to those at the Victoria River bridge or spread footings.

6.7 **UNDERPASS AT KATHERINE ABUTMENT.**

The continued use of the existing level crossing for internal movement between different parts of Katherine and traffic to the Victoria Highway will become increasingly difficult as road and rail traffic increases.

It would be possible to provide an underpass immediately behind Abutment B of the proposed bridge and the Abutment of the Railway Bridge. This would adequately cater for movements of cars and commercial vehicles between the two existing sections of Katherine. Because of the necessarily tight horizontal alignment leading to both sides of the underpass it may not be suitable for use by road trains and other very large loads.

Maintenance of the existing crossing with gate control or ultimate provision of an overpass East of Lindesay Street would provide for these very large vehicles. Alternatively if the underpass road were
UNDERPASS AT KATHERINE ABUTMENT (Cont'd)

continued along the river bank as an esplanade until adequate manoeuvring space for large vehicles could be provided the underpass would cope with all but extreme special permit vehicles.

Proposed dimensions of the underpass are

| Clear Span   | 36'0"   |
| Clear Height of opening | 15'0"   |

The provision of an underpass under the railway immediately behind the Katherine Abutment would be necessary. Informal discussions on this were held between the Chief Engineer Country Roads, the Chief Engineer of the Commonwealth Railways and Mr. Cameron of this firm in Darwin.

It would appear that no objection will be raised to this proposal provided that adequate provision is made for the maintenance of the track in service during construction.

The existing railway bridge abutment has large piled footings whose tops are 20' below formation level (Drawing M37). The underpass could either be built over the footings by removing some of the wing walls or if necessary completely behind the wing walls.

The proposed level of the underpass roadway (figure 7) is just above the level of the once in five year flood. This will provide adequate service in all but very wet years. In 1957 the road surface would have been underwater for five days and in 1968 for two and three quarter days (figure 6.1/6 of Ref. 1). In addition to these times there would probably be another day for cleaning up the road surface prior to use.

 Interruption of traffic in 17% of years with maximum period of interruption of about six days would be acceptable provided that an alternative higher level crossing were maintained for these emergency conditions.
7. EFFECT OF PROPOSED BRIDGE ON FLOODING IN KATHERINE.

The total main channel waterway reduction caused by the proposed bridge below Q₅₀ is:

<table>
<thead>
<tr>
<th>Component</th>
<th>Area (sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superstructure</td>
<td>3,000</td>
</tr>
<tr>
<td>Substructure</td>
<td>850</td>
</tr>
<tr>
<td>Approaches</td>
<td>760</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,550</strong></td>
</tr>
</tbody>
</table>

The estimated once in 50 year discharge is 200,000 cusecs. Should all of this flow down the main channel (assuming no flood plain flow) the calculated afflux caused by the proposed bridge is only about three inches.

The once in 100 year flood has an estimated discharge of 300,000 cusecs. However it is reported in reference 1 that at this level the existing railway bridge causes no measurable afflux. As the proposed road bridge presents no more restriction to main channel flow than does the railway bridge the effect of the highway bridge will also be very small.

There is some doubt as to the validity of the upper line marked "Railway line acts as weir" in figure 3.3/1 of Reference 1. We do not question the statement in Conclusion 2.50 of that report which states inter-alia

"For floods in the range of return periods 10 to 20 years the railway embankment can increase flooding in the area upstream of the railway by up to 2 1/2 feet."

However the transposition of this figure of 2 1/2 feet to the Main Stream Stage - Discharge curve in figure 3.3/1 is questionable. We think that the effect of the railway bridge and approaches will be much smaller in the main channel of the river. An afflux of 2 1/2 feet means an increase in river velocity through the bridge opening by about 15 feet/second to 25 feet/second.

We are of the opinion that levels in the main river channel will be little affected by either the railway bridge or the railway approach embankments. The embankments will act as dams to the flood plain flow and cause an increase in water level behind
7. EFFECT OF PROPOSED BRIDGE ON FLOODING IN KATHERINE.

(Cont'd).

the natural river levee and upstream of the railway. In other words
the water level in the Katherine town area will be higher than the
river level on the other side of the natural levee.

As the value of capital improvements in the present Katherine
Central Business District increases there will be mounting pressure
to achieve some reduction of the afflux caused by the railway
embankment in the town area.

The only way of providing this relief and maintaining a relatively
high level approach to the bridge would be the construction of large
banks of culverts under the railway. This would be very expensive.

We therefore propose that as a first stage of construction of the
approach roads to the new highway bridge the road level be kept
down to about 2' above flood plain level giving low points in both
approaches at about R.L. 350. This would result in negligible
interruption to flood flow even if the railway embankments were
lowered as has been suggested in 2.50 of reference 1.

The approaches at R.L. 350 would only be inundated by a flood
with a return period of about 12 years and the 1957 flood would
have submerged the low points for 2½ days.

In summary the proposed bridge with approaches about 2' above
flood plain level should cause negligible increase in flooding even
if the railway embankments were removed and with the railway
embankments in their present form will not aggravate the present
flood position at all.

7.1 FLOOD LOADING.

The once in 100 year flood is predicted to reach R.L. 357.8 (ref.
1). As this is deck level of the proposed bridge, the bridge must
be designed as a submersible structure.

Using the following parameters and Manning's formula average
stream velocities can be calculated.
7.1 **FLOOD LOADING.** (Cont'd)

Slope = 0.00041 (ref. 1)

Cross sectional area at Q₅ = 21,900 sq. ft.) From C. D. W.

- at Q₁₀ = 28,800 sq. ft.) survey.
- at Q₂₀ = 32,550 sq. ft.)

Mannings 'n' = 0.035

Average stream velocity at R.L. 338 = 9.0 ft./sec.

- at R.L. 348 = 10.2 ft./sec.
- at R.L. 353 = 10.4 ft./sec.
- at R.L. 358 = 10.6 ft./sec.

Using the calculated discharge and flood levels given in reference 1 much lower average velocities are obtained. These two conflicting results would be resolved if there were large areas of eddies in the Katherine River.

The above calculated velocities are consistent with the writer's observations and so will be adopted for bridge design purposes.

- **Design Velocity = 1.3 x Average Velocity = 14 ft./sec.**

The nature of the stream upstream of Katherine would indicate that debris is unlikely to be a major problem and there is no sign of large debris in the river at Katherine. Nevertheless the bridge itself will present a large frontal area to a major flood.

- **The depth of bridge below the level of Q₁₀₀ = 6'.**

- **Calculated flood force on girders = 1.5 x 6 x 14² = 1,760 lbs/foot run.**

This value will be subjected to further check before use in bridge design.

8. **BRIDGE LIGHTING.**

In figure 8 we have indicated the type of lighting proposed. Light standards would be set behind the front face of the rubbing rails on the barrier rail.
8. **BRIDGE LIGHTING. (Cont'd)**

The type, dimensions and spacing of lights would comply with Australian Standard CA 19 for Low Semi-cut-off Lanterns.

9. **BARRIER RAILINGS.**

We propose barrier railings as illustrated in Figure 8. The barrier on the footwalk side would be three rail x 3½'' high. The other barrier would be two rail x 2½'' high. Dimensions and loading would conform with the current N.A.A.S.R.A. requirements.

10. **BRIDGE AESTHETICS.**

As this bridge will form a very prominent feature in the town of Katherine it is important that the completed bridge be aesthetically pleasing. The proposed pier shape has been used on two bridges in Northern Queensland and has a pleasing appearance. The slight shaping of the pier columns and the headstock while achieving practical advantages also removes the starkness which would be associated with completely rectangular shapes.

Parallel girders with large deck overhang and simple barrier rail detailing combined with the large radius vertical curve will result in a superstructure which will appear to span the river in a graceful arc somewhat independent of the intermediate support.

Provided that adequate precautions are taken to prevent staining of the piers by rust from the weathering steel during construction the colour contrast of deep purple - brown girders and light coloured concrete will be pleasing.

11. **FOUNDATION TESTING.**

As set out in our letter of 4th November, 1970 it is important in any bridge of this size that subsurface conditions are known accurately. As the bedrock at the site is limestone this is doubly important. Bore holes in the following positions should be drilled.
11. **FOUNDATION TESTING. (Cont'd)**

<table>
<thead>
<tr>
<th>Chainage</th>
<th>Pier</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1850</td>
<td>A</td>
<td>Centreline</td>
</tr>
<tr>
<td>1950</td>
<td>1</td>
<td>20' U/S and 20' D/S</td>
</tr>
<tr>
<td>2050</td>
<td>2</td>
<td>20' U/S and 20' D/S</td>
</tr>
<tr>
<td>2150</td>
<td>3</td>
<td>20' U/S and 20' D/S</td>
</tr>
<tr>
<td>2250</td>
<td>4</td>
<td>Centreline</td>
</tr>
<tr>
<td>2350</td>
<td>5</td>
<td>Centreline</td>
</tr>
<tr>
<td>2450</td>
<td>6</td>
<td>Centreline</td>
</tr>
<tr>
<td>2550</td>
<td>B</td>
<td>Centreline</td>
</tr>
</tbody>
</table>

The overburden should be visually classified at each change of material and undisturbed samples and standard penetration tests should be taken at 10' intervals or major changes in material. Water table level in each hole should be recorded. Rock should be core drilled at least 10' into limestone. One hole at piers 1, 3 and 5 should be drilled to 20' into limestone to check for cavernous limestone. Cores should be logged and kept in core boxes.

12. **COST.**

The cost of the bridge and overpass has been estimated. Detailed estimates are in Appendix A. Bridge approaches have not been estimated in detail. However order of cost estimates for the immediate approaches to the Stage 1 proposal would be as listed below.

In summary the estimated cost of the proposed Stage 1 crossing is:

- Katherine River bridge:
  - A) Substructure: $286,426
  - B) Superstructure: $360,870
- Road Underpass C): $45,745
- Road approach North of river 1.1 miles: $50,000
- Road approach South of river 0.12 miles: $20,000

Sub Total: $647,296

Total: $763,041
13. SUMMARY OF RECOMMENDATIONS.

We recommend -

a) The Stage 1 bridge be located in a position to suit the eventual development of a four lane route paralleling the railway line as illustrated in Figure 4. Stage 1 bridge and approaches are illustrated in Figure 5.

b) The new bridge should be connected to Katherine Terrace as illustrated in Figure 5.

c) The lessees of land between Katherine Terrace and the Railway and the Commonwealth Railways should be advised that their land will be required for road purposes at some estimated date. The Commonwealth should be willing to pay compensation for land which the lessees wish to surrender before that date. To minimise eventual compensation, lessees should be advised that any construction other than that already approved and essential maintenance will not be compensated.

Alternatively the Commonwealth could acquire the necessary land now and release on short term leases to present lease holders.

d) The Stage 1 bridge should have the following dimensions.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spans</td>
<td>7 x 100'</td>
</tr>
<tr>
<td>Deck level at crown</td>
<td>R.L. 358.0</td>
</tr>
<tr>
<td>Deck profile</td>
<td>65,000' R. Vertical Curve.</td>
</tr>
<tr>
<td>Carriageway</td>
<td>28'</td>
</tr>
<tr>
<td>Footpath</td>
<td>8' on U/S side only.</td>
</tr>
<tr>
<td>Kerb height</td>
<td>10''</td>
</tr>
<tr>
<td>Barrier height</td>
<td>3''-3'' footwalk, 2 1/3'' road.</td>
</tr>
</tbody>
</table>

e) Bridge Construction: Simple span composite steel girder and concrete deck spans (Unpainted weathering steel in girders) on reinforced concrete portal piers.

f) Underpass: An underpass as detailed in 6.7 should be
13. SUMMARY OF RECOMMENDATIONS (Cont'd)

f) Cont'd
   provided at the Katherine end of the bridge.

g) Foundations: Probably steel piles to limestone.

h) Foundation Testing: As detailed in section 11 of the report.

i) Lighting: Lighting on footwalk side of bridge only as
detailed in section 8 of the report.

j) Approaches: Low level with low points at R.L. 350.00

k) Design loading: Live Load: A.A.S.H.O. - HS20 + 15% (to
   provide for proposed new loading ordi-
   nance).
   Flood Load: 1760 lbs/lin ft.

l) Cost: The cost of the crossing including an underpass and
   Stage 1 approaches is $763,041.

       CAMERON, McNAMARA & PARTNERS,
       12th November, 1970.

REFERENCES:
1. "Katherine - Investigation of Flooding from Katherine River -

## APPENDIX A
### KATHERINE RIVER BRIDGE
### PRELIMINARY ESTIMATES

### (A) SUBSTRUCTURE.

<table>
<thead>
<tr>
<th>Item</th>
<th>QTY.</th>
<th>UNIT</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Provision for traffic.</td>
<td>Item</td>
<td>Item</td>
<td>4,000</td>
</tr>
<tr>
<td>2.</td>
<td>Cleaning site.</td>
<td>Item</td>
<td>Item</td>
<td>1,000</td>
</tr>
<tr>
<td>3.</td>
<td>Excavation</td>
<td>150</td>
<td>c. yd.</td>
<td>5-00</td>
</tr>
<tr>
<td>4.</td>
<td>Supply and Pitch 12&quot; x 12&quot; Steel piles.</td>
<td>3,252</td>
<td>lin. ft.</td>
<td>18-00</td>
</tr>
<tr>
<td>4a.</td>
<td>Driving Piles.</td>
<td>3,160</td>
<td>lin. ft.</td>
<td>10-00</td>
</tr>
<tr>
<td>5.</td>
<td>Cut back piles and pile cap.</td>
<td>92</td>
<td>No.</td>
<td>20-00</td>
</tr>
<tr>
<td>6.</td>
<td>Concrete in Abutments.</td>
<td>241</td>
<td>c. yd.</td>
<td>150-00</td>
</tr>
<tr>
<td>7.</td>
<td>Concrete in Piers.</td>
<td>765</td>
<td>c. yd.</td>
<td>150-00</td>
</tr>
<tr>
<td>8.</td>
<td>Bearing block assemblies.</td>
<td>1.2</td>
<td>ton</td>
<td>800-00</td>
</tr>
<tr>
<td>9.</td>
<td>Anchor bolts, nuts etc.</td>
<td>0.9</td>
<td>ton</td>
<td>1,200-00</td>
</tr>
<tr>
<td>10.</td>
<td>4&quot; diameter G. W. I. pipe.</td>
<td>40</td>
<td>lin. ft.</td>
<td>4-00</td>
</tr>
<tr>
<td>11.</td>
<td>Reinforcing bar.</td>
<td>89</td>
<td>ton</td>
<td>400-00</td>
</tr>
</tbody>
</table>

**SUB TOTAL A:** $266,426

### (B) SUPERSTRUCTURE.

<table>
<thead>
<tr>
<th>Item</th>
<th>QTY.</th>
<th>UNIT</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.</td>
<td>Multi layer bearings</td>
<td>16</td>
<td>No.</td>
<td>250-00</td>
</tr>
<tr>
<td>13.</td>
<td>Steel plate girders and cross girders.</td>
<td>280</td>
<td>ton</td>
<td>700-00</td>
</tr>
<tr>
<td>14.</td>
<td>Reinforced concrete.</td>
<td>670</td>
<td>c. yd.</td>
<td>120-00</td>
</tr>
<tr>
<td>15.</td>
<td>C. I. Kerb outlets</td>
<td>42</td>
<td>No.</td>
<td>450-00</td>
</tr>
<tr>
<td>16.</td>
<td>Reinforcing bar.</td>
<td>82</td>
<td>ton</td>
<td>400-00</td>
</tr>
<tr>
<td>17.</td>
<td>Deck expansion assemblies</td>
<td>3</td>
<td>ton</td>
<td>1,000-00</td>
</tr>
<tr>
<td>18.</td>
<td>Deck gap assemblies.</td>
<td>1.5</td>
<td>ton</td>
<td>1,000-00</td>
</tr>
<tr>
<td>19.</td>
<td>Footwalk expansion assemblies.</td>
<td>1,000</td>
<td>lb.</td>
<td>1-00</td>
</tr>
<tr>
<td>20.</td>
<td>Kerb expansion assemblies.</td>
<td>470</td>
<td>lb.</td>
<td>1-00</td>
</tr>
<tr>
<td>21.</td>
<td>Acme tube to deck gaps.</td>
<td>1,400</td>
<td>lin. ft.</td>
<td>15-00</td>
</tr>
</tbody>
</table>

**SUB TOTAL B:** $196,000

**TOTAL A and B:** $47,296

Cost/sq. ft. = **647,296** = **$24-16**

(A and B) **38 x 705**
APPENDIX A
KATHERINE RIVER BRIDGE
PRELIMINARY ESTIMATES CONT'D

(c) UNDERPASS.

1. Concrete in Abutment and additional Main bridge concrete.
   QTY.  UNIT  RATE  AMOUNT $
   150  c., yd.  150-00  22,500

2. Abutment Reinforcing bar.
   QTY.  UNIT  RATE  AMOUNT $
   13  ton  400-00  5,200

   QTY.  UNIT  RATE  AMOUNT $
   95  c., yd.  120-00  9,300

4. Deck reinforcing bar.
   QTY.  UNIT  RATE  AMOUNT $
   12  ton  400-00  4,800

5. Excavation.
   QTY.  UNIT  RATE  AMOUNT $
   935  c., yd.  3-00  2,805

   QTY.  UNIT  RATE  AMOUNT $
   76  lin. ft.  15-00  1,140

Cost / sq. ft. = 45,745 = $31-6
   38 x 38
Looking North West across the River towards Darwin approximately on line.

Main Channel of Katherine River and railway bridge.
Looking U/S from Railway Bridge across the proposed bridge site.
POSSIBLE ROAD CROSS SECTION OF STUART HIGHWAY AT KATHERINE OUTSIDE C.B.D.

DRG. NO. G294

FIG. 2
POSSIBLE ROAD CROSS SECTION
IN KATHERINE C.B.D. (3 BLOCKS)

DRG. No G295

FIG. 3
RECOMMENDED STAGE 2
LAYOUT FOR STUART
HIGHWAY THROUGH KATHERINE
SCALE: 1'-200'-0'
DRG. NO 6298 FIG.6
KATHERINE RIVER BRIDGE
PROPOSED LONGITUDINAL SECTION
(GROUND LEVELS FROM SURVEY ON PROLONGATION)
of Katherine River,
SCALE: HORIZONTAL - 1:100000
VERTICAL - 1:1000

DRG N° G299
FIG. 7
KATHERINE RIVER BRIDGE

TYPICAL CROSS SECTION

SCALE: 1" = 10'-0"

DRG. NO 6300

FIG. 8