5/5/2/9

DECEMBER 1941

ORIGINAL

HEADQUARTERS R.A.E.

I CORPS TROOPS

APPENDICES

AUSTRALIAN WAR MEMORIAL

NOTICE OF FOLIO REMOVAL

AWM52 5/5/2/9

Folios 52, 55, 56

The folios to which this notice refers are wholly exempt under the Archives Act 1983, Sections 33(1)(a) and 33(1)(e)(iii), as they contain:

(a) information or matter the disclosure of which under this Act could reasonably be expected to cause damage to the security, defence or international relations of the Commonwealth; or

(e)(iii) information or matter the disclosure of which under this Act would, or could reasonably be expected to endanger the life or physical safety of any person

Stuart Bennington
Curator Official Records

25 January 2019

To :- CRE I AUST CORPS TPS

From :- O.C. 2/15 AUST A FD COY RAE

REPORT ON

<u>HUTTING</u>

24 DEC 41.

..................................MAJ.
O. C. 2/15 AUST A FD COY RAE

REPORT ON HUTTING

PRELIMINARY :-

1. In order to provide winter accomodation for the elements of 1 Aust Corps in Syria a large scale program of hut fabrication and construction was initiated early in Sept 1941.

The 2/15 Aust A Fd Coy was detailed to supervise the construction of hutting in the TRIPOLI, BEKAA and BEIRUT areas.

Only 500 Nissen type huts, capacity 8000, were available of Indian manufacture. These cover an area 36' X 16' and are of a circular design with double sheathed corrugated walls mounted on tee iron ribs and timber base plates. They were largly used in France during the first winter and were allotted in Syria to the higher altitudes of the BEKAA valley.

To provide the remaining accomodation a design was prepared by CE I Aust Corps for a sectional hut of two sizes, the " A " type 81' X 18' and the " B " type 27' X 18'. The framework for the side walls consisting of 9'0" panels 8'0" high of 3" X 2" with end frames of two sections of similar material, the whole roofed and sheeted with corrugated galvanised iron. The circular roof, 10'0" radius, in three segments bolted together was self supporting and thereby ensured economy in timber which was not plentiful.

The design of the framing in panels enabled pre-fabrication in workshops by mass production, which saved considerable erection time on the site.

A drawing showing details of the design is attached as appendix I.

2. **SCALE OF ACCOMODATION :-** A scale of accomodation was laid down for down for major and minor units as shown in attached appendix 2. In these categories units in excess of 450, such as Inf Bns, Fd Regts etc, became major units and Fd Coys, Fd Amb etc, minor units. This scale was amended for special cases. It was further ordered that units located higher than 1000ft would be provided with sleeping huts and others tents.

In addition to huts, latrines, ablution benches and water tanks were provided on a suitable scale.

In terms of areas the following approx requirements indicate the extent of construction required.

AREA	" A " HUTS	" B " HUTS	NISSEN HUTS	FLOOR AREA
TRIPOLI	100	200	-	250,000 ft^2
BEKAA Valley	150	200	400	555,000 "
BEIRUT	10	60	20	55,000 "
TOTAL	260	460	420	860,000 "

Special installations for F.S.Ds and F.A.Ds were also required. The former consisted of a modified A type hut with the centre panel removed and a 9' 0" sliding door substituted for stores. The latter constructed of excavated pits located in hill side sites having a floor area 30' X 12' and covered with curved CGI 6'0" radius supported with timber framing. (See drawing appendix 3.)

3. **CONTRACTS :-** Contracts for the erection of the hutting were let for the sectional hutting and Nissen hutting seperately. The accepted prices were as follows :-

A HUTS	£S 80	each
B HUTS	£S 50	"
NISSEN	£S 70	"

These prices included excavation or fill of 6" for foundations and levelling of sites for the floor area and one metre all round. The cost of camouflage painting is included in the above.

3. CONTRACTS Contd.

After a period with a practiced gang it was found th that contractors constructed at the following rates :-

A HUTS	50 Man/hours
B HUTS	20 Man/hours
NISSEN HUTS	20 Man/hours

In regard to plant and supervision the same difficulties were present which seem common to all contracts in this country.

It was found impossible to ensure accuracy in times of completion or punctuality of work. Owing to the difficulties of retaining labour during the cold weather the schedules for completion of camps in the BEKAA valley became impossible to realise and the construction was completed by sappers. One sec was attached to this coy from 2/1, 2/2, and 2/16 Fd Coys in order to realise the schedule.

4. CONSTRUCTION SECTIONAL HUTTING :-

(a). Foundations. As far as possible the sites for huts were located on slopes varying from 1-20 to 1-30 for drainage. The foundations therefore became either cut and fill or fill on the lesser slopes. The panel points were fixed on petrol tins filled with concrete with hoop iron straps grouted and extensions nailed to the studs of the framing. In the cases of larger slopes, tiers of up to four petrol tins, with bottoms removed, were used as a pile, the base excavated and grouted.

(b). Side and End Frames. After some experience, it was found expedient to nail the CGI sheeting to the connected side and end frames flat on the ground, then raise and connect in position. The light framing was thereby stiffened for movement and prevented nailed joints springing.

(c). Roofing. The roofing segments were delivered by sheets to the sites and then bolted together for mounting which was carried out on a temporary ridge structure to prevent initial buckling.

(d). Flooring. Concrete slab tiles 18" X 18" X 2", mix 1 : 1½ : 2½ were used for floors. They were manufactured at factory centres at TRIPOLI, BEIRUT and DAMASCUS and transported to sites. These have proved satisfactory and add enormously to the comfort and cleanliness of the accomodation. In all some 800,000 slabs will be provided.

(e). Constructional Failures. In the BEKAA valley during construction high wind velocities were experienced, causing the destruction of a number of completed and partially completed huts.

A detailed investigation into the causes of failure revealed -

(i) Weakness of nailing of tie beams causing fracture in long grain with consequent collapse of sides.
(ii) Springing of roof caused by aerofoil stressing of curves in high wind conditions. This effect produced lifting of roof edges nailed to framing and complete destruction of roofs.
(iii) Lifting of roofs due to overhang of ends.

These effects were countered by -

(i) Hoop iron strapping of joints between tie beams and studs at panel points.
(ii) Complete tying down of huts with wire straps over roof and connected to angle iron pickets.
(iii) Diagonal wire bracing at tie beam plane between alternate panel points and end timber knee braces.
(iv) Turning and nailing of end overhang of roof
(v) Additional nailing of roof.

These measures have so far been effective. Appendix A

(vi) Ridge
(vii) Outside strips bolted [illegible] roof down to top plate

5. CONSTRUCTION NISSEN HUTTING :- The construction presented no difficulties. If available this design would constitute a complete answer to rapid hutting problems. The components are light, easy to handle and erect. It has been proved that Inf working parties under sapper supervision can construct readily as no tools are required other than spanners which are included with the huts.

6. STORES :- The stores problems during this project were by no means small. Constant checking was found necessary owing to the number of times material had to be handled, often three times by M.T. and once by rail before arrival at the site.

In particular the NISSEN hutting deliveries caused difficulty in realising schedules due to haphazard loading of components from base. It is submitted that the solution to this type of stores problem is the posting of a representative of the constructing unit at the source of supply with power to ensure deliveries of components as required.

7. CONCLUSIONS :- During the construction excellent opportunity was available for the sappers to carry out works responsibility which were accepted fully with credit.

Many incidents occurred of unit officers approaching personnel from sappers upwards and attempting to obtain priorities and extra accomodation by methods varying from persuasion to " bulldozing ". These were treated with patience, tact or amusement according to the circumstances.

CE 1 AUST CORPS
6. 9.41

S. W. A. SCALE OF HUTTING.

Note 16A = 40N

Appendix 2.

MAJOR UNIT

Men	31 N	@ 20 per hut	
Sgts	6 N	@ 10 " "	
Off	6 N	@ 6 " "	

For Personnel 43 Ns

EFI Store ⌶
Bn HQ & Q ⌶
Inst. ⌶ 1A each
Drying Room ⌶ = 6A
Officers' Mess ⌶
Sgts' Mess ⌶

Kitchen Off 1 ⌶
Sgts 1 ⌶ 1. BEACH
Men 2 ⌶ = 10Bs
Coy's HQs 5 ⌶
Gd Room 1 ⌶

Total 6A + 10B 43N

Latrines 200 ft run covered
Ablutions 100 ft run open
+ tanks
Meat Safes Ordnance

Drainage & Grease traps — to Cook-houses & ablutions

MINOR UNIT

Men 11 N @ 20 per hut
Sgts 2 N
Off 2 N
15 N

Cookhouse 3 ⌶
HQ 1 ⌶
Drying 1 ⌶ 8B
Gd Room 1 ⌶
Sgts' Mess 1 ⌶
Off Mess 1 ⌶

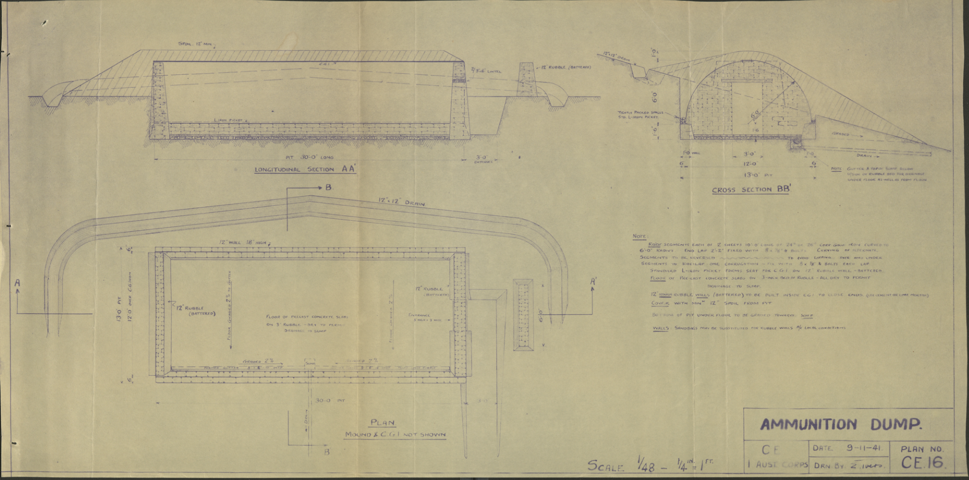
Total 8B — 15N

A = hut 81' x 18'

B = " 27' x 18'

N = N issen Hut 36' x 16'
(total available 500).

Div HQ	Billets
Bde HQ	Billets
Bde bath-house	Bldg.
Camp Hosp.	1A


SPOIL 12" MIN.
C.G.I.
2/3'-6" LINTEL
12" RUBBLE (BATTERED)
L-IRON PICKET
PIT 30'-0" LONG
3'-0" ENTRANCE
LONGITUDINAL SECTION AA'
12"×12" DRAIN
1'-0"
6'-0"
1'-6"
TIGHTLY PACKED SPALLS
STD. L-IRON PICKET
6'-0"
1-6
GRADED
DRAIN
1'-0 WALL
3'-0"
1'-0
6
12'-0"
6
13'-0" PIT
NOTE: GUTTER & TOP OF SUMP BELOW U/SIDE OF RUBBLE BED FOR DRAINAGE UNDER FLOOR AS WELL AS FROM FLOOR
CROSS SECTION BB'
B
12"×12" DRAIN.
12" WALL 18" HIGH
6"
13'-0" PIT
12'-0" OVER C.G.IRON
12" RUBBLE (BATTERED)
FLOOR GRADED 2% TO GUTTER
FLOOR OF PRECAST CONCRETE SLABS ON 3" RUBBLE - DRY TO PERMIT DRAINAGE TO SUMP
FLOOR GRADED 2%
12" RUBBLE (BATTERED)
ENTRANCE 3' HIGH × 3' WIDE
6'-0"
A
A'
GRADED 2%
GRADED 2%
SUMP
6"
30'-0" PIT
3'-0
DRAIN
B
PLAN
MOUND & C.G.I NOT SHOWN
NOTE:
ROOF SEGMENTS EACH OF 2 SHEETS 10'-0" LONG OF 24" OR 26" CORR. GALV. IRON CURVED TO 6'-0" RADIUS. END LAP 2'-2" FIXED WITH 8 × 1/8" [illegible] BOLTS. CURVING OF ALTERNATE SEGMENTS TO BE REVERSED [illegible] TO AVOID LAPPING. OVER AND UNDER SEGMENTS TO SIDE-LAP ONE CORRUGATION - FIX WITH 8 × 1/8" & BOLTS EACH LAP.
STANDARD L-IRON PICKET FORMS SEAT FOR C.G.I. ON 12" RUBBLE WALL - BATTERED.
FLOOR OF PRE-CAST CONCRETE SLABS ON 3-INCH BED OF RUBBLE - ALL DRY TO PERMIT DRAINAGE TO SUMP.
12" ROUGH RUBBLE WALLS (BATTERED) TO BE BUILT INSIDE C.G.I. TO CLOSE ENDS. (USE CEMENT OR LIME MORTAR)
COVER WITH MINM 12" SPOIL FROM PIT
BOTTOM OF PIT UNDER FLOOR TO BE GRADED TOWARDS SUMP
WALLS: SANDBAGS MAY BE SUBSTITUTED FOR RUBBLE WALLS A/C LOCAL CONDITIONS
SCALE 1/48 - 1/4 IN. = 1 FT.
AMMUNITION DUMP.
C.E.
1 AUST. CORPS
DATE 9-11-41.
DRN. BY Z. Ivers.
PLAN NO. CE.16.

APPENDIX "C"

CHEMIN DE FER DE DAMAS HAMA ET PROLONGEMENTS

SERVICE DE LA VOIE ET DES BATIMENTS

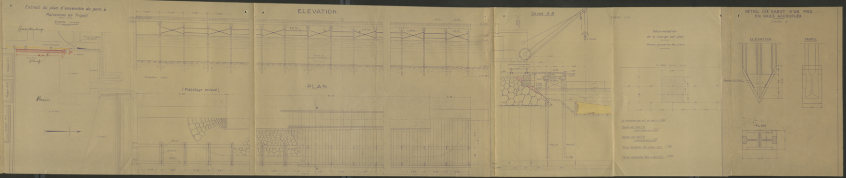
PORT A MAHONNES DE TRIPOLI

CONSTRUCTION D'UN APPONTEMENT DE 76m00 DE LONGUEUR A L'OUEST DU BASSIN

Beyrouth le 17 Novembre [illegible]
L'Ingénieur, chef du service
de la voie et des Bâtiments

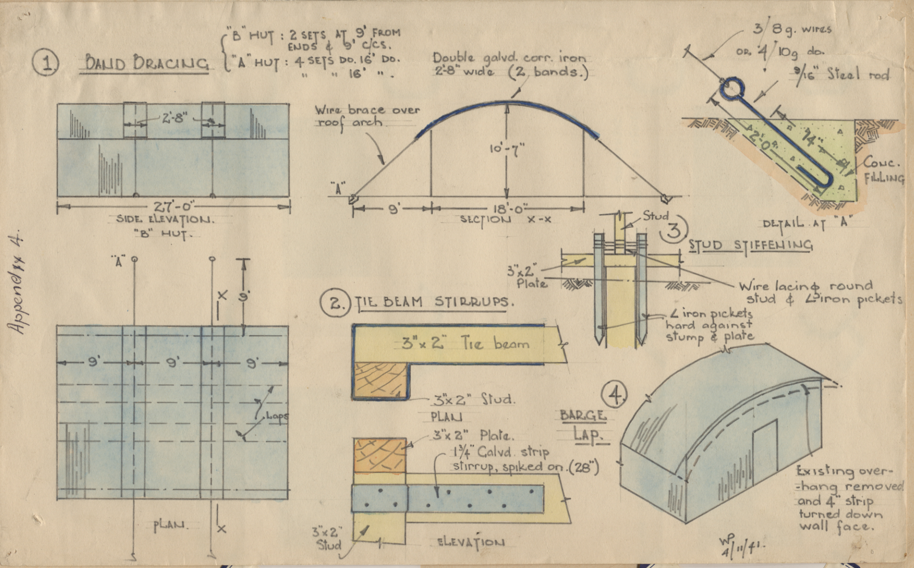
[signature]

N° 871



Appendix 3.

MJR. MEYER
C/O CRE CORPS TPS


Appendix 4.
1 BAND BRACING
"B" HUT : 2 SETS AT 9' FROM ENDS & 9' C/CS.
"A" HUT : 4 SETS DO. 16' DO.
" " 16' ".
2'-8"
27'-0"
SIDE ELEVATION.
"B" HUT.
"A"
X
9'
9'
9'
9'
Laps
PLAN.
X
Double galvd. corr. iron 2'-8" wide (2 bands.)
Wire brace over roof arch
10'-7"
"A"
9'
18'-0"
SECTION X-X
3/8g. wires
OR 4/10g do.
9/16" Steel rod
2'-0"
14"
Conc. FILLING
DETAIL AT "A"
Stud
3 STUD STIFFENING
3"x2" Plate
Wire lacing round stud & ∠ iron pickets
∠ iron pickets hard against stump & plate
2. TIE BEAM STIRRUPS.
3"x2" Tie beam
3"x2" Stud.
PLAN
3"x2" Plate.
1 3/4" Galvd. strip stirrup, spiked on. (28")
3"x2" Stud
ELEVATION
BARGE LAP.
4.
Existing over-hang removed and 4" strip turned down wall face.
WP 4/11/41.

1. NISSEN HUT. INSIDE SHEATHING

2. INTERIOR, A TYPE HUT

3 GENERAL HUTTING

4. NISSEN HUT. SUPPORT FRAMING.

ADDENDA TO SPECIFICATION FOR CULVERTS.

11. Excavate for Culverts, etc. Excavate for pipe culverts, wing walls, etc., as directed on site. Form bottom surfaces to required slopes, falls or levels, well ram finished surfaces, return, fill in and ram around culverts, wing walls, etc., and make good to ground, also make up road formation over culverts well consolidated to conform to and receive the road.

Remove surplus spoil where directed, spread and level.

12. Inspection of Trenches. Notice must be given to the C.R.E. when trenches are ready for inspection and before any concrete or pipes are laid.

13. Shoring Excavations. The sides of excavation shall be shored as required.

14. Cement. The cement will be provided by the Contractor, and will be purchased from civilian sources.
THE W.D. WILL NOT SUPPLY CEMENT.

The cement will be normal setting and the best obtainable and must be approved by the C.R.E. and the Contractor will provide samples if called upon to do so.

15. Sand, to be approved clean sharp sand free from organic matter or other impurities.

16. Aggregate to be clean approved hard broken limestone, free from clay, loam organic matter or other impurities, screened free from dust and as graded below:-

Medium aggregate to be made up of:

3 parts of 4 cms. broken stone,
$1\frac{1}{2}$ parts of 6 mm. chippings.

[illegible] for the C.R.E's

10. Junction between new roads and Existing Municipal or Government Highways. The Contractor shall join up new roads to existing highways to entire satisfaction of the Municipal Engineer or the Director of Public Works, as the case may be, and pay any necessary fees demanded by either body in connection therewith.

The Contractor shall secure from the Department of Public Works or from the Municipal Engineer Department as the case may be, all necessary permits for the construction of road junctions, culverts, drains or other work adjacent to or affecting public roads, and will be responsible for observing the instructions issued by the above mentioned public bodies.

N.B. Width of road, extent of hardstandings, gradient, camber and superelevation to be decided locally.

No provision has been made for culverts, bridges, etc., which will be carried out under separate arrangements.

F.H. SHERWOOD, LIEUT. R.E.
Surveyor of Works.
1st Aust. Corps Tps.

J.W. MAIN, LIEUT. COL.
C. R. E.
1st Aust. Corps Tps.

[illegible] SEPTEMBER 1941.

To :- CRE I AUST CORPS TPS

From :- O. C. 2/15 AUST A FD COY RAE

REPORT ON

CAMP ROADS

24 DEC 41.

A J Meyer ....MAJ.
O.C.2/15 AUST A FD COY RAE

REPORT ON CAMP ROADS

1. **PRELIMINARY :-** Consequent on the tactical location of troops, winter accommodation was required on an extensive scale in the TRIPOLI and BEKAA valley areas and also a small quantity in BEIRUT.

The necessary roads within the camp areas, including certain strategic laterals in the BEKAA valley area were let to contract in the middle of September and the task of supervising the contracts allotted to 2/15 Aust A Fd Coy.

The extent of the road work eventually expanded to approx 20 Km in the TRIPOLI area and 40 Km in the BEKAA valley area.

2. **CONTRACTS :-** Suitable contracts to cover these requirements were let under a specification drawn up by S.W. I Aust Corps. Details of contracts are shown in appendix 1.

The specification in brief consisted of a rolled sub-base, side drains, one metre shoulders, pavement 6" - 8" soling, chinked, rolled and then bound with fines added with water, and rolled again. The road was thus a simple Telford pavement without a surface course. The width was normally 5 metres with short lengths of 3 metres for single traffic.

It is understood that the intention was to produce a second class road with a solid base which could be improved if the necessity or duration of use demanded.

The average prices for this type under the contracts was £S 12 per metre run, made up of the following details :-

DESCRIPTION	PRICE
Excavation	1.70 M^3
Kerbs	1.00 MR
Completed Pavement	1.95 M^2

The contractors in Syria suffer from a lack of capable supervisors and a general inexperience of engineering projects. This difficulty is further magnified by the habit of sub-letting sections of the work which cannot be successful without strict supervision.

However, most of the initial errors in these contracts were made rather due to ignorance than intent and after some perserverance by the sappers and the supervising officers, good results were obtained.

Reccomendations for amendments on contracts are included in the conclusion para of the report.

3. **TRIPOLI AREA :-** In this area the camps were located largely in olive groves or cultivated ground with the emphasis on concealment.

In most cases these locations did not allow the best conditions for road making, particularly, in regard to the sub-base which was loose, difficult to consolidate and badly drained owing to the impervious nature of the clay loam subsoil and lack of suitable slope.

The stone was plentiful and of good quality ; the majority, however, had to be quarried.

Suitable filling material with good binding characteristics was difficult to obtain in the area. Some successful experiments were carried out with a combination of coarse sea sand and native lime. The supply of the latter, however, was inconsistent and the method could not be adopted generally.

Some of the camp roads in this area have already shown signs of subsidence after two months with traffic owing to loose base and rain and will probably need re-carpeting.

4. **BEKAA VALLEY AREA :-** The road problems in this area are not as serious as the former.

The camps were located on good drainage slopes and the subsoil although of a similar clay nature contains a quantity of natural stone which assists the base material.

The stone for soling is generally available without quarrying and good garvel fines are present although not plentifully.

The road developement here was more extensi consisting of several laterals to main ~~xxxxxx~~ roads and routes to supply and ammunition dumps.

5. **CONCLUSIONS :-**

(a) Plant Particularly in the BEKAA valley area the conclusion must be that had a small quantity of mechanical equipment consisting of a bulldozer, rooter plough power grader and power lo loader been available the work would have been completed much more rapidly and effeciently, using macadam or gravel types. The contractors were unable to providesatisfactory quantities of plant of any description. The lorries and rollers were insufficient and in bad mechanical condition.

(b) Labour Owing to the quantity of work proceeding in the area, the contractors were not able to obtain sufficient labour locally ; the importation of labour provedinconsistent and unreliable. In addition the cold weather late in November and early December causes a general exodus of imported labour and virtually stopped progress for some days.

Local labour under contractor control is quite effective however and produces good results on road building.

(c) Specification. The following ammendments are submitted as improvements in existing specifications :-

(i) Drainage by subsoil pipes or centre drains
(ii) Use of quarried stone for Telford base instead of natural smooth stone to increase binding grip.
(iii) Alteration of specification to provide for macadam or gravel types on sites where suitable materials are available in quantity.
(iv) Investigation of contractor's resources of plant before acceptance of tender.

(d) Supervision. The supervision of this work in Syria, owing to general inability of contractors, must always be placed in the hands of a thoroughly capable and determined officer. This coy is fortunate in having such personnel available. Some commendation is due to the individual sapper in the method of handling the supervision. Owing to the extent of the works under control long lengths of road were the direct responsibility of individuals.

(e) Photographs of roads are attached as appendix 2.

Appendix 1.

The exact location & extent of roads and hardstandings will be indicated on ground and where possible by drawings.

BRIEF SPECIFICATION FOR TAR-BOUND

MACADAM ROADS AND HARDSTANDINGS

E X C A V A T O R.

1. Site Clearing. Where required the area to be occupied by the road and hardstandings is to be completely cleared of all shrubs, bushes and other vegetation by grubbing up removal from site and burning.

2. Excavation for Roads & Hardstandings. Excavate over area and form bottom to gradients, camber and superelevation as directed to conform to the finished surface.

Fill in, well ram and consolidate any soft or defective spots in excavation with suitable hard material, to the satisfaction of the C.R.E.

(Formation of new roads and hardstandings to be rolled and any defective parts filled in with hard dry metalling, before soling is laid).

To sides of roads and hardstandings excavate trenches for spall kerbs, return, fill, ram and remove surplus spoil as directed.

3. Side Ditches. Excavate for, or form, side ditches to the extent indicated on site, on each or either side of the road or hardstanding as directed. Form bottom surface, trim and form neatly battered slopes. Surplus spoil to be disposed of as directed.

Ditches to be formed in such a manner and to such a depth so that the road bed shall be at least 12" (30 c.m.) above bottom of the ditch.

4. Form Berms & Embankments to Roads. Form berms and embankments with approved spoil as may be directed and to the extent indicated on the drawings or at site, well ram and consolidate in 25 c.m. layers including watering and rolling, or by other approved means, including trimming as work proceeds to the required slopes.

All berms to be constructed to the extent indicated on site and shall have a fall of 1 in 30 and the outer edges a slope of 1.5 in 1.

Material for the construction of embankments and berms may/shall be obtained from the excavation of roads and ditches and shall be properly consolidated by rolling or ramming as directed.

R O A D M A K E R.

5. Material for Roads & Hardstandings. All material shall be of good quality and approved by the C.R.E.

a) STONE. To be good quality hard limestone, basalt or other approved local stone, free from dust, loam, clay and other impurities, and shall conform to the following dimensions respectively :-

(I) Spall kerbs to sides of roads. Greatest dimension to be at least 30 cm and the smallest not less than 10 cm.

(II) Spall kerbs to sides of Hardstandings. Greatest dimension to be at least 25 cm and the smallest not less than 10 cm.

(III) Soling for roads. Greatest dimension to be 20 cm. and the smallest not less than 10 cm.

(IV) Soling for Hardstandings. Greatest dimension to be 15 cm. and the smallest not less than 10 cm.

b) Filler (or Hogging). To consist of limestone dust, quarry waste or weathered stone, kurkar sand, sandy loam or sand of approved quality possessing good binding qualities.

c) Blinding Material. Shall consist of hard limestone, basalt or other approved chippings broken to 5 - 15 mm gauge. (N.B.) Gauge of blinding material may be changed at discretion of C.R.E.

6. Spall Kerb. At the edge of roads and hardstandings hand pack spall kerb as Clause 5 A(II)with the greatest dimension of stones placed vertically. Spall kerb shall be rolled or rammed into position until no part projects above the finished road or hardstanding surface.

7. Soling. On the top of road formation and between spall kerbs, hand pitch soling as Clause 5 (a) to such gradients, camber or superelevation as may be directed, gauge pegs being driven in to indicate the thickness of soling to be laid. Soling shall be hand pitched to produce the maximum density, each stone being laid with its greatest area vertically. Where necessary irregularly shaped stones shall be shaped before being placed. Voids in the soling shall be properly "chinked" or filled in, as far as possible by means of spalls driven in, and projections shall be cut down with hammers. Irregularities appearing after rolling shall be rectified.

8. Filler. The whole of the surface of the soling course will then be covered with approximately 5 cms of the filler (or hogging) as Clause 5 (b), as much as possible being swept into the voids dry and the remainder by the addition of water and additional sweeping. This process is to be repeated until no more of the filling material can be absorbed into the voids in the soling course.

During this process rolling will be carried out with a suitable roller. Rolling will commence at the sides of the roads and hardstandings and will be worked to the centre.

Sufficient water shall be used to cause a slurry to be formed on the surface. Rolling will continue until the road is well consolidated to the satisfaction of the C.R.E.

9. Blinding. A blinding of chippings as Clause 5(c) shall then be applied to the surface obtained by the process described in Clause 8 at the rate of 1 cubic metre of chippings to 150 metre super of road or hardstanding surface.

This blinding is to be carried out immediately after the final application of the filler described above and whilst the road surface is still in a wet state.

Rolling with a light power roller shall then be continued until a hard compact wearing surface has been obtained to the satisfaction of the C.R.E.

1. LABOUE - LABOUE STN RD.

SOLING CAMP ROAD
2.

3. COMPLETED ROADS
E CAMP JDEIDE

4. COMPLETED CAMP
ROAD. SECTIONAL HUTTING
RIGHT

F

Army Forms A 3091 (Stout)

HUTTING ERECTION

uments. DEMOLITIONS

APPENDIX F.

CRE I Aust Corps Tps

AUSTRALIAN IMPERIAL FORCE. SECRET.

2/9 AUST.A.FD.COY.R.A.E.
17 DEC.41.

C.R.E.
I AUST CORPS TPS.
C.R.E.
7 AUST DIV.

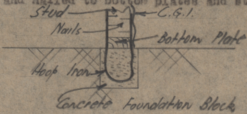
IN REPLY TO C.R.E.891.
REPORT ON ENGR WKS - SYRIAN OCCUPATION 15 JUL. to 31 DEC.41.
BY CAPT.N.T.JELBART.

OBJECT: To report on items of technical value discovered during the above period, for future work.

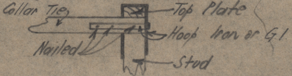
SUBJECT MATTER.

1. Hutting.

(a) Foundation Difficulty was experienced in obtaining firm connection to foundation blocks. A satisfactory method was found to be hoop-iron, strips of G.I. or Galv. wire firmly embedded in the concrete foundation and nailed to bottom plates and studs.



(b) TIMBER. Much timber used was of very poor quality and under snow load, some studs split for their full length. By wrapping hoop-iron round joint and nailing, the strength could be increased.



(c) ROOF. 9" to 1'8" of snow fell on the huts erected in this area. 16 of 19 Huts Types "A" and "B" at DM.IB collapsed.
The three that did NOT collapse had a tempory ridge pole and vertical toms in them for pointers.
Huts that were fully occupied in other areas did not collapse but showed severe signs of stress in C.G.I. roof and collar tie joints.
The huts that failed did so in two main ways:-

(1) The curved C.G.I. roof buckled and rested on collar ties without any other point failing.
(11) The curved C.G.I. roof thrust the walls out either splitting the stud or the collar tie, or dragging the nails out. The roof then buckled, broke the collar ties and dragged the walls inward.

CONCLUSION. Huts occupied are less likely to fail from snow load than unoccupied huts, presumably due to internal heat melting and shedding some of the snow. Huts built in snow areas should have their roofs strengthened or pitch increased.
RECOMMENDATION. Include a 4" x 1 1/2" H.W. ridge pole supported at each collar tie by (1) 3" x 3" H.W. vertical toms from floor, or (11) 3" x 2" diagonal struts from ridge and collar tie to wall stud in lieu of present knee braces.

(e)Ammonal. 37 tests were made with primacord straight into ammonal without primers or Dets.
Results. 3 tins of loose detonated after 3 months in site.

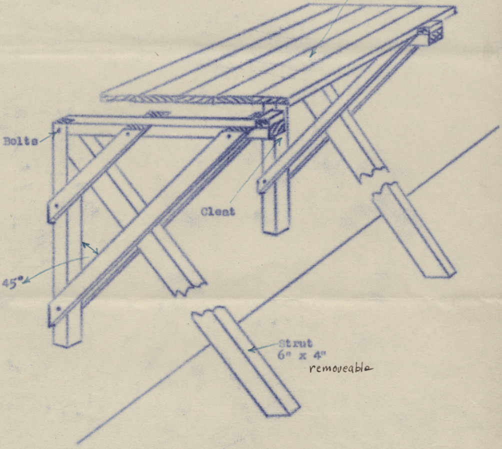
8 one lb charges partially detonated.
8 " " " Fully detonated.
8 out of 8 charges detonated when 1lb charges were disintegrated first by rolling cartridges under foot.

Conclusion. It is indicated that Primacord without a primer may be unreliable to detonate ammonal but is helped by kneeding charge first.
(f)Gun cotton exposed to weather could NOT be detonated in three out of five cases after three months exposure.

4.DUMPS.
(a)Selection of sites.(1)Caves are unsatisfactory for POL Dumps as fumes make them almost uninhabitable and very dangerous for fire.
(11)Orchards ,although providing apparently good concealment for dumps have so much traffic over the soft ground that they become most difficult to camouflage.
(111)A very satisfactory place is a wide open quarry.
(IV)Ammunition dumps are very satisfactory in good caves.
(V)Blast walls 6 feet ~~high~~ thick for ammunition dumps are suggested by A.A.D.C.to be provided to reduce possibility of sympathic detonation or mechanical detonation.
This has been used in one cave prepared ~~XXXX~~ as dump.

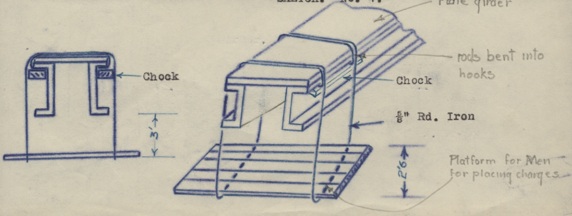
N.J. Jelbart ..CAPT.
A/O.C.2/9 AUST.A.FD.COY.R.A.E.

SKETCH No. 1.

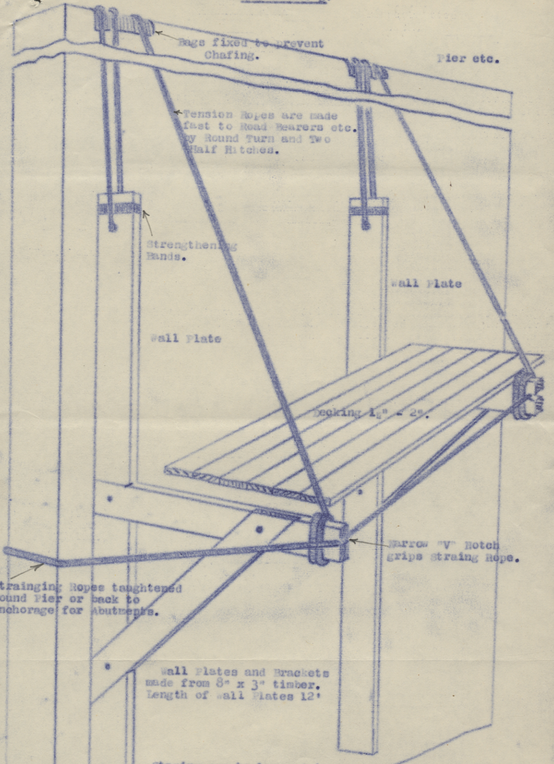


Constructed from 4" x 3" Timber. Time of erection two minutes.
Time of dismantling one minute.
Width of staging used was four feet six inches.

SKETCH. No. 4.



SKETCH NO. 3.



Staging can be lowered in one piece - which is quicker- by nailing decking on before lowering. Diagonal rope bracing - from ends of Wall Plates - strengthen structure for lowering into place. Time to place in position five minutes.

27 Nov 1941

Reports to O.C. 2/9 AUST A FD COY RAE on experiments carried out with Primacord by J. HASKER Lieut. RAE.

A.

1. OBJECT. To test the efficiency of detonation of Ammonal by Primacord alone.

2. METHOD. Primacord detonated by safety fuse and detonator, and end of Primacord placed in one of four four ounce cartridges of Ammonal. Four cartridges bound together and buried about one foot in the ground. Ammonal in most of cartridges had become hard and compacted.

CHARGE NO.	RESULT	REMARKS.
1	Successful	-
2	"	-
3	Only partial detonation of Ammonal occured, and possibly none.	~~XXXXXXXXXXXXXXXX~~
4	Successful	Earth well tamped
5	Only partial detonation of Ammonal occured and possibly none.	" " "
6	Successful	Ctges. rolled under foot and powder loosene
7	Successful	do do
8	Successful	do do
9	Successful	Earth well tamped but powder not loosened as above.
10	Partial Detonation	Earth well tamped but powder not loosened.
11	" "	Earth lightly tamped.
12	Successful	Earth lightly tamped & powder loosened as above
13	Partial Detonation	Powder not loosened.
14	" "	" " "
15	Successful	" " "
16	Successful	" " "
17	Partial Detonation	" " "
18	Successful	" " "
19	Partial Detonation	" " "
20	" "	" " "
21	Successful	" " "
22	Successful	Powder loosened.
23	Successful	" "
24	Successful	" "

NOTE. Primacord detonated in each case.

3. DEDUCTION.

CONCLUSION. As eight out of twenty-four charges were partiaially detonated, it seems that the detonations of these pound charges of Ammonal, by means of Primacord placed in the powder, is not reliable. The ~~xx~~ powder has become compacted and loosening of the powder seems to make the process more reliable.

4. CONCLUSION. The primacord merely acts as a detonator and a primer is necessary to ensure reliable detonation.

1600 hrs
26 Nov 41

J Hasker ....Lt. R A E.
2/9 AUST A FD COY.

49

B.

5. OBJECT. To test the efficiency of detonation of Ammonal with Primacord and dry guncotton primer.

6. METHOD. Primacord detonated by safety fuse and detonator, end of Primacord firmly fixed in G.C. primer. Primer and three and a half cartridges of Ammonal tied together and charges buried about one foot in the ground. Ammonal was hard and compacted and came from similar batch to that used previously without primer. Primers were of recent date of manufacture.

7. RESULT. Twelve charges were ~~xxxx~~ fired and all detonated successfully without any loosening of Ammonal powder.

8. CONCLUSION. Use of Primacord and Gun Cotton primer is reliable even when Ammonal has become hard and compacted.

2200 hrs.
26 Nov 41

J Masker ....LT. R A E.
2/9 AUST A FD COY.

48

Time 1400
Date 6 Jan
No. CRE 1505 R.

12 day Delay noted

Appendix G

WATER SUPPLY FROM BOREHOLES

SYRIAN OCCUPATION I5 SEP. to 3I DEC. I94I

W.FRAME CAPT.
I JAN 42.

App.II

Drilling Times.

Hole No.	Location	Depth Ft.	Total Time. Hours	Total Time. Feet per Hr.	Drilling Time. Hours	Drilling Time. Ft. per Hour.	Remarks.
I.	Meskene	I5I	84	I · 8	42	3 · 6	Hole abandoned
2.	Meskene	I00	II6	·86	42	2 · 38	
3.	Minnik	74	92	·8	38	I · 99	
4.	Rasin-el aboud	65	I44	·45	34	I · 9	
5.	Koussier	323	576	·56	I90	I · 7	
6.	Katana	342	504	·68	370	·92	
7.	Katana	50	I00	·5	40	I ·25	Hole incomplete at time of report.
8.	Bab-el-Hadoua	342	336	I · 0I	98	3 · 5	Hole abandoned.
9.	Bab-el-Hadoua	32	29	I · I	I4	2 · 3	Hole incomplete
I0.	Affiche	365	264	I · 4	I27	2 · 9	
II.	Irbid.	66	I68	·4	6I	I · 08	Hole incomplete

Total Time :From arrival on site until completion of hole, but Excluding installing of pump, and testing supply.
Drilling Time: Actual working hours of Rig.

APP.I.

Detail of Boreholes.

Hole No.	Location	Purpose	Commen.	Completed.	Hole Size inches.	Hole Depth Ft.	Yield Gals/Hr.	Salinity Parts/100.000.	Remarks.
I.	Meskene 35346I	Aerodrome.W. Supply.	I5 Sep.	I8 Sep.	9"	I5I'	600.	50.	Aerodrome site abandoned by 7.C.R.E. Aerodromes.
2.	Meskene 363455	A.W. Supply.	20 Sep.	2 Oct.	I0"	I00'	II00	40.	II00 Gals per Hr. was the Max. output of pump no depression in W.L. at this rate.
3.	Minnik. 272507	A.W. Supply.	3 Oct.	I4 Oct.	I0"	74'	650	25.	Depression of 8'-0" in W.L. at 650 gall/hr.
4.	Rasin-el-aboud 32I470	A.W. Supply.	I5 Oct.	24 Oct.	I0"	65'	II25	I5.	II25 Gals per hr. was Max. output of pump no depression in W.L. at this rate.
5.	Koussier 228.289	A.W. Supply	28 Oct.	24 Nov.	I0"-I20 8"-323	323'	960	5.	960 Gals. Per Hr. was Max. output of pump no depression in W.L. at this rate.
6.	Katana I85.I69	Camp W. Supply.	2 Dec.	2I Dec.	I0"	342'	Nil.	-	Hole abandoned.
7.	Katana	Camp W. Supply	23 Dec		6"	50'	-	-	Prospecting Hole, not yet complete.
8.	Bab-el Hadoua 24747I	A.W. Supply.	27 Oct.	4 Nov.	I2"	336'	Nil.	-	Hole abandoned.
9.	Bab-el Hadoua 24747I	A.W. Supply.	29 Dec.		I2"	32'	-	-	Hole not yet Complete.
I0.	Affiche 246443	A.W. Supply.	I8 Sep.	I3 OCT.	I0-265 8-365	365'	960	5.	960 Gals/Hr. was Max. output of pump no depression in W.L. at this rate.
II.	Irbid.	Camp.W. Supply.	2 Dec.	-	II"	66'	-	-	Hole not yet Complete.

A.W.Supply (Aerodrome Water Supply)

Eng Wks -Syrian Occupation I5 Sep to 3I Dec.4I

O.C.I Aust Boring Sec.R.A.E. to C.R.E. I Aust C.Tps.

I Jan.42.

Map Ref.Levant I:200.000

Subject- Water Supply from Boreholes.

A total of eleven holes were sunk during the above period and were mainly for Aerodrome Water Supply,of the eleven holes, six were productive,one non-productive,two abandoned and three not completed at date of this report. (App.I).

Plant. Three plants were used ,one rotary and two percussion rigs,The Keystone Plant which is the lightest and most mobile produced the greatest footage.
For detail of plant see App.IV.

Hole sizes The Diam. of the holes were dependant on the size of the casing available which was usually 8" inside Diam. and 9I/2" outside Diam. necessitating a I0" Diam. Hole.
Depth varied from 65' to 365'.

Quantity.
In all holes in the northern area an abundant supply was obtained,in no case was the test pump used capable of coping with the "make",the tests were carried out over 24 Hrs.with a Climax Recip. deep well pump rated at I000 Gals.per hour from 250Ft.
One hole only that at Katana in the central area abandoned because of "No Supply"

Quality
Two tests of quality were carried out on each bore.
A.Horrocks Test.
B.Salinity Test.
A;In every case a reaction was obtained in the first cup/
B.The salinity varied between 5:I00.000 and 50:I00.000 the highest salinities being found to the east of Alleppo.

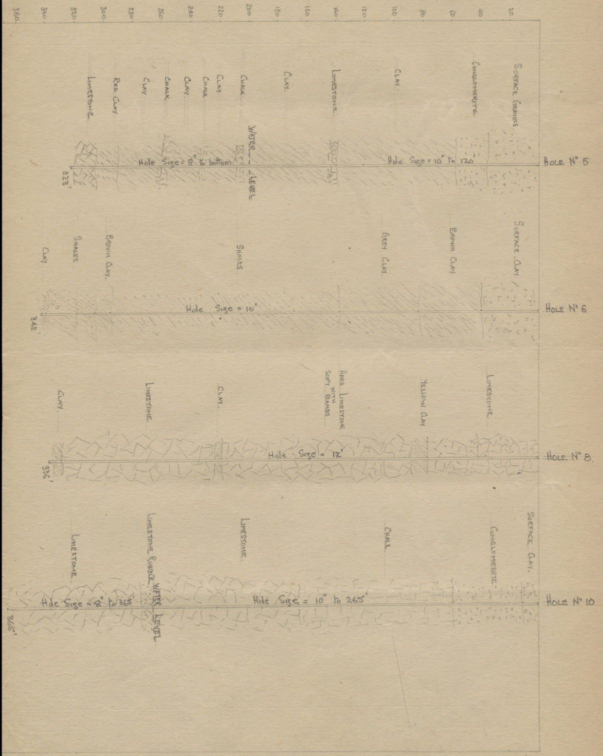
Drilling Times. (App.II.)
The drilling times varied with the nature of the ground,the slowest drilling being in clay and the Fastest in limestone.

W. Keane
.........................Capt.
O.C.I Aust Boring Sec R.A.E.

APP. III

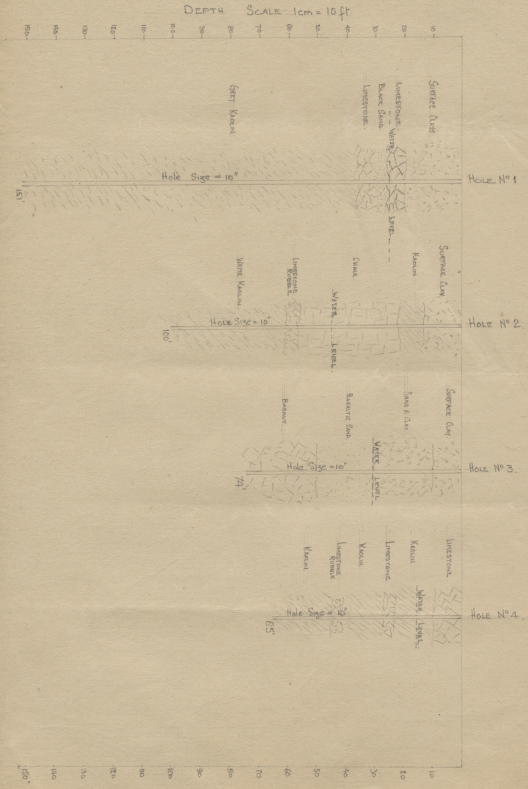
SECTIONS OF BOREHOLES

DEPTH SCALE: 1cm = 20ft.



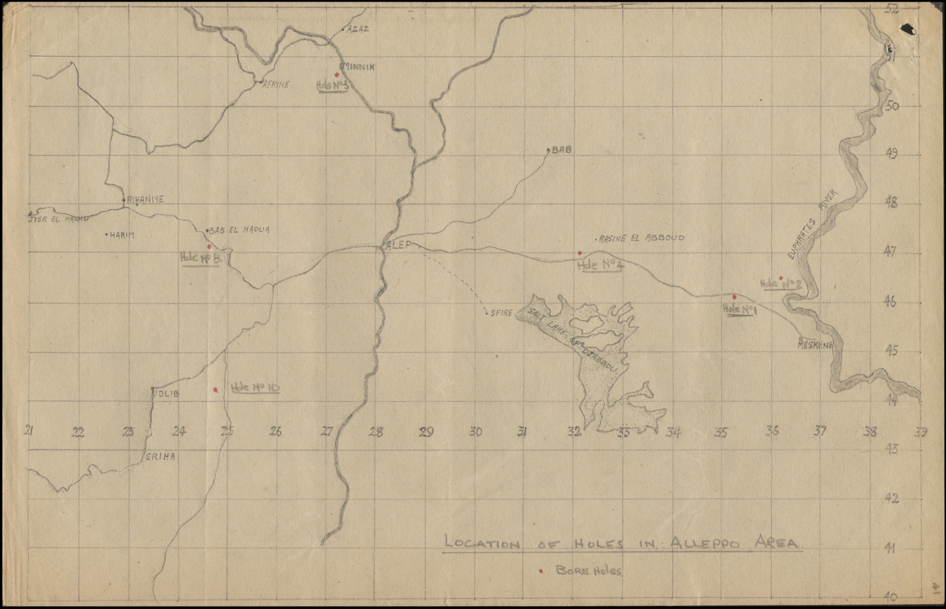
APP. III

SECTIONS OF BOREHOLES



Details of Plant. App.IV

Type	Make	Capacity	Rating	Mounting
Rotary	Portable Rig Coy.	36" Hole 1750 Ft.	140 H.P.	8-3 ton Trucks.
Percussion	Clyde Iron Works.	18" Hole 600 Feet.	31-34 HP	Trailer
Percussion	Keystone Drilling Coy	12" Hole 350 Ft.	16 HP.	International 3 Ton Truck.


LOCATION OF HOLES IN ALLEPPO AREA
Bore Holes
AZAZ
MINNIK
Hole No 3
AFRINE
BAB
RIHANIYE
JISR EL HADID
HARIM
BAB EL HAOUA
Hole No 8.
ALEP
RASINE EL ABBOUD
Hole No 4.
EUPHRATES RIVER
Hole No 2
Hole No 1
SFIRE
SALT LAKE OF DJABBOUL
MESKENE
IDLIB
Hole No 10
ERIHA
21
22
23
24
25
26
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40

Army Forms A 3091 (Stout)

C

H

ocuments.

MAIN ROADS

Appendix H.

closures.

CE (Works) Syria

Contract CE/140 - Tell Beach

1 This contract originally reported by C.E.P. T.J. to amount to £P.150,000 (excl. Head. Buseum. 22(4) of Crédits to on Alep-Katma Rd) & to be completed in 2 months.

Measurement of work to be executed should £P.204,000 (including items mentioned above) which checked by Inspector R.W.D.s. Late contractor was compensated for this decision - allotment of work on Damas-Deraa rd under C.R.E. Works.

Work actually carried out by contractor £P.180,000 in four months in Aust Corps Area & approx in Homs area to date £P.50,000.

2. Cash payments to contractor were specified at £P.20,000 on commencing work & £P.25,000 per fortnight thereafter the arrangement for holding a percentage on final payment against a guarantee period appears.

A penalty clause of £P.250 is noted - this is rather below the usual amount for a contract of this size.

3. Cash payments to contractor have been made to date

£P.145,000 on a/c Aust Corps Area } Total
£P.50,000 on a/c Homs Area } £P.195,000.

4 Extra charges are summarized (provisionally) in Appendix A (Rollers, vehicles etc) & amount to approx £P.37,000. Penalty clause enforcement recommended at £P.250 per day as submitted on 28 Dec & approx (the same period) £P.16,000.

War Diary

5 Extras demanded by contractor will be shown on final submission on 26 January.

6 Financial Statement

Work done Aust Corps Area	£P 180,000	
Work done Third Area	£P 70,000	£P 250,000
Contra charges Aust C Area	£P 37,000	
Penalty recommended	£P 16,000	
Payments made Aust Corps	£P 145,000	
Total	£P 50,000	£P 248,000
Balance in favour WD		£P 2,000

7 Material & Plant is in accordance with Schedule B attached

8 Final Submission

This will be completed & available at HQ 2/14 Aust Fd Coy by 2400 hrs 25 Jan in charge of the Div Supervising Officer, who thereafter will forward it to you if not previously seen by SORE this. The latter I beg to advise.

This will include

(a) Measurement Books

(b) Abstract

(c) Other relevant information including list of repair work

Copy to CE 1 AUST CORPS
7th CRE HQS
7th CRE WKS
SAR. SUPER OFFICER
WAR DIARY

Contract No CE/40 Albert Chamoun & Fils [37]

Bonch

The following items chargeable to the contractor have been misdisregarded & are set out under

A/ MT Hire charges (WD vehicles)

B/ Plant

C/ Wasted materials

D/ Repairs to contractors plant by WD personnel

E/ Extra acct

A/ 8 SEP 41 to 3 JAN 42 3451 truck days at LP5 — LP 17255.000

Note. From period 8 Sept 41 to 20 Dec 41 contractors record shows a discrepancy of 68 truck days also a further 270 truck days of vehicles carrying machinery back & forth which he claims should NOT be charged against him the total: would be 3113 truck days & at LP5 the debit LP 15565

B 28 AUG - 20 DEC 41 2754 Roller days at LP 3.25 — LP 8950.500

21 DEC - 16 JAN 42:-

Note. A correct record of roller days over this period is not available a fair charge could be made over the period by reckoning an average of 10 Rollers over 8 days as large portion of this time road under rain & wet conditions — 80 Roller days — LP 260.000

C These consist of chiefly

Bitumen 80/100

Cement & Reinf steel

Bitumen 64 drums [illegible]

Cement 137 bags (50k)

Reinf steel 3 cwt.

D. Schedule of Repairs & Contractor's Plant compiled by Major [illegible] and is appended hereto, duly signed & approved by Mr [illegible] representing Contractor.

8 Sep. - 13 Nov 41

3144 man hours at

14 Nov. - 11 Jan 42 Nil.

E. Contra A/cs

Bill No 1 rendered 15 Dec 41
approved by Maj J C [illegible] Smith
also did not agree to Contractor's Prop.

Petrol - fuel & oil & lubricants
Flow 1568 lb at — L.L.S. 13,541.39

F. Additional charges are also to be made against Contractor for (a) Explosives.

(a) Gelignite 1600 lb at £6.8.0 per 50 lb — £204.16.0
Dets No 27 2525 at £15.15.0 /1000 — £114.18.0
Safety fuse 7296 ft at 6/- /100 ft. — 7.4.0
— A £327.15.0

(b) Cement issued by 23 Aust C. Fd
Park Coy from Baalbek dump for setting up crusher. 42 bags (50 Kgs)

(c) Bolts & Nuts
1" x 22 - 10
½ x 7½ - 5
¾ x 4 - 19
34 bolts only of average £1.14.0

(d) Medical Treatment to Contractor's Labour
56 Medical Attns @ 50 each - £ 2800 [illegible]

G. Deduction for [illegible] vide [illegible] 243 from 2 Jan 7 [illegible]
[illegible] 15 Dec

35

Army Form C.2128
(Pads of 100.)
(Revised Sept. 1936.)

MESSAGE FORM.

RECEIVED
1500
10 JAN 1942
File No.
C.E. 1 AUST. CORPS.

CALL AND INSTRUCTIONS.		No. of Groups	Serial No.
IN	Time 1400 Date 5 Jan 42 File No. GF 1428	GR.	OFFICE DATE STAMP
OUT			

(ABOVE THIS LINE IS FOR SIGNALS USE ONLY.)

TO ~~AA~~ CRE 1 Aust Corps Tps

FROM	Originator's Number.	Date.	In Reply to Number
2/14 Aust A Fd Coy	RT 3/6	3 Jan	–

Notes on Engr works SYRIA forded 2 Jan ⊙ Will you please note the following corrections ⊙

page 1. Labour – last line 1st para m$90 – Should read P£5,90 ✓

Following line 1940 Summary read 1941

CRE for info.

Amended a.g. 10/1/42.

SoRE

Correction to Eng. Wks. Summary

This message may be sent AS WRITTEN by any means:

Signed H.J. Thompson Capt

If liable to be intercepted or fall into enemy hands, this message must be sent IN CYPHER.

Signed

Originator's instructions
Degree of priority.

Time of origin

(BELOW THIS LINE IS FOR SIGNALS USE ONLY.)

System In.	Time In.	Reader.	Sender.	System Out.	Time Out.	Reader.	Sender.	System Out.	Time Out.	Reader.	Sender.

T.H.I.

T.O.R.

WILKE & CO.—8/40.

34

Notes on Engr. Works, SYRIA - July to Dec 1941.

by Senior Supervising Eng. Contract CE/40
Capt R Tompson RAE.

General.

The period of occupation of SYRIA from July to December 1941 was marked by a very large and very rapidly inaugurated programme of construction works. These works embraced defences, road construction, bridges, hutting and camps, dock and harbour works, aerodromes and railway construction.

In addition to the construction programme all maintenance and operational services, such as supply, railway transport, road maintenance, were greatly inflated. These conditions imposed a severe strain upon the civil resources, which had developed in accordance with a moderate normal public and private expenditure. The effect of this was only too clearly felt in the works programme and the engineering technical problems were merely a part of the difficulties which constantly confronted officers engaged in the supervision of these works.

Labour.

Until the end of August or the middle of September the labour market presented no difficulties; work was available in moderate amount after a lean and difficult period, and labour was fairly readily obtained. Nevertheless even at this stage Contractors were obliged to offer higher rates of pay in some areas where the villages were small and the claims of the local Public Works authority and the Contractors conflicted. Whereas the normal rate of pay for a labourer was m.s. 70-75 per day, Contractors were sometimes offering up to ~~m.s.~~ P.L.S. 90.

Towards the latter part of September ~~1940~~ 1941, as preparations commenced for winter accomodation, defences and other works, the demand frequently exceeded the available supply. This difficulty was increased to some extent by local objections against people belonging to one village working in the area of another and in one instance representations were made for a postponement of the work until other works (upon which the local people were engaged) were completed.

Transport restrictions limited the number who could be carried to the job and in many places camps were established. In the warmer period the people slept in the open.

Competition for labour between contractors became fairly keen but it is understood that there was a general agreement between contractors to stabilize wages. To what extent this was observed faithfully is not known but the rates were generally higher than normally payable by Public Works authorities. One more enterprising contractor opened a store on his works for the sale of food, available to his own employees only, and this ruse succeeded in attracting over three hundred workers from a neighbouring job. Another artifice employed was to pay standard wages but to shorten the working hours.

As the result of all this the Supervising Officers were constantly spurring on their contractor to greater enterprise and beneficence in an endeavour to maintain the output.

Food.

Shortage of food stuffs, especially flour and wheat (the staple commodities) was very pronounced after the end of August. There seems to be reason to believe that this shortage was due to attempts to raise prices by local speculators. The position became acute and it appeared that unless active steps were taken to relieve the situation it would be difficult to keep the works going. Arrangements were therefore made for the Contractors to purchase flour for re-sale to the workers, and this in turn involved certain serious political difficulties. The sources of supply of flour for the principal road works were in SYRIA and political opposition was raised to the transfer of any portion of this to LEBANON. Satisfactory arrangements were finally made, after considerable trouble, but it was stipulated that only W.D. transport should be used for the conveyance of the goods.

Transport.

Until about the middle of September civilian vehicles were available in moderate numbers, though insufficient for the rate of progress demanded. This transport was supplemented by Army vehicles which were supplied to the Contractor (with Army drivers) on hire.

About the end of September, however, difficulties started to occur. The civilian vehicles were for the greater part old and these started to break down; spare parts were frequently unobtainable, tyres were very scarce and such as were available in the country were under control and very costly.

Accordingly in order to keep the work going, the Army made available an increasing number of lorries to the Contractors until eventually nearly fifty were constantly employed. These vehicles gave splendid service and , like the sappers engaged on direct supervision, knew no limit to working hours. Local camps were established at a number of places, in conjuction with the supervisions, from which these lorries operated.

Construction plant.

It was provided in the contract that the War Dept. would supply road rollers for the works and this (with other matters of supply) became the responsibility of R.E. Stores Branch, with a liaison officer on the Staff of C.E. 1 Aust Corps. The whole resources of the country were mobilized but heavy demands were also imposed for aerodrome construction and the numbers of rollers finally available was substantially less than the original expectation. Moreover such as were obtainable were for the most part old and badly worn and broke down at frequent intervals. Maintenance of the rollers was undertaken by 1 Aust Corps Tps and a permanent organization was established. Regular maintenance, and indeed a large amount of minor repair work, was carried out by sappers of 2/14 Aust Fd Coy. ; large repairs, involving the use of power tools and special equipment, were undertaken by a detachment of 23 Aust. Corps Fd Pk Coy. Both these parties worked arduously to keep the plant in operation.

Apart from breakdowns of plant, many of the Arab roller-drivers were not sufficiently skilful to maintain the required output, and selected sappers were accordingly trained in roller-operation and took over the duties from these men.

Equipment.

The Contractor was generally inadequately equipped and in order to expedite the progress of the work items of unit equipment, especially air-compressors, were frequently made available for his use.

Stores.

The following stores were supplied by the War Dept. free of charge to the Contractor :

Bitumen	for road construction.
Oil	for fluxing of bitumen.
Cement	
Coal)	for heating of bitumen and
POL)	operation of rollers.

After 24 Oct 41 higher policy was altered and the Contractor was required to supply all POL.

For the purposes of this supply R.E. stores dumps were opened at two central sites under the control of sappers. These dumps were responsible for the receipt and issue and accounting for all stores supplied for the contractor by W.D.

Constructional difficulties.

The contract was let from 11 Aug 41 and work commenced about ten days later. Full output was reached early in September. During these earlier months the weather was fine and warm, although very frequently there were strong cold winds which interfered with the use of bitumen, output being reduced and the addition of an increased proportion of flux becoming necessary.

Constructional difficulties. 3.
(cont).

Bitumen supplies were maintained fairly regularly until the latter part of October, notwithstanding very heavy demands for the large programme of works. Supplies were then suddenly curtailed for reasons beyond the control of 1 Aust Corps and by 5 Nov 41 accumulated stocks on the works had been consumed and the general use of bitumen ceased.

Work on the unconstructed sections of the road was then continued in water-bound macadam, generally with quite satisfactory results, but very long lengths of grouted carpet, which had been laid down as rapidly as possible in order to cater most effectively for traffic, and which were then in process of being sealed, were left without surface protection.

The majority of the roads were located at altitudes above 1500 feet and consequently wintry conditions were experienced very early. The early part of November was moderately warm but during the first week of December two fairly heavy falls of snow occurred which caused considerable damage to the unsealed pavement, through the intrusion and freezing of water and other effects. Areas which had been sealed have successfully withstood the winter conditions so far; nevertheless it is considered from experience to date that new grouted macadam in this locality should for safety be given two seal coats before winter, especially if constructed in the cooler weather when the bitumen in the grout application does not rise to seal the surface.

The winter conditions experienced this season are reported to be the most severe for 31 years.

Traffic.

Traffic on the roads has been remarkably heavy, especially on the ZAHLE - BAALBEK - HOMS Road. During the whole period of the work the volume of traffic on this road has been greatly in excess of that on many main roads in Australia and the average weight of vehicles has been heavier. The greater part of the traffic has consisted of 3-ton lorries carrying supplies and materials of war and almost invariably travelling at high speeds, sometimes at 50 m.p.h. Moreover on account of the comparatively narrow pavements in this country (as judged by Continental and Australian Standards) and the large volume of traffic in both directions, vehicles are forced to track close to the edges of the pavement. Wear and tear under the circumstances has been high.

Width of pavements.

Widths prior to construction were usually from 4 - 4½ metres. General widening to 5 metres was adopted.

Subgrade conditions.

Subgrade conditions have generally proved to be bad but time did not permit of the provision of sub-grade drainage. Much of the country is of the commonly-known "Cotton Soil", which possesses the detrimental quality of swelling considerably when wet. This has been a fruitful source of trouble, especially under new widening which could not be sealed (owing to shortage of bitumen).

It is recommended for future guidance that any new widening of old pavements should conform to the following :

Soling	minimum thickness	9"
Grouted carpet	" "	5"

Sealed twice or plant-mix seal.

If possible subgrade drainage should be provided throughout the whole length.

Quantity of work.

Contract Item	Description	Length Km.	Area m. s.
1 *	Seal coat	65.4	203,000
2A	Surface course 1"	6.9	34,800
2B	do. do. 2"	8.8	42,600
3,4,5.	Repairs to pot-holes (total area of road treated as required).	patches in 29 km.	43,800
6,9.	New grouted carpet, 4"	73.6	369,300
8	New road, including base course and 4" carpet.	3.48	17,400
10	Widening (incl. stone kerbs.)	126.0	192,000
11	Excavation.	35.4	76,000m. c.
12	Stone kerbs (only).	33.72	66,200m. r.
-	Cement concrete approx.	156 metres.	300m. c.

* includes seal coat as part of other items.

Materials.

Materials used, including small quantities prepared for seal coat, etc. , and not consumed :

Hand broken stone	75,000 m. c.
Crushed metal	30,200 m. c.
Binder over metal dust	600 m. c.
Soling stones	40,000 m. c.
Spall kerbs	450,000 m. r.
Bitumen	4,500 tons.

30

2/14 Aust A Fd Coy.

Technical Notes on Works.

The following observations result from experience in roadwork in SYRIA from August 41 to December 41. These works have been carried out by the War Dept., through the medium of contracts with private contractors or by direct labour under the immediate direction of the Public Works authorities. In each instance the Army has been providing technical supervision, a large proportion of which has been by Royal Australian Engineer units of 1 Aust. Corps. Necessarily the work has been done at high speed, as judged by normal civil standards, and many of the finer details which would normally receive close attention have had to be eliminated or relaxed.

Further considerations in the execution of these works have been the limitation of plant and the shortage of skilled labour, and normal methods have to be modified to a great extent to suit these conditions.

The notes appended below are therefore not to be regarded as applicable in all respects to civil practice but describe the methods which have perforce been adopted in the somewhat difficult circumstances.

23/12

GROUTED BITUMINOUS MACADAM.

Much of the work carried out has consisted of the reconstruction of badly worn macadam pavements by the provision of a new grouted bituminous macadam carpet. This carpet has normally been constructed to a thickness of 10 cms. loose but variations of 2.5cms. more or less have been adopted in certain locations according to requirements.

The sequence of operations is as follows :

1. Preparation of base (a) by scarifying and re-shaping if very badly worn, or
   (b) by making up with new metal.

In either method the base should as far as practicable be re-shaped to the proposed camber and grade in order to obtain uniform thickness of carpet (thus avoiding differential consolidation. The base must be well compacted by rolling before the carpet is applied and any further irregularities made good.

2. Application of carpet of hand-broken stone 4-7cms. gauge. This gauge should be adhered to as closely as possible as excessive size in particular is likely to cause trouble later on.

3. Roll to moderate compaction, starting from each edge and progressing towards the centre(for super-elevations start at lower edge and work outwards). Make up any imperfections in grade or camber by loosening and adding new material.

Before rolling the carpet the berms should be well consolidated by rolling or other means. In these works stone kerbs were used throughout to support the edges of the carpet, but such kerbs have also certain disadvantages.

4. Grout (penetrate) with bitumen.

5. Blind with crushed metal approx. 19 mm. gauge (excessive size should be avoided). Roll to compaction.

As a normal practice it is advisable to leave the pavement open to traffic for a period to tighten up and in Summer this has the benificial effect of inducing the bitumen to work to the surface and partly close the voids. In cold weather this unfortunately does not occur and if rain or very severe traffic is experienced more harm than good may result. In either conditions sealing is necessary to close the voids in the carpet and to reduce attrition. This consists of the application of binder (hot bitumen or bituminous emulsion) and spreading of chippings. The latter should with advantage be of maximum gauge of 15 mms. but in colder weather some of thelarger sizes are apt to be lost owing to the reduced adhesive power of the bitumen.

During the period when the grouted carpet is open to traffic constant maintenance should be provided, the principal function being to brush back any blinding material which is thrown off by traffic.

Binder. The rate specified for penetration carpet ("semi-grouting") is 4kg per m.s. (equivalent to 0.71 gall. per sq. yd.). This is fairly light, the normal rate in AUSTRALIA being from 1 to 1¼ galls per sq. yd.

For surface application ~~and~~ (seal coal) the rate specified is 1½ kg. per m.s. (equivalent to 0.26 galls per sq. yd.) --normal.

The bitumen supplied was "Mexphalte" 80/100 grade. This grade is commonly used in Summer for penetration but under the conditions of these works, with air temperatures frequently as low as 50° to 65° Fahr., and with hand pouring it was usually considered advisable to cut back with furnace oil in order to secure satisfactory penetration and adhesion. Such fluxing is not recommended for penetration work in more suitable conditions. The percentages of flux added were as follows, varying according to weather conditions :

Penetration	8 - 18%
Surface application.	5 - 10%

More volatile flux oils are preferable but were not usually obtainable.

Note that 80/100 bitumen cut back with 12% flux is approx. equivalent in use to F70 grade, but the latter is prepared from 40/50 grade bitumen and will exhibit different properties after prolonged exposure.

Note also that when the higher percentages of flux are employed the pavement should be closed to traffic from 24 to 48 hours to enable the binder to set up by evaporation of part of the semi-volatile flux.

METHOD OF APPLICATION OF BINDER.

On the works to which these notes refer the only mechanical spraying equipment consisted of bitumen kettles, approx. 400 galls. capacity, fitted with hand-operated pumps and spray hose. The output of this equipment is limited by the following factors:

Time required to heat - approx. 3 to $3\frac{1}{2}$ hrs. (varying according to weather).

Time occupied in spraying - approx $\frac{3}{4}$ hr.

Consequently each sprayer was able to spray only about one hour in four and the number available was insufficient to secure satisfactory output. Generally therefore it was necessary to fall back upon road-side heaters and hand-pouring ~~in special heaters~~; this necessitated modification of binder as described.

Resort was also made to pre-heating of bitumen on the roadside and admission to the sprayer for application but certain practical difficulties detracted from complete success.

AGGREGATE.

The greater part of the aggregate available was limestone, usually of moderately hard quality; in certain areas basalt of varying quality occurred. For use with bitumen basalt is much to be preferred, as it possesses much greater affinity for bitumen and better fracture. Limestone crushes into an impalpable powder which tends to adhere to the surface of the aggregate and cannot be removed entirely by screening. Even clean stone weathers to some extent and exhibits similiar characteristics. Satisfactory application of bitumen to such material is obtainable only if the stone is as clean as practicable and the binder is applied at a temperature of approx. 325° Fahr. If a thermometer is not available the emission of blue fumes from the surface of the bitumen and slow bubbling is a fairly good indication of correct temperature.

In certain areas it was found impossible to keep the carpet stone free from dust, (which blew over from side tracks no matter how these were located), and recourse was had to Unit W.E. air-compressors to blow the material clean immediately prior to grouting. This method proved successful.

SEAL COAT.

If sealing is done after the pavement has been under traffic, the surface is brushed clean and all foreign matter (specially traces of manure) removed. If the surface is unduly opened a small quantity of dry chippings may be applied but not such as to interfere with complete covering of surface of the pavement with bitumen. Bitumen is then applied at correct temperature, covered with chippings at the rate of approx. 1 m.c. per 60 m.s., and rolled. The recommended grading of aggregate is as follows:

10-15 m.m.	60%	..... Applied first.
8-10 m.m.	25%	..... May be applied together for convenience.
3- 8 m.m.	15%	

LIGHT BITUMINOUS SURFACE COURSE.

For the repair and strengthening of existing worn bituminous surfaces and on good macadam surfaces the following processes was found economical and was capable of a comparatively high rate of progress. It requires good supervision and careful control, but if properly applied produces good riding surfaces and enables small surface irregularities to be removed.

1. Clean existing surface free of all dirt and foreign matter.
2. Apply tack coat of hot bitumen at rate of approx. $1\frac{1}{2}$kg. per m. s.
3. Cover with chippings 15-20 mm. gauge, 25 mms. thick measured loose. Trim to true surface and roll.
4. Grout with bitumen at the rate of $1\frac{1}{2}$ kg. per m. s.
5. Blind with chippings 6-12 mm. gauge and roll.
6. Apply seal coat as described in previous paragraph.

The processes set out should as far as practicable be carried out in continuous succession and if possible the road should be kept closed to traffic until completed. By this means the blinding material in (5) is retained and the resulting surface is true to shape and compact.

With basalt it is considered that a two-coat process (omitting (6) above) would be satisfactory but with limestone the adhesion to the bitumen is not as good and some ravelling is apt to occur.

BINDER.

(a). Tack coat.

On existing bituminous surfaces and under the fairly adverse weather conditions encountered, 80/100 bitumen cut back with 5% furnace oil was satisfactory.

On existing macadam surfaces the initial coat had to combine the qualities of a primer and a tack and preliminary tests indicates that 23% flux was most satisfactory. This percentage ~~was~~ may vary according to local conditions but 25% is considered to be the maximum advisable.

(b). Grouting coat.

80/100 bitumen with 8-15% flux recommended in AUTUMN conditions.

(c). Seal coat.

5-8% flux recommended.

When using the higher percentages of flux for the grouting application it is advisable to keep the road closed to traffic for a period of 24 to 48 hours to enable the binder to set up.

SURFACE TREATMENT WITH BITUMINOUS EMULSION.

Bituminous emulsion as normally prepared consists of approx. 55% bitumen and 45% water and other ingredients (known as stabilizers). It is consequently suitable for cold application or for application to damp surfaces or with damp aggregates. Owing, however, to its fluidity it does not provide a thick film and modification of the normal process of seal coat work is necessary when using it. Two methods are commonly adopted, namely:

1. Single-coat application of emulsion with cover stone about 5-10 mm. gauge.
2. Two coat application using normal size aggregate.

The first method is suitable only for light work and is not normally recommended. In view of the water content in the emulsion the rate of application is necessarily greater than for hot bitumen. Opinions as to the required increase in rate of application vary from 33% to 80% ; it will usually be found impracticable on normal pavements to apply uniformly more than about 1½kg. per m.s. owing to the tendency of the material to run into depressions.

The second method has the advantage that normal size aggregate can be retained and a strong surface course produced. The following specification is recommended:

1. Sweep pavement thoroughly.
2. Apply 1¼-1½ kg. per m.s. emulsion.
3. Apply aggregate 10-15 mm. gauge at rate of 1 m.c. per 100 m.s. Do NOT roll.
4. Apply second coat of emulsion 1½ kg. per m.s.
5. Cover with chippings 3-10 m.m. gauge at rate of 1 m.c. per 150 m.s.

   Grading preferably -

8-10 m.m.	60%
3- 8 m.m.	40%

6. Roll.

By avoiding rolling of the first course of chippings the second course is enabled to enter and thus provide a more interlocked surface.

It will be found that the finished surface is mottled in colour but this is of no consequence as the film thickness is small.

The pavement must be closed to traffic for at least 24 hours (or longer according to weather conditions) in order to permit the emulsion to set up. During this period damage can readily occur. The work should not be carried out if rain is expected to occur.

25

PRIMERS FOR BITUMINOUS TREATMENT OF MACADAM OR GRAVEL SURFACES.

In the absence of normal materials for this purpose experiments were conducted using bitumen (80/100 grade), bituminous emulsion and crude oil. Furnace oil was also used for fluxing.
The following results were obtained :

(a). For priming of existing water-bound surfaces for subsequent surface treatment (see above) 80/100 bitumen cut back with 23% furnace oil.

(b). for priming of new water-bound surface, covered with binding material :
Crude oil alone satisfactory
Crude oil with addition of 10% by volume of bitumen is recommended
Bituminous emulsion applied after watering of surface moderately satisfactory.

The above materials were all applied cold.
Rates of application :

Crude oil	1½ kg
Crude oil plus 10% bitumen	per m. s.

Emulsion ...... 2 kg. per m. s.

Method of adding bitumen to crude oil :
Heat bitumen to slightly above melting point, add equal quantity of crude oil.
Add appropriate proportions of the above mixture to the crude oil to be used.

By this method the necessity for heating of the crude oil is avoided and mixing can be made with least labour. (Note : the crude oil used contains about 25% benzine and is highly inflammable, consequently excessive heating or exposure to fire is inadvisable.)

For subsequent surface treatment on gravel or new macadam surfaces two-coat emulsion surface course (as described above) is recommended.

STANDARDS FOR ROAD DESIGNS.

The following standards have been used and are considered satisfactory for general adoption :

Surface camber -

	bituminous surfaces	3%
	water-bound macadam and gravel surfaces.	4%

Super-elevation on curves -

Old work :	Minimum.		3%
New work :	Maximum		10%
		Radius 50 m.	10%
		75 m.	10%
		100 m.	8%
		150 m. and above	5%

Superelevation to be applied uniformly on tangent to curve in a length of $\frac{430}{R}$ metres, where ~~K K~~ R = radius of curvature in metres.

Widening of pavement on curves -

Additional width of 60 cms. on all curves; to be applied uniformly with the super-elevation.

CONSTRUCTION OF CONCRETE CULVERTS USING BITUMEN DRUMS.

This system is applicable where ordinary concrete pipes are not available or for purposes of economy in certain instances.

The drums are laid on a prepared concrete bed (preferably reinforced with bar-mat), carefully aligned and true to level. Light scabbling of the surface is advisable in order to secure satisfactory bonding with subsequent work. Particular care should be taken in bedding in the drums with cement mortar in order to avoid weak sections. This mortar must be well rammed.

Where parallel lines of drums are used a minimum separation of 20 cms. has been adopted and placing of concrete on each side of the drums carried on as far as practicable simultaneously in order to avoid displacement.

Joints between drums were made up with paper from cement bags.

The drums are of course regarded as formers only and the structure designed as in mass concrete.

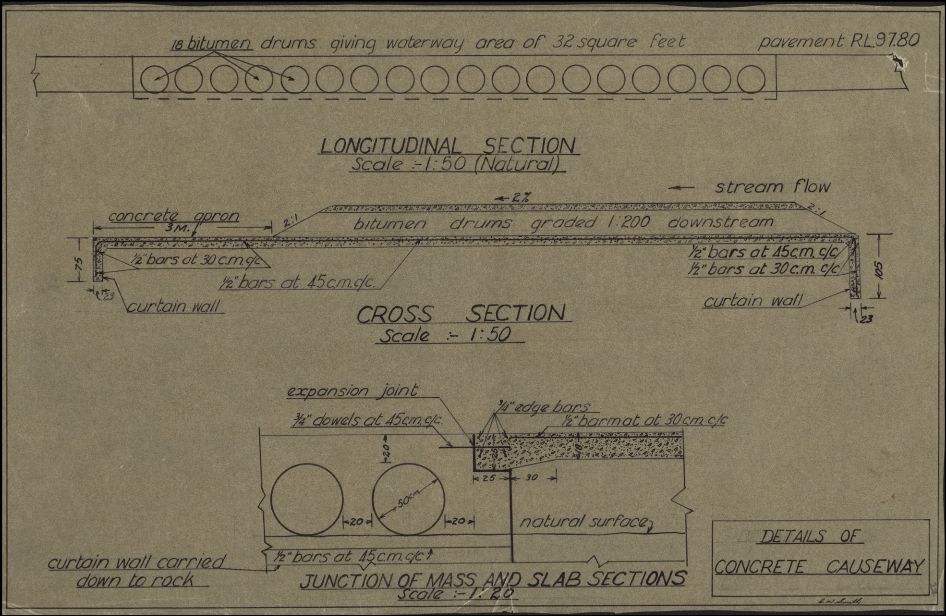
A design of a concrete causeway with openings for moderate flow is attached. This was constructed in a situation where fairly extensive flooding occurs at long periods. The methods of construction were normal and embodied the details outlined above. In order to secure as far as practicable an unbroken face on the upstream side to avoid infiltration of water and consequent hydraulic pressure within the structure, the whole length of the face was poured in one operation. The remainder of the structure was divided into convenient sections representing a normal day's output and poured in a selected sequence with the object of securing maximum structural strength and resistance to movement. Construction joints were scabbled and prepared in the normal manner. Uplift was provided against by carrying the upstream curtain wall down to rock.

As the weather conditions were cold, with occasional frosts, precautions were taken to cover each day's pour the same night.

Approach slabs were dowelled into the main structure, with half of each dowel painted with bitumen for purposes of expansion.

The normal methods of curing of concrete were modified as follows:

Covered and wet	3 Days.
Covered dry.	11 Days.


18 bitumen drums giving waterway area of 32 square feet
pavement R.L. 97.80
LONGITUDINAL SECTION
Scale :- 1:50 (Natural)
stream flow
← 2%
2:1
2:1
concrete apron
3 M.
bitumen drums graded 1:200 downstream
75
½" bars at 30 c.m. c/c
½" bars at 45 c.m. c/c.
23
curtain wall
½" bars at 45 c.m. c/c
½" bars at 30 c.m. c/c
105
curtain wall
23
CROSS SECTION
Scale :- 1:50
expansion joint
¾" edge bars
¾" dowels at 45 c.m. c/c.
½" bar mat at 30 c.m. c/c
20
18
25
30
50 cm.
20
20
natural surface
½" bars at 45 c.m. c/c
curtain wall carried
down to rock
JUNCTION OF MASS AND SLAB SECTIONS
Scale :- 1:20
DETAILS OF
CONCRETE CAUSEWAY

Grading of Concrete Aggregates and Design of Mixes.

The method described below in the design of concrete mixes is submitted as being of practical interest to Officers engaged on larger works. It is not suggested that divisional field companies would normally have time or opportunity for elaborate analysis. On the particular works on which this method was applied the quantity of concrete poured amounted to about 300 m.c. and consequently some care was necessary. The actual tests occupied approximately five hours.

The aggregates available consisted of -

A. Fine white sand.
B. Fine screenings from stone crushers, rejected from road works.
C. Medium screenings - max. gauge 16m.m.
D. Screened wadi gravel - max. gauge 40 m.ms.

Aggregates A, B, and C were all poorly graded; aggregate D was moderately well graded.

Method employed.

As testing sieves were not available to enable Fineness Modulus or other gradings to be obtained, the method of Trial Mixes was employed, by which trial mixes of selected gradings were made up for examination. The principal considerations to be satisfied are -

1. Maximum density.
2. Minimum water per cement ratio.
3. Satisfactory workability.

These are to some extent inter-dependent.

Procedure.

(a). Maximum density.

In determining the combined grading of maximum density, the work was simplified by first blending aggregates A and B and aggregates C and D to produce combined Fine and Coarse Aggregates respectively, each of maximum density, after which these blended aggregates were examined in combination to produce the required dense mix. This method is not perfect but with intelligent application the necessary adjustments are readily apparent.

Maximum density was tested by weight of a measured sample. The apparatus employed consisted of the following :

Measuring box 8" x 8" x 9" high (volume 1/3 cubic foot.)

Tamping rod m.s. 5/8" dia., 24" long.

Salter spring balance weighing by $\frac{1}{4}$ lb. to 100 lbs.

Petrol tin with handle.

Shovel, square-mouth.

The measuring box was filled with the aggregates in turn in a standard manner, namely ; fill in three layers, each approximately 3", tamping each layer with tamping rod 20 times. The contents, after screeding off flush, were transferred to the petrol tins and weighed. Trial combinations of A and B, and C and D, and subsequently of the blended mixtures, were treated similarly until in each instance the density was obtained.

(b). Water-cement ratio.

For strength a conservative formula of Abrams was employed-

$$S = \frac{18000}{6^{w/c}}$$

where S - Strength (28 days) in lbs. per sq. in.
w/c = Water-cement ratio by volume.

Thus for a water-cement ratio of 1, S - 3000
" " " " " $1\frac{1}{4}$, S = 1930

A water-cement ratio of 1.1 was adopted, giving a nominal strength of 2500 lbs per sq. in.

(c). Workability.

This was tested by the use of a standard slump cone, constructed out of sheet iron, 12" high, end diameters 4" and 8" ; filling and tamping as specified for measuring box (above).

The following are the normal maximum slumps :

Reinforced concrete :	
Heavy sections ; deck slabs	$4\frac{1}{2}$"
Thin vertical sections and columns	$4\frac{1}{2}$"
Thin confined horizontal sections	6 "
Mass concrete, lightly reinforced only	2 " - 3"
Road slabs	2 "

A slump of $2\frac{1}{2}$" was adopted.

In addition satisfactory smoothness and plasticity were required.

The proportion of cement to the mixed aggregates was varied until, with the corresponding water content (w/c = 1.1), the desired workability was obtained.

Conversion.

The experimental results were then converted into practical quantities by volume, based upon half-bag batches of cement, measuring boxes (open-ended) were constructed for each aggregate, and the determined quantity of mixing water for dry aggregates measured in calibrated tins.

With wet aggregates, the prescribed water-cement ratio can be controlled by occasional slump tests.

Time 1300
Date 14 Dec
File No.

CONTRACT CE/40: A. PHARAON & SOLEL BONEH.

DRAFT SPECIFICATION FOR ROCK ASPHALT SURFACE COURSE.

1. Clean pavement free of dirt and loose stones.

2. Apply tack coat of bitumen emulsion at rate of 1½ litres m. s.

3. Spread evenly 2 Kg./m. s. of fine powder (0-5mm. gauge).

4. Spread evenly, grading to camber as required 22 Kg./m. s. of coarse rock asphalt (5-15 mm.)

5. Roll.

6. Fill voids and make up as necessary with approx. 3 Kg./m. s. coarse rock asphalt.

7. Roll until well bound.

8. Spread 1½ kg./m. s. fine powder.

9. Roll to finish.

10. Spread 1½ kg./m. s. fine powder.

NOTE: If using bitumen instead of emulsion a mixture of ¾ Kg. bitumen 80/100 and ¼ Kg. Solar oil is customary in fine weather. At the present time (12 Dec 41) under satisfactory weather conditions 2/3 Kg. bitumen and 1/3 Kg. Solar oil will probably be satisfactory, subject to trial.

L A J Thompson
Capt.
Senior Supervising Officer.

12 Dec 41.

Copy to Contractor

18

Time 1400
Date 1 Jan 42
File No. CRE 1208R

2/14 Aust A Fd Coy.

30th Dec 41.

C.R.E.

1 AUST CORPS TPS.

Trials of HASBAYA - Asphalt.

This investigation has been continued and further comparative tests made of mixtures of HASBAYA natural asphalt and crude oil. As the result of these tests the proportions have been limited to the following :

100 parts asphalt to 65 parts crude oil
100 " " " 60 " " "
100 " " " 55 " " "

These mixtures were compared under cold conditions with 80/100 "Mexphalte" bitumen by the following rough Tests :

(a). Softness, by feel.

(b). Flow test, by turning containers on side and comparing flow after 12 hours.

(c). Ductility, by elongation.

The mixture 100:60 gave results most closely resembling 80/100 bitumen but there are naturally considerable dissimilarities. The following features are most noticeable :

(1). At low temperatures the mixtures are very brittle.

(2). It has been found very difficult to obtain uniformity of samples owing to practical difficulties in the process of heating and solution. The facilities available were crude, considerable frothing took place as before and the oil frequently caught fire while being stirred. (This could probably be overcome with a more suitable designed heater.)

(3). Owing to frothing it was difficult to raise the material to a satisfactory temperature, for use.

Trials have been made of the mixtures by application to an existing bituminous pavement (adjacent to Camp). The weather conditions have been unsuitable and pavement temperature much too low for satisfactory work. On this account adhesion both of bitumen and mixtures was unsatisfactory but the bitumen somewhat better. Nevertheless, under adverse climatic conditions (low temperatures and rain) and with traffic impact, the material is still intact and the cover stone is adhesing to a reasonable extent.

Probably because hotter; but see (3) above

There is some evidence of evaporation of the lighter oils from the mixtures and they appear a little more brittle than before application ; however, samples removed from the road surface and warmed in hot water displayed reasonable plasticity and ductility.

Recommendation. In my opinion if the material is to be fluxed with crude oil for use on road pavement the following proportions are most suitable :—

100 parts asphalt to 60 parts crude oil.

These proportions should be checked again for the climatic conditions under which the material is to be applied.

It is considered that crude oil is unsuitable for fluxing purposes and a heavier oil of more uniform grade would be preferable if available.

The material would probable NOT be suitable for emulsification but a trial could be made if desired.

R. J. Thompson
Capt.
O.C. 2/14 Aust A Fd Coy.

Engr. Works Syrian Occupation 15 July to 31 Dec 41.

To C.R.E. 1 Aust Corps Trps R.A.E.
From Lieut. Chester.

Type of Work.	Location.	Type of Work.	Size.	Date commenced.	Date finished.	Remarks.
Road Repair	Beirut-Tripoli	Widen - maintain	80 Km.	1 Sept.	In progress	Complete except for resealing
	Tripoli - Arida	and repair	27 "	1 "	" "	" " " "
	Arca - Homs	Bituminous Rd	21 "	1 "	" "	" " " "
	Azmi-Bey Rd	Remaking - macadam & Sealing	1·2 "	——	——	Start due 7 Jan 42.
	Chtaura - Ablah,	Widen & repair Bitumen Rd	12 "	1. Sept.	22 Nov.	
	Ablah - Talia	W.B. macadam sealed with Lattaquie Asphalt.	14 "	18 Nov	In progress	
	Boulevarde - Senn-el-Fil	W.B. macadam sealed with Idealite.	1·3 "	18 Nov.	" "	
Hardstanding Construction.	Tripoli Port	W.B. macadam sealed with Lattaquie Asphalt.	16,000. m^2	5. Nov.	" "	This and above rds constructed P.W.D. Lebanon.
Quay Construction	" "	Steel Piling Wood Superstructure.	85. m. lin.	1. Nov.	9 Dec.	Constructed by D.H.P. Coy.

Note Photographs of above works could be obtained by arranqment between photographer. and Fd. Engr.

R C Chester Lt

A

Lattique 'ASPEL' Asphalt

Notes by Fd Eng II Lieut R Chester RAE

Requirements etc

1. Must be laid on solid foundation
2. Can be laid at night – laying is simple & good light is not essential.
3. May be laid during light rain
4. Very small amt. of bitumen tack coat.
5. Pot holed road repair – if badly potholed, is much faster than scarifying and relaying, needs less rolling (200 m. of 5m road per day per roller) but foundation of road must be intact.
6. Traffic can use road during remaking operations

Specification

Repair of pothole roads

Sweep rd well. Wash rd with water. Paint sides of potholes with Colas

Fill pothole with Asphalt (powder, chippings or mixture)

Hand ram with heavy rammer & roll

Spray $\frac{1}{2}$ Kg m² of emulsion (bitumen) over entire rd surface

Spread chippings at 20Kg. m² & roll

Spread powder at 5Kg m² & roll

Traffic uses road

Leave, as work progresses small dumps of powder at road side
– for irregularities developing, spread on screed off level, hand tamp & traffic consolidates.

Final thickness of asphalt complete is 1 cm.

Cost, dependant on number of potholes & haulage – up to £S 3 m²

Reseal Only

As above from Spraying emulsion. Thickness 1 cm
Cost, dependant on haulage, £S 1 to £S 1.5

Asphalt Seal on W.B. Macadam (Hardstanding Tripoli Port)

Grade formation
Sole 20-30cm & Roll
Broken Stone 4-7cm 15cm carpet & Roll
Blinding 5-10mm 10 litres m²
Emulsion 0.8 Kg. m²
Asphalt chippings 18 kg m² & Roll
" Powder 7 kg m² & roll
Asphalt seal cost £S 1 Thickness 1 cm.

Appendix B

File Technical Data

IDEALIT ROAD PROCESS

Report to C.R.E. I Aust Corps Tps
From : Lieut CHESTER. Fd Eng II

GENERAL DESCRIPTION

Idealit is a bitumen hot-mix manufactured at a central depot and spread on road as soon after as possible. Should be placed on same day as it is manufactured, but can be placed the day after.

It is suitable for operation in warm dry weather. It consist of a first course and a sealing carpet, the material for the sealing carpet is called SELMA. It can be used straight on a W. B. macadam Road or for patching and resurfacing a worn bituminous road.

There is a type called Stock Idealit which can be stored for long period and spread cold. This is suitable for operations in cold weather or places a long distance from the central plant. It is used mostly for patching and not used in steep places.

CONSTITUENTS

Material	1st course	Idealit carpet: SELMA	Pot holes	Stock Idealit
Bitumen	4.5 per cent	2.5 %	3.5 - 4%	5 % (Carpave No 7)
Petrol	.5 %	1.25 %	4 - 4.5%	
Crushed stone (hard & none porous	85 % 3 - 6 mm.		86 % appr. 3 - 12 mm.	
Sand	9 %	95 %	9 % appr.	86.5 %
Filler	1 %	1.25 %	1 % appr.	8.5 %
Remarks			~~Pr~~ Size of stones depends on size of pot holes.	

Before mixing the bitumen is heated to 120 - 130 degrees c. and the crushed stones and sand to 50 - 60 degrees C.

SOURCE OF CONSTITUENTS

At the present time the stone is quarried and crushed at DAHR El BAIDER where the mixing plant is located.

The sand and filler are products of the crushing plant.

PLACE OF MANUFACTURE

At present time DAHR El BAIDER which is the location for the summer operations. During winter the plant is moved to FAYADIEH as the colder weather necessitates at smaller working radius.

Time for the plant to transfer this distance and be operating again is 4 days. Radius of operation around central plant is 40 Km.

OUTPUT OF FACTORY

Idealit - 5 tons per hour
Stock " - 2 tons per hour
Salme - 2 tons per hour

PLACING Idealit should be placed day of manufacture

W.B. macadam road, either newly made or an old one in good condition.

(1) Spray 1 Kgm colas per sq. metre
(2) Sand
(3) Let traffic over for two or three days
(4) Spread Idealit 30 - 40 Kgms per sq. metre (~~Roller 6 Ton less~~)
(5) Roll (Roller 6 Ton or less)(thickness after rolling 1.2 - 1.5 cm.)
(6) Spread Salme ~~is~~ carpet (On level road quantity of salme is 10 % of first course. On steep roads up to 5 % of first course)

Traffic can use road immediately.

POT HOLES

(1) Square up potholes
(2) Paint edges with colas
(3) Fill with pothole Idealit

WORN BITUMINOUS ROAD

(1) Repair potholes
(2) Sweep road
(3) If Idealit is hot it can be placed without application of colas but if cold spray 150 - 200 gms colas per sq. metre.
(4) Place 25 Kgms per sq. metre
(5) Roll (Finished thickness approx. 1 cm)
(6) Place Salme carpet

COST

At factory if stone is:

on factory site	7 S.L. per ton + Cost bitumen
Transport (Say 20 km)	4 S.L. per ton
Placing	1 S.L. " "
Total	12 S.L.

Taking 44 Kgm per sq. metre and bitumen at 100 L.S. per ton this gives a cost of .75 L.S. per sq. metre .

According to the P.W.D. Lebanon this is an average cost of work they have done.

R Chester Lieut. R.A.E.
~~Attached~~ H.Q., R.A.E., I Aust C. Tps.

To C.R.E. 1 Aust. C.Tps.
From. Fd. Eng. I

ENGR. WKS. 1 Jan. 42

SYRIAN OCCUPATION - TECH. SUMMARY

Brief Report on

Road Improvement - N. Syria & Alaouite Territories

A. General

1. ~~Nature~~ Object of Work: - ~~Object was~~ to improve roads ARIDA - LATTAKIA - ALEPPO and ARIDA - HOMS - ALEPPO within N. Syria and Alaouite territory to provide 5m. width of bitumen sealed macadam road by 15 OCT.

2. Historical: Existing roads were all W.B. macadam, sealed, (bitumen or asphalt) except for 52 km, in varying stages of repair and widths varying 4m to 5m, as revealed by early recce by 7 DIV. first week of Aug. Taking over during 2nd week, RAE. 1 Aust H.Q. Corps Troops ~~Eng.~~ completed recce, contacted P.W.D's arranged schedule of work & called contracts for work to commence. ~~Most~~ Main contracts were let between 20-30 Aug. Vide attached sketches for location of work. (G.10 & G.11)

3. Procedure adopted for road improvement
   (a) Pothole repairs or
   (b) Resurfacing, single coat bitumen or
   (c) Seal and ~~resurfacing~~ surfacing (i.e. 2 coats bitumen) or Natural asphalt
   or (d) Remetal 2" with seal & ~~resurfacing~~ surfacing or natural asphalt.
   ~~and~~
   Widening to 5 m as in (d), modified in ~~December~~ to W.B. macadam owing to weather.

SUMMARY OF WORK - Completion to 31 Dec.

		Remetal & Widen to 5m.	2 Coats Bitumen	Natural Asphalt	1 Coat Bitumen	Widen to 5m.	Extensive Repairs
N. Syria.	Schedule	47	28	22.5	22.6	—	22.6
	Completed	45*	23	17	0	—	22.6
Alaouite	Schedule	~~20~~ 5.5	~~5.5~~ 3.4	~~3.4~~	76	100	20
	Completed.	~~20~~ 5.5*	~~5.5~~ 3.4	~~3.4~~	65	50	20

*Completed in 2 months. Sealing & widening incomplete 31 Dec.

Adoption of remetalling, thorough rolling & 2 coat bitumen seal had adv. of large saving in bitumen (c.f. penetration) & P.W.D's were familiar with method. Disadv. in more rollers reqd.

4. Supervision - In both areas contracts made direct with P.W.D's concerned who were responsible (under W.D.) for direct supervision. N. Syria had excellent organisation in field and office, ~~worked~~ cooperated throughout with speed and efficiency, completing all except surfacing ~~within~~ by 20 Oct, general W.D. supervision only being necessary. Alaouite P.W.D. cooperated well, but lacking adequate technical & field staff, required W.D. assistance in supervision - main to speed up contractors.

4. (cont'd) Roughly, over 50 km were remetalled and widened within the schedule time, just under 2 months. And of 150 km of sealing, about half had been completed in same period.

B. Technical

1. Metalling & Rolling –
Rate of Progress – dependent on rollers as stonework was up to schedule & could be expedited.

Av. rate of progress per roller = 500 m^2/14 hr. day for av. stone. (excl. major breakdowns)

Formula used to determine extent of rolling required.

Compression (5–12 depending on stone) $= \frac{P \times D}{C}$

P = wt. of roller in tonnes
D = dist. run by roller in km
C = n^o of m^3 of metalling rolled.

Comp.ⁿ vary 5–6. soft limestone
7 hard "
8–12 basalt

2.

2. Bitumen Sealing :
Av. rate of progress, = 2500 m^2 (av.) per (10 hr.) day (Oct & Nov.)
(1 gang, 1 sprayer, 2 boilers) ~~excl.~~
(excl. loss due to weather)

3. Asphalt Sealing. – (from asphalt mine Kfarie, 37 km. from Lattakia)
Specification available if required. % Asphalt varies 8%–12%
In early stages, use of nat. asphalt was discouraged on account of ~~stiffeness~~ smoothness. When necessary to economise on bitumen instructions were received to use asphalt wherever possible in N. Syria & Alaouite
Salient points in the use of nat. (Latt.) asph. arising from 3 m. experience are :-

a. The better the foundation, the more efficient & lasting is the seal. (On good foundation, 10 yr. old asph. rd. in Lattakia is still in excellent condition & has required no mtce)
b. Large saving in bitumen (approx. ½ kg/m^2 ~~to~~ i.e. $\frac{1}{6}$ of amount required for 2 coat bitumen sealing)
c. Can be laid in colder & wetter weather than bitumen and normal traffic is not diverted during work
d. Rate of progress ~~much~~ – av. in good weather 1500 m^2/day. (about equivalent to 2 coat bitumen seal, 1 gang)
e. Normal thickness after compression 1 cm. requiring 1 tonne per 40 m^2.
f. Major disadv: Quantity of material required, hence transport costs ~~form~~ large proportion of cost. : Stiffeness, which can be overcome by surface layer of basalt screenings

but with loss of ~~to~~ speed & increased cost.

If PWD fairly honest & Pro British

C. Miscellaneous Notes

1. The system of using P.W.D's using contract labour with P.W.D supervision gives ~~is~~ satisfactory results. ~~as~~ Full use of P.W.D. records of roads saved time in commencement of work. In particular, P.W.D. N. Syria are capable of high speed work and NOT usually restricted by local administration inertia.

2. Roads should be 5½ m. wide, if practicable, for passing convoys at night; ~~to prevent which~~

D. BRIDGES

1. Wadi Ishaby – vide report by 2/15 Aust A. Fd. Coy.

2. Orontes Br. –

Location: DJISR EL CHOGOUR vide plan att^d

History: Existing br. – old Turkish multi-arch masonry structure width approx. 11', load capacity 24 T with unknown factor of safety against foundations sinking.

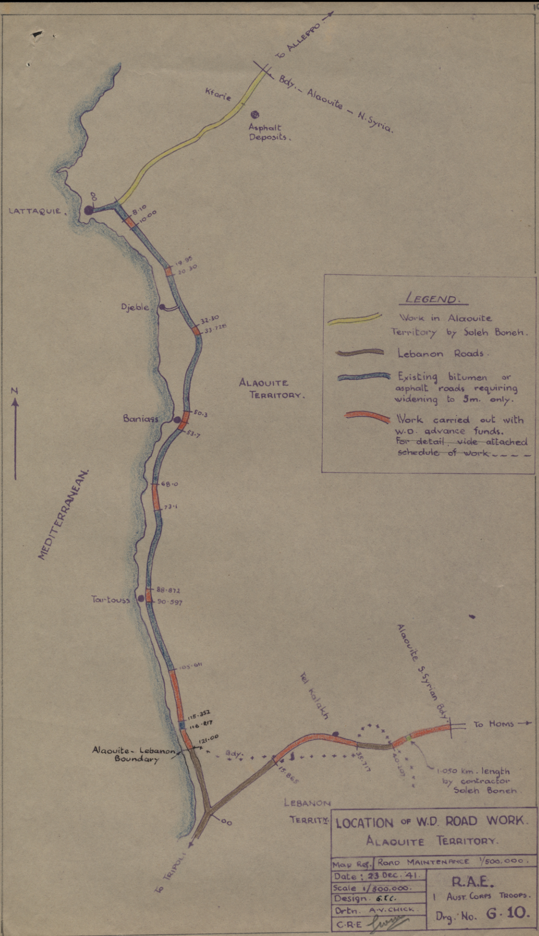
New Br. Instns from C.E. for deviation and new bridge 2900 T.
1st Design – 20' wide, 250' long, 10 bays of 25', 24 T normal, 47 occasional – to be temporary structure, timber piles, R.S.J. bearers, timber pile cap and decking – for completion 31 Dec.

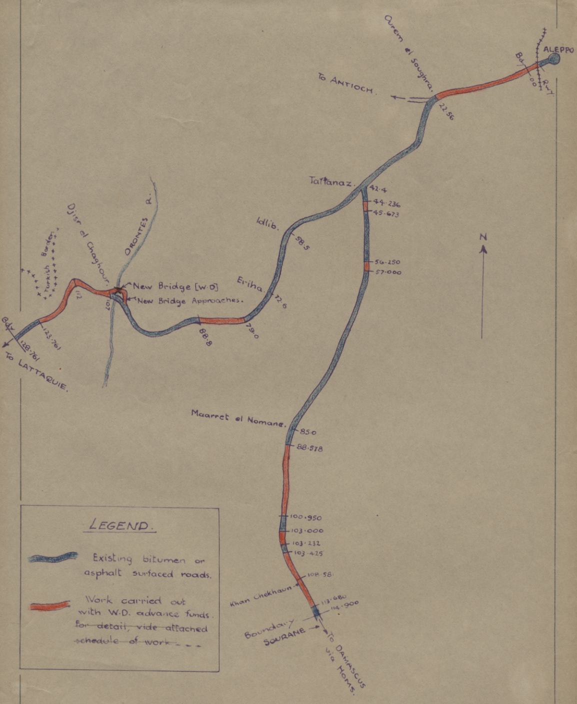
8 bays 25' span
1 " 30' "
4 piles per pier
} 230' Long }
Amended Design (20 Nov. approx) increase load to 65 T required smaller pile ~~penetration~~ set in driving, ~~Piles, to be 25' in 4 bents, & be~~ extra R.S.J. bearer, modification of stiffening details. Completion estimated 31 Jan.

Constr^n: Fd. Coy. not available, 2 Aust Boring Sec. detachment ~~(under Capt)~~ of 25 with Fd. Pk. personnel for driving mechanical equipment plus civilian labour. Weather conditions very wet, windy and cold in Dec.

3. Other Br. Recce. to determine if any br. would NOT take Class 24 loads – Result; while some bridges ~~could~~ were not designed for 24 T loads it is considered that all will take such loads with factor safety at least 3.

S F Colebatch Capt
Fd. Eng. I.


10
To ALLEPPO
Bdy. - Alaouite - N. Syria.
Kfarie
Asphalt Deposits.
LATTAQUIE.
00
8.10
10.00
19.95
20.30
Djeble.
32.30
33.725
ALAOUITE TERRITORY.
N
Baniass
50.3
53.7
MEDITERRANEAN.
68.0
73.1
Tartouss
88.872
90.597
105.611
115.352
116.217
121.00
Alaouite - Lebanon Boundary
Bdy.
Tel Kalakh
Alaouite S. Syrian Bdy.
To HOMS
35.717
40.203
15.865
1.050 Km. length by contractor Soleh Boneh
LEBANON TERRITY.
00
To TRIPOLI
LEGEND.
Work in Alaouite Territory by Soleh Boneh.
Lebanon Roads.
Existing bitumen or asphalt roads requiring widening to 5m. only.
Work carried out with W.D. advance funds.
~~For detail vide attached schedule of work~~
LOCATION OF W.D. ROAD WORK.
ALAOUITE TERRITORY.
Map Ref. ROAD MAINTENANCE 1/500,000.
Date: 23 Dec. '41.
Scale 1/500,000.
Design. G.T.C.
Drtn. A.V. CHICK.
C.R.E.
R.A.E.
1 AUST. CORPS TROOPS.
Drg. No. G. 10.



LOCATION OF W.D. ROAD WORK.
NORTH SYRIA [Aleppo West.]

Map Ref.	ROAD MAINTENANCE 1/500,000.
Date. 23 Dec 41.	R.A.E.
Scale. 1/500,000	1 Aust. Corps Troops.
Design. G.T.C.	
Drtmn. A.V. CHICK.	Drg. No. G. 11.
C.R.E. [signature]	

2/14 Aust A Fd Coy.

30th Dec 41.

C.R.E.

1 AUST CORPS TPS.

Trials of HASBAYA - Asphalt.

This investigation has been continued and further comparative tests made of mixtures of HASBAYA natural asphalt and crude oil. As the result of these tests the proportions have been limited to the following :

100 parts asphalt to 65 parts crude oil
100 " " " 60 " " "
100 " " " 55 " " "

These mixtures were compared under cold conditions with 80/100 "Mexphalte" bitumen by the following rough Tests :

(a). Softness, by feel.

(b). Flow test, by turning containers on side and comparing flow after 12 hours.

(c). Ductility, by elongation.

The mixture 100:60 gave results most closely resembling 80/100 bitumen but there are naturally considerable dissimilarities. The following features are most noticeable :

(1). At low temperatures the mixtures are very brittle.

(2). It has been found very difficult to obtain uniformity of samples owing to practical difficulties in the process of heating and solution. The facilities available were crude, considerable frothing took place as before and the oil frequently caught fire while being stirred. (This could probably be overcome with a more suitable designed heater.)

(3). Owing to frothing it was difficult to raise the material to a satisfactory temperature, for use.

Trials have been made of the mixtures by application to an existing bituminous pavement (adjacent to Camp). The weather conditions have been unsuitable and pavement temperature much too low for satisfactory work. On this account adhesion both of bitumen and mixtures was unsatisfactory but the bitumen somewhat better. Nevertheless, under adverse climatic conditions (low temperatures and rain) and with traffic impact, the material is still intact and the cover stone is adhesing to a reasonable extent.

Probably because hotter; but see (3) above
A.J.

There is some evidence of evaporation of the lighter oils from the mixtures and they appear a little more brittle than before application ; however, samples removed from the road surface and warmed in hot water displayed reasonable plasticity and ductility.

Recommendation.

In my opinion if the material is to be fluxed with crude oil for use on road pavement the following proportions are most suitable :

100 parts asphalt to 60 parts crude oil.

These proportions should be checked again for the climatic conditions under which the material is to be applied.

It is considered that crude oil is unsuitable for fluxing purposes and a heavier oil of more uniform grade would be preferable if available.

The material would probable NOT be suitable for emulsification but a trial could be made if desired.

L.A.J. Thompson

Capt.
O.C. 2/14 Aust A Fd Coy.

7

C.R.E. 1 Aust Corps Tps. 10 Oct 41

P.W.D. LEBANON.

Revised Estimate of Cost of Road Works.

1. P.W.D. LEBANON have now (30 Sep) supplied a reasonably detailed estimate of cost for works being carried out in Corps area. Comparison of original and revised estimate is shown below:-

Section	Original Estimate L.S.	Revised Estimate L.S.
1) BEYROUTH - TRIPOLI - ARIDA.	249,900	90,730
2) ARCA - HOMS	306,000	44,646
3) CHTAURA - ABLAH	30,600	25,800
Contengencies 10 %	58,650	------
Total	645,150	161,176

2. The huge difference is explained as follows:-

a) M. RENDU, Conseiller, states that by mistake the Unit Rates originally used included the cost of coal and bituman.

The comparison of rates is as follows:-

UNIT RATES (L.S. per m.sq.)

Work	Original	Revised Est.
Reseal (1 coat)	0.30	0,18
Remaking TRIPOLI - ARIDA	2.15 (macadam & asphalt)	1.16 (Semi grouting)
ARCA - HOMS.	3.00 (macadam & asphalt)	1.16 (Semi grouting

b) Total Amount of Work

ARCA - HOMS Rd. The program originally drawn up by the P.W.D. allowed for 102,000 sq.m. of new macadam, which amounted to practically the whole of the Lebanese portions.

The reduction to 21,000 sq.m. leaving the rest to be treated by repair of pot holes and re-seal has been discussed with the "Conseiller" and appears to be justified for the following reasons:-

(i) The road has apparently always given trouble owing to nature of soil and intermittent inundations each winter. The Dept. has investigated the matter and considers the only really satisfactory solution to be extensive deviation to higher ground, an expensive and lengthy job. The "Conseiller" now states that the original plan would NOT guarantee against deterioration of the road during the coming winter.

Cont.......

File Road PWD Liban

The amended program provides for remaking those portions now needing it. Dumps of metal are to be distributed along the road to provide material for any portions requiring repair after flooding.

(ii) Shortage of plant, and time necessary to prepare road metal (basalt in this area) would prevent completion in time (even if the Dept. had not delayed commencement of work).

(iii) Economy.

TRIPOLI - ARIDA Rd

(iv) Original proposal for 90,000 sq.m. of remaking was an over estimate of work required. On the other hand the present proposal, 30,500 sq.m. leaves a considerable quantity of pot - holed road to be repaired by patching. P.W.D. Engineers justify this by shortage of plant and time and assert that patches will last for years, this opinion being based on previous experience of repairs on this road.

The methods of patching used are unorthodox but examinations of those patches subjected to fairly heavy traffic for these weeks indicates that they will probably last more than a year at any rate. The repair of any that are found defective will be only a matter of routine maintenance.

Sgd G. Aiken Major R.A.E.

Engr. Works - Syrian Occupation - 15 Jul - 31 Dec. 41

Notes on construction

Beirut - Tripoli Road

Original Road - Bituminous macadam 5 metres wide, generally in good order. Required sealing over approx 28 Km and widening of dangerous bends at Ras Cheka

Treatment - Hot bitumen seal - 8 Km (Mack Sprayer available 4 days transferred CRE Aerodromes)

Lattaque Asphalt Seal. - 7 Km.

Other spraying equipment not available for this road owing to urgent condition of roads north of Tripoli

Hand maintenance of weak spots with colas was carried on in lieu of sealing and over entire length of road - 65 Km.

Present Condition - Satisfactory for winter period.

Tripoli - Arida Road

Original Road - Bituminous macadam 5 metre wide badly potholed and broken up.

Treatment - Where potholed up to 20% road patched - 7 Km
Where potholed above 20% and where foundation was bad
~~Scarify and relay hot bitumen~~ - 4 Km.
Lattaque Asphalt repair and seal - 2.5 Km.
(See appendix A)

All portions of road remade were sealed.

Approx 12 Km originally on programme for resealing were not done owing to lack of plant.

Hand maintenance of weak spots with colas was carried out over entire road not otherwise treated - 20 Km.

Present Condition Satisfactory for winter period.

Arca - Homs Road

Original Road - Bituminous Macadam 4 m wide badly potholed and broken up.

Treatment - Where potholed up to 20% road patched - 10 Km.

Where potholed above 20% and where foundation was bad - road scarified remade and widened. - 5.7 Km.

Time and plant did not allow widening of this road over entire length. Where road was remade it was put down 5 metres wide. Elsewhere it was widened to 5 metre for approx 150 metres at each Km. (In practise these do not fulfil any practical role as passing places)

New Bridge over HISSA River was completed

Deviation for new bridge - construction of new road 800 metre

Repair and seal Lattaque Asphalt at 40 Km mark - 3.7 Km

Portion of road remade was sealed. As weather became too cold and wet for bitumen sealing, operation was continued with Lattaquie Asphalt.

Present Condition Satisfactory for winter period.

<u>Chtaura-Abla Rd</u>

Original Road - ~~Bituminous~~ macadam road approx half 5 and half 4 metres wide in fair condition. Required resealing throughout.

Treatment - ~~Hot.~~ Bituminous seal — 7 Km
Idealit carpet — 3.7 Km (See Appendix B)
Wider — 5. Km
Widening was done using colas. This showed a tendency to break up in places under rain and heavy traffic. In widening operations roller sometimes fails to consolidate the new road immediately against the original surface, resulting later in failure in the part of the road which bears the most wheel loads. Rolling should be under close supervision and metal filled in against the original surface till a very compact mass is formed.

Present Condition - Satisfactory for winter period.

<u>Abla-Zahle Road</u>

Original Road - Water-bound macadam 4 metres wide badly broken up.

Treatment - Road scarified, widened to 5 metres, soling retained
New W.B. macadam carpet. — 11.3 Km.
Only 1 - 8T roller was available for use on this road. Macadam roads should be given at least 8 Km Tons of rolling or it will break up under rain and traffic.
It is intended to surface this road with Lattakia Asphalt
W.B. macadam was resorted to in this road as no bitumen was available.

Present Condition - 4.3 Km W.B. macadam in good condition
Remainder of road has stone laid out at side ready for construction when weather permits.

Boulevarde - Sin - el - Fils Road

Original Road - W.B. macadam badly broken up under heavy W.D traffic to T camps and Lasts. Dump.

Treatment. W.B. macadam with 1 coat colas. followed by Idealit carpet. (See Appendix B)
This method of construction results in a large saving of bitumen which was practically unobtainable at the time.
Disadvantage is that dry weather is necessary for application of Idealit. Winter had set in by the time the 1coat colas was complete, and second roller not available to follow up simultaneously with the idealit.

Present Condition. Showing signs of wear under rain and heavy traffic. May last through winter but will need repair before Idealit coat is applied.

Hardstanding Tripoli

Original Surface. Earth.

Treatment. Level earth.
Salinge and macadam carpet as appendix A
Lattaquie Asphalt seal. (Appendix A)
Necessary drains.

Present Condition.
Macadam complete. Lattaquie sealing in progress.

Quay + Tripoli Port

Timber superstructure on steel piles.
See attached plan. Appendix C.
Piles Railway rails bolted together with welded steel shoe.
40 constructed on site by 2/3 Corp Fd PK welders.
40 " " in 2/2 Fd PK workshops.
Superstructure Redwood supplied from Alma Dump.
Plans of wharf altered to suit timber available.
Duty Supervision of construction consisted of organising work properly, seeing maximum number of workers that could be economically placed were used and that materials were on site when required.

4

Grouted Macadam Constrn.

Roadside bitumen heater

Concrete causeway under constrn.

Concrete causeway completed.

Water-bound macadam constrn.

Negatives returned to Capt Jompson, as owing to movement of Corps, C.E.'s Staff, unable to get the prints. Prints to be fwded later.

Swan.