File 16-R. Fileg.

SECTION A: INTRODUCTION

1. Project Description:

The Altus Atlas Missile Complex consists of twelve launching sites located by number and name as follows: #1-Lone Wolf; #2-Snyder; #3-Cache: #4-Frederick; #5-Fargo; #6-Creta; #7-Hollis; #8-Russell; #9-Willow; #10-Hobart; #11-Manitou; #12-Granite.

Sealed bids for the construction of the complexes were opened in the office of the District Engineer, Tulsa, 26 April 1960.

The prime construction contract was awarded to Morrison-Knudsen Company, Inc., and Hardeman and Associates on 27 April 1960. Work began 6 May 1960. The prime construction contract was bid for all 12 sites at \$20,926,500 as compared with a government estimate of \$23,686,717.

2. Foundation Investigations:

a. Scope of Explorations; Preliminary investigations include one soil boring per site to a total depth of approximately 225 feet in the center of the silo and one soil boring per site to the top of rock or approximately 40 feet, whichever is deeper, in the area of the Launch Control Center. Bailing tests were performed on all sites and included in the contract plans(see drawing nos. 20714-x3-C-4, 20714-x3-C-5, 20714-x3-C-6, and 20714-x3-C-9 included in this section).

At site #5-Fargo two additional soil borings were taken for further classification and included in contract documents by addendum(see Section 5 for inclosure).

All explorations (i.e. number, type, location, depth, etc.) as well as all testing(i.e. type of test, quantity, etc.) were at

the discretion to Bechtel Corporation with Tulsa District acting as exploratory and testing agency only.

b. Scope of Tests; Tests performed include unit weight and water content test performed by the Southwestern Division Laboratory and grain size analysis by Tulsa District Laboratory, Drilling was performed by Tulsa District except for pumping tests which were performed at sites #5-Fargo and #8-Russell by Layne-Western Company (results included in this section on soil boring tabulations sheets).

3. Excavation:

- a. Open Cut; The contract for open-cut excavation was sub-contracted to Amis Construction Company, Oklahoma City, Oklahoma, for all 12 sites. Contractor's plan of open cut excavation at site #1
 Lone Wolf is included in this section. Open-cut excavation planning on all sites were similar.
- <u>b. Shafting</u>; Morrison-Knudsen performed the shaft excavation on all sites from the open-cut area to the bottom of the silo. Contract drawing number 20714-1-3-C-4, "Earthwork Cross Sections", site #1-Lone Wolf, is included in this section and is similar for all sites.

 4. Construction Control:
- a. Control Testing: Control testing is performed under government contract by Oklahoma Testing Laboratories at an initial negotiated contract price of \$132,000 plus cost for overtime. Personnel includes one registered engineer-in-charge and one assistant in the central laboratory located in Altus, and four laboratory technicians located at the sites. Surveillance is maintained by Area Laboratory personnel.
- c. On-Site Laboratory Facilities; A building for use as a laboratory was included as a construction item in the prime construction contract issued to Morrison-Knudsen-Hardeman and Associates. The site

laboratory is equipped and manned by Oklahoma Testing Laboratories for all soils and concrete control testing except the crushing of concrete test cylinders, which is performed in the central laboratory.

5. Physical Data:

- a. Weather Conditions; The climate in the area is usually classified as semi-arid, with long, hot summers, during which temperatures have risen as high as 120°F., and short mild winters with cold snaps of frequent occurrence, but with scanty snowfall. The extreme low recorded temperature is -9°F. Mean annual temperature is 62.9°F. The average frost-free period is 224 days per year. Precipitation is extremely variable, ranging from a recorded minimum in 1917 of 13.92 inches to more than 48 inches in 1941. Mean annual precipitation for the mears 1929-1953 is 23.5 inches. Weather data obtained from Altus Air Force Base Weather Station, during the construction period is included in this section, and is considered typical for all sites.
- b. Foundation Materials; The area is generally on the western limits of the Wichita Mountain disturbance. Soils in the area have been developed as sedimentary formations and are generally underlain by the "Permian Red Beds". The terrain is generally flat to gently rolling hills and is within the boundaries of the Red River watershed. Material encountered at the bottom of the silos ranged from shale at sites numbers 1,4,6,7,8,9,10,11 and 12, to fine grained, shaley sandstone at sites numbers 2, 3 and 5. Material encountered during excavation constitutes backfill material except material wasted offsite due to over size or containing more than 20% gypsum or anhydrite as set forth in contract specifications.

Logs of materials encountered during excavation, maintained by

the Project Engineer on site, are included in the sentence of site presentations.

Site No. 1 - Lone Wolf

1. Site Location:

Site No. 1 is located 4 miles south of Lone Wolf, Oklahoma, on the east side of U. S. Highway 64. Mean sea level of original ground at the center of the silo is 1526.3 feet. The east shore of Lake Altus is approximately 1 mile southwest of the site and at conservation pool elevation, surface of water is 9 feet above ground level at the site.

2. Geology:

In an area of fertile wheat farmland, ground surface is relatively flat with surface drainage to the east. In the site aerial photograph can be seen a small granite bathslith approximately 1500 feet west of the site. Three miles to the south and five miles to the east of the site, massive granite mountains of the Wichita Mountain disturbance rises over 200 feet above ground level.

Overburden in the area is of sedimentary nature composed chiefly of clays. At a depth of 11 feet, red-bed shale was encountered and experienced throughout the remaining open-cut and silo excavation. A few small areas containing thin gypsum partings were observed intermittantly and sparingly below 60 feet.

Though groundwater was experienced at various elevations during excavation, quantity was considered minor and all areas were contained.

3. Excavation & Stockpiling Procedures:

Open-cut excavation was commenced on 11 May 1960. Normal excavation procedures and equipment were employed. Equipment utilized were as follows: 3-DW 21 scrapers, 1-30 cy tractor drawn scraper, 1-push cat, 1-dozer, and 1-motor grader.

Topsoil from the area was first stripped and stockpiled for use in final grading. The remaining material was then stockpiled according to type for future backfill.

Open-cut excavation was completed on 21 May 1960 to a depth of 34.5 feet.

Silo shaft excavation was commenced on 24 May 1960 from bottom of open-cut area. Equipment utilized in shafting were: 1-crane w/clam bucket, 2-8 cy dump trucks, 1-D 6 loader w/ripper, 5-air hammers w/points and spades, and 1-compressor.

Shafting sequence employed were as follows:

- 1. Excavate by use of loader w/ripper to elevation midway to next ring beam elevation, stockpiling material behind bang-board for removal by crane.
 - 2. Miners trim sides with air tools to neat line.
 - 3. Set ring beam, wire mesh, and gunite walls.

Bang-boards were installed as excavation progressed and are visible in photograph lr as well is crane loading dump truck for removal to stockpile.

Slope conditions of open-cut are apparent in photograph 135 as well as upper portion of silo, guniting machine, and work area.

Silo excavation was completed on 6 July 1960.

4. Unusual Conditions Encountered:

No conditions were encountered that were considered unusual. It was not necessary to waste any of the material from excavation and all will be used in backfilling operations though it is considered shale to be not an ideal backfill material for this type construction.

Site No. 2 - Snyder

1. Site Location:

Site No. 2 is located 2 miles north of Snyder, Oklahoma on the east side of U. S. Highway 183. Mean sea level of original ground at the center of the silo is 1373.9 feet.

2. Geology:

Site No. 2 is located in an area of fertile wheat farmland with a relatively flat surface with drainage to the north. The area is bounded by massive granite mountains of the Wichita Hountain disturbance.

Overburden in the area is of sedimentary nature composed chiefly of clays. At a depth of 40 feet, bedrock was encountered in the form of red-bed shale. At 44 feet shaley sandstone was encountered and was experienced through the remaining excavation except for a fifteen foot strata of sandy shale from 66 feet to 81 feet.

Very little groundwater was observed causing no difficulties in handling.

3. Excavation & Stockpiling Procedures:

Open-cut excavation was commenced on 9 May 1960. Normal excavation procedures and equipment were employed. Equipment utilized were as follows: 3-DW 21 scrapers, 1-push cat, 1-dozer, 1-motor grader.

Topsoil from the area was first stripped and stockpiled for use in final grading. The remaining material was then stockpiled according to type for future backfill.

Open-cut excavation was completed 22 May 1960 to a depth of 35 feet.

Silo shaft excavation was commenced on 24 May 1960 from bottom of the open-cut area. Equipment utilized in shafting were: 1-crane w/clam bucket, 2-8 cy dump trucks, 1-loader w/ripper, 1-compressor, and air hammers w/points and spades.

Shafting sequence employed was as follows:

- 1. Excavate by use of loader w/ripper to elevation midway to next ring beam elevation, stockpiling material behind bang-board for removal by crane.
 - 2. Miners trim sides with air tools to neat line.
 - 3. Set ring beams, wire mesh, and gunite walls.

Bang boards were installed as excavation progressed as a safety measure. Material removal from shaft was accomplished from behind the bang boards with clamshell loading dump trucks for hauling to stockpile.

Slope conditions of open-cut area are apparent in photograph 139 and during installation of wedge in photograph 248. An aerial view of the overall area is shown in photograph 29r with the town of Mountain Park in the background as well as the granite mountains.

Silo excavation was completed on 7 July 1960.

4. Unusual Condition Encountered:

No conditions were encountered that were considered unusual and none of the material from excavation was wasted.

Site No. 3 - Cache

1. Site Location:

Site No. 3 is located $3\frac{1}{2}$ miles west of Cache, Oklahoma and 6 miles east of Indiahoma on the south side of U. S. Highway 62. Mean sea level of original ground at the center of the silo is 1311.1 feet.

2. Geology:

The site is located on the north edge of wheat farmland and is in an area of rolling hills. The site is situated atop a small hill and surface drainage is to the south and east. The Wichita Mountains and Wildlife Refuge are located less than 8 miles to the north of the site. The land is generally rough and unattended between the site and the mountains as seen in photograph 28r.

Overburden in the area is of sedimentary nature composed chiefly of clays to a depth of 22 feet. Bedrock was encountered at this depth in the nature of arkosic sandstone and was experienced throughout the remaining excavation(see log at end of this section).

Very little groundwater was observed causing no difficulties in handling.

3. Excavation and Stockpiling Procedures:

Open-cut excavation was commenced on 10 May 1960. Normal excavation procedures and equipment were employed. Equipment utilized were as follows: 2-DW 21 scrapers, 1-tractor drawn scraper, 1-push cat, 1-dozer, 1-motor grader.

Topsoil from the area was first stripped and stockpiled for use in final grading. The remaining material was then stockpiled according to type for future backfill.

Open-cut excavation commenced on 26 May 1960 to a depth of 34 feet.

Silo shaft excavation commenced on 26 May 1960 from bottom of the open-cut area. Equipment utilized in shafting were 1-crane w/clam bucket, 2-8 cy dump trucks, 1-loader w/rippers, 1-compressor, and air hammers w/points and spades.

Shafting sequence employed were as follows:

- 1. Excavate by use of loader w/ripper to elevation midway to next ring beam elevation, stockpiling material behind bang board and removed by crane.
 - 2. Miners trim sides with air tools to neat line.
 - 3. Set ring beams, wire mesh, and gunite walls.

Blasting was necessary to facilitate excavation at various elevations in the silo. Dynamite was used in quantity to as much as 1 pound per 3 cy of material.

Silo excavation was completed on 18 July 1960. Photograph 142 shows removal of loader from hole upon completion of excavation, also slope conditions as well as work area are shown.

4. Unusual Conditions Encountered:

No conditions were encountered that were considered unusual. It was not necessary to waste any of the material from excavation and all will be used in backfilling operations.

Site No. 4 - Frederick

1. Site Location:

Site No. 4 is located 3 miles north of Frederick, Oklahoma, $\frac{1}{2}$ mile west of U. S. Highway 183. Mean sea level of original ground at the center of the silo is 1327.8 feet.

2. Geology:

The site is located in an area of wheat farmland with a relatively flat surface with drainage to the southeast.

Overburden in the area is of sedimentary nature composed of clays.

At a depth of 7 feet bedrock was encountered in the form of red-bed shale and was experienced throughout the remaining excavation (see log at end of this section).

3. Excavation and Stockpiling Procedures:

Open-cut excavation was commenced on 26 May 1960. Normal excavation procedures and equipment were employed. Equipment utilized were as follows: 2-DN 21 scrapers, 1-tractor drawn scraper, 1-push cat, 1-dozer, 1-motor grader.

Topsoil from the area was first stripped and stockpiled for use in final grading. The remaining material was then stockpiled according to type for future backfill.

Open-cut excavation was completed 10 June 1960 to a depth of 33.3 feet.

Silo shaft excavation commenced on 11 June 1960 from bottom of the open-cut area. Equipment utilized in shafting were: 1-crane w/clam bucket, 2-8 cy dump trucks, 1-loader w/ripper, 1-compressor, and air hammers w/points and spades, 1-track drill(occasionally).

Shafting sequence employed were as follows:

- 1. Excavate by use of loader w/ripper, and where necessary line drill shot holes for blasting, stockpile material behind bang board and remove from shaft by crane.
 - 2. Miners trim sides with air tools to neat line.
- 3. Set ring beams, wire mesh, and gunite walls. Infiltration of groundwater was not considered extreme, however, a system of collection pipes were installed to control water to bottom of excavation, where it was pumped out. These pipes remained through concreting operations and no trouble was experienced.

4. Unusual Conditions Encountered:

No conditions were encountered that were considered unusual. It was not necessary to waste any of the material from excavation and all will be used in backfilling operations.

Site No. 5 - Fargo

1. Site Location:

Site No. 5 is located $5\frac{1}{2}$ miles east of Odell, Texas and 3 miles south of the Red River, on the west side of U. S. Highway 283. Mean sea level of original ground at the center of the silo is 1362.9 feet.

2. Geology:

The site is in an area of cultivated farmland and is relatively flat with surface drainage to the east.

Overburden material is an alluvium deposit composed of fine sands, slagey sands, and sandy clays and is in a state of saturation from the 17 level to sandstone bedrock at 82.3 feet. Sandstone encountered from the 82.3 feet level to the bottom of the shaft were of a fine grained, moderately hard, friable nature, with occasional thin shaley sandstone areas.

3. Excavation and Stockpiling Procedures:

Open-cut excavation was commenced on 24 May 1960. Equipment utilized include 3-DW-21 scrapers, 1-tractor drawn scraper, 1-dozer, 1-push cat, and 1-motor grader.

Normal excavation procedures were used to a depth of approximately 16.5 feet where operations were halted due to subsurface groundwater(as shown in photograph 110). At this elevation a Stang Shorty well point system was installed around the perimeter of the open-cut area(see photograph 130). Water discharge rate from this system measured to be 150

gpm on 108 well points.

Excavation resumed on 17 June 1960 after a 16 day delay while installing well points and pumping down water. Groundwater continued to present a problem, however, excavation of the openacut area was completed 25 July 1960.

Due to the nature of the saturated alluvium soils, two rings of sheet piling were specified by contract to be set from the bottom of the open-cut area into the bedrock at 82.3 feet, effecting a cut-off of the groundwater. Photograph 235 shows driving of the inner ring in progress. A mat of crushed stone has been placed around area as a working base except in the area of the Launch Control Center where groundwater conditions continue to be prevailant. A "French Drain" type system is installed around the lower peryphery of the open-cut with 2 sump pits installed to collect water for pumping out of area. The rate of discharge from area now approximately 300 gpm.

Haliburton Cementing Company was employed to grout around the inner piling in an effort to halt any further infiltration of water at the base of the piling.

Upon completion of the setting of the sheet piling and grouting, excavation of the shaft commenced on 29 September 1960. Free clamming was used for the excavation of the overburden within the piling.

On 4 October 1960, the Haliburton Company returned to the site and started grouting around the outside of the outer pile ring. This operation completed on 6 October 1960.

Shaft excavation to sandstone bedrock reached 82.3 feet 22 October 1960. Upon reaching this elevation it was found sheet piling in many instances was stopped short of bedrock effecting no seal. Therefore.

a 12 foot curtain wall of concrete was poured in this area. This was found to reduce inflow but not alliviate it. Contractor attempted to grout through sheet piling to stop inflow of water using cottonseed hulls, horse manure, 40 sacks of calcium chloride and 2170 sacks of cement.

Shaft excavation continued in sandstone utilizing 1-crane w/clamshell, 1-loader w/ripper, 2-8 cy dump trucks, 1-compressor with air hammers, points and spades, and 1-truck drill(occasionally to bottom of hole).

Gunite was found to be unfeasible on the saturated walls, therefore, by modification, hardwood lagging was installed around the shaft and water was handled behind this lagging and pumped from the bottom of the excavation.

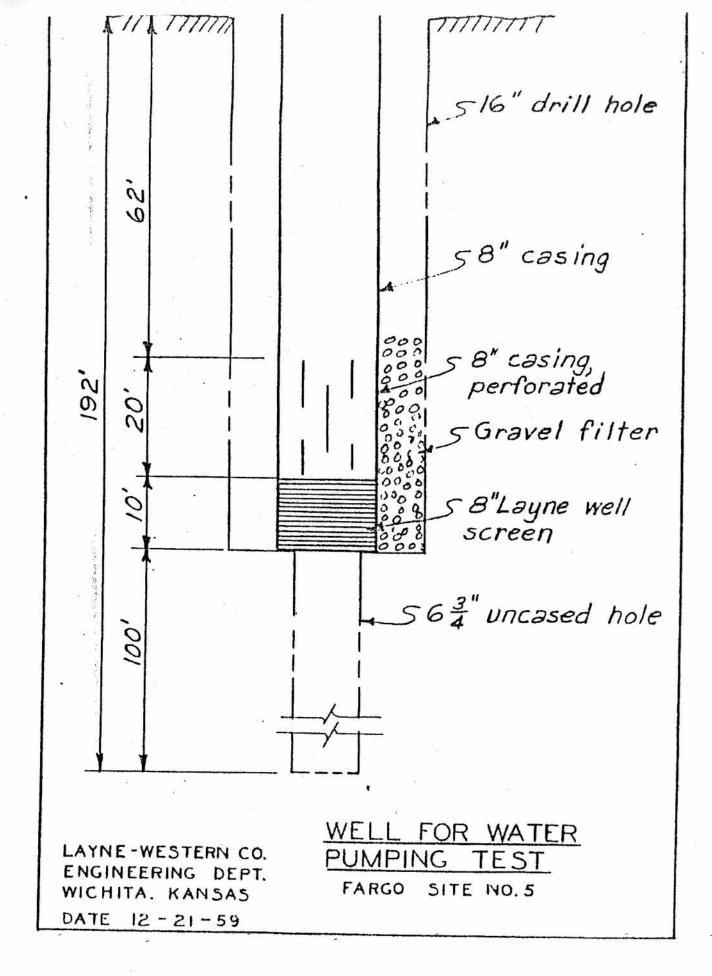
Water pumpage during excavation averaged 336 gpm with a recorded high of slightly over 600 gpm.

Shaft excavation was completed on 12 December 1960.

A Stang Shorty Well Point System was installed around the Launch Control Center area to effect a drawdown of water to facilitate a firm base for construction of the Launch Control Center.

4. Unusual Conditions Encountered:

Inability to control the subsurface water has been of major concern and has developed numerous problems in excavation of both the open-cut area and the shaft, as well as construction of the Launch Control Center and the installation of the sight tube. An extensive claim has been prepared by the contractor in this regard.



Site No. 6- Creta

1. Site Location:

Site No. 6 is located $5\frac{1}{2}$ miles east and $3\frac{1}{2}$ miles north of Eldorado, Oklahoma, on the north side of State Highway 44. Mean sea level of original ground at the center of the silo is 1346.6 feet.

2. Geology:

The site is situated in an area of waste land, used principally for grazing. Surface drainage is to the southeast at approximately 1 foot fall per 100 feet.

Overburden in the area is shallow and composed chiefly of clays.

At a depth of 4.5 feet bedrock was encountered in the form of red-bed shale. Massive gypsum was encountered at 33 to 40 feet and the remainder of the excavation was shale containing many gypsum seams and partings above 114 feet(see log at end of this section).

Excavation and Stockpiling Procedures:

Open-cut excavation was commenced on 24 May 1960. Normal excavation procedures and equipment were employed except blasting was required below 21.8 feet. Equipment utilized were as follows: 2-DW 21 scrapers, 1-dozer, 1-push cat, 1-motor grader, 1-track drill for short time.

Topsoil from the area was first stripped and stockpiled for use in final grading. The remaining material was then stockpiled according to type for future backfill. Material classified as gypsum or anhydrite in quantity in excess of 20 percent and oversize material was stockpiled for off-site wasting in accordance with specification requirements.

Open-cut excavation was completed on 6 June 1960 to a depth of 33.5 feet(see photograph 17r).

Silo shaft excavation commenced on 13 July 1960 from the bottom of the open cut area. Equipment utilized in shafting were: 1-crane w/clam bucket, 2-8 cy dump trucks, 1-loader w/ripper, 1-compressor with air hammers, points and spades, and 1-track drill(occasionally).

- 1. Excavate by use of loader w/ripper and where necessary line drill shot holes for blasting, stockpile material behind bang board and remove from shaft by crane.
 - 2. Miners trim sides with air tools to neat line.
 - Set ring beams, wire mesh, and gunite.
 Silo excavation was completed on 17 August 1960.

4. Unusual Condition Encountered:

No conditions were encountered that were considered unusual. Very little groundwater was encountered, causing no trouble, however, considerable blasting was necessary to facilitate excavation.

Site No. 7 - Hollis

1. Site Location:

Site No. 7 is located 4 miles east of Hollis, Oklahoma on the north side of U. S. Highway 62. Mean sea level of original ground at the center of the silo is 1639.0 feet.

2. Geology:

As seen in aerial photograph 18, the site is in an area of fertile, irrigated farmland. The ground surface is almost flat with surface drainage at the site to the southeast with a fall of less than 1 foot per 100 feet.

Small gypsum boulders and cobbles are visible at the ground surface in the surrounding fields. Overburden in the area is composed chiefly of clays with large gypsum boulders to 8 feet in diameter floating at random in the clay from 10 feet to bedrock. Bedrock was encountered at 41.5 feet in the form of massive gypsum. From the 41.5 feet depth to the bottom of the shaft, bedrock was found to be in alternating zones of shale, gypsum, and dolomite(see log at end of this section).

3. Excavation and Stockniling Procedures:

Open-cut excavation was commenced on 2 June 1960. Hornal excavation procedures and equipment were employed. Equipment utilized were as follows: 3-DN 21 scrapers, 1-tractor drawn scraper, 1-dozer, 1-push cat,

1-motor grader.

Topsoil was first stripped from the area and stockpiled for use in final grading. The remaining material was then stockpiled according to type for future backfill. It was necessary to waste approximately 40% of material excavated due to gypsum content and size throughout open-cut and shaft excavation.

Open-cut excavation was commenced on 25 July 1960 from bottom of open-cut area. Equipment utilized in shafting were: 1-crane w/clam bucket, 2-3 cy dump trucks, 1-loader w/ripper, 5-air hammers w/points and spades, 1-compressor, and 2-track drills occasionally.

Shafting sequence employed were as follows:

- 1. Excavate by use of loader with line drilling and blasting as necessary to facilitate excavation to midway to the next ring beam elevation, stockpile material behind bang board for removal by crane and hand to stockpile area.
 - 2. Miners trim sides with air tools to neat line.
 - 3. Set ring beam, wire mesh, and gunite.

4. Unusual Condition Encountered:

Groundwater was first encountered at a depth of 51° below original ground level and became excessive at 136.5 feet. Considerable amounts of gypsum and anhydrite were encountered during excavation and water was found to be contained in solution channels in these areas and discharge was measured at 391 gpm. When excavation reached the 136.5 feet level, Morrison-Knudsen employed the Haliburton Cementing Company to drill and grout the area of water around the silo. This operation proved successful

and normal construction operations proceeded. Cost born the contractor for this unforeseen condition were reimbursed by government.

It will be necessary to borrow backfill material to compensate for the material wasted, however, no additional cost is expected for this item as covered by specifications.

Site No. 8 - Russell

1. Site Location:

Site No. 8 is located 6 miles south and 5 miles west of Mangum,
Oklahoma. Mean sea level of original ground at the center of the silo
is 1678.6 feet.

2. Geology:

The site is located at the north edge of farmland area. Immediately north of the site is wasteland dropping rather sharply to the Salt Fork Red River, running west to east, I mile north of the site. Weathered gypsum outcrops in abundance in the wasteland area.

Overburden in the area is of sedimentary nature composed of fine grained sands, silts, and clays in stratified structure(see photograph 152).

Bedrock was encountered at a depth of 24.5 feet in the form of clayey shale. Gypsum was encountered at a depth of 71.3 feet to 98 feet and again at 166 feet and shaft excavation was bottomed out in gypsum(see log at end of this section).

Excavation and Stockpiling Procedures:

Open-cut excavation commenced on 6 June 1960. Normal excavation procedures and equipment were employed. Equipment utilized were as follows: 2-DW 21 scrapers, 1-tractor drawn scraper, 1-dozer, 1-push cat,

and 1-motor grader.

Topsoil was first stripped from the area and stockpiled for use in final grading. The remaining material was then stockpiled according to type for future backfill.

Open-cut excavation was completed on 21 June 1960 to a depth of 33 feet.

Silo shaft excavation was commenced on 1 August 1960 from the bottom of the open-cut area. Equipment utilized in shafting were: 1-crane w/clam bucket, 2-8 cy dump trucks, 1-loader w/ripper, 1-compressor w/air hammers, points, and spades, and 1-track drill(occasionally).

Shaft sequences employed were as follows:

- 1. Excavate by use of loader w/ripper with line drilling and blasting as necessary to facilitate excavation to midway to the next ring beam elevation, stockpile material behind bang-board for removal by crane and haul to stockpile area.
 - 2. Miners trim sides with air tools to neat line.
 - 3. Set ring beam, wire mesh, and gunite.

4. - Unusual Conditions Encountered:

It was necessary to waste approximately 20% of the material excavated from the shaft due to gypsum content and size. It will therefore be necessary to borrow material for backfill, however, no additional cost is anticipated for this item as covered by specifications.

Groundwater infiltrating the silo was not considered excessive (actual discharge averaged approximately 45 gpm, with a recorded high of 80 gpm) and was handled very effectively by weep pipes and collection

pipes. However, the contractor does claim damage due to the artesian effect of the water encountered as well as material of a harder nature than anticipated.

WATER PUMPING TEST Russell, Oklahoma January 13, 1960

TIME: 8 hours continuous;
Static-Water-Level: (below land surface) 120'7"
Drawdown: (after first 10 minutes) 65'5"
Pumping-Water Level 186'0"
Pumping Rate, G.P.M 55
WELL CONSTRUCTION:
Depth 203 *0"
Drill Hole Dia 11"
Cased to 80' with 10" I.D. pipe
Open Hole (uncased) from 80° to 203°
Adjacent Existing Observation Hole; 22' from pumped well:
Static-Water-Level 120'4"
Water Level at Close of Test 131'8"
This cored hole, cased to $\pm 30^{\circ}$, open to $+200^{\circ}$
Recovery of Water Level in Pumped Well: 121' 4 Hrs.
Recovery of Water Level in Observation Hole: 121'4" 4 Hrs.
LAYEN-WESTERN CO.
Engineering Dept.

Wichita, Kansas

Date 1-14 , 19 60

Site No. 9 - Willow

1. Site Location:

Site No. 9 is located 1 mile north and $\frac{1}{2}$ mile east of Willow, Oklahoma, on the east side of U. S. Highway 283. Mean sea level of original ground at the center of the silo is 1754.5 feet.

2. Geologg:

In an area of fertile farmland, the ground is relatively flat with surface drainage to the southwest at approximately 2 foot fall per 100 feet. In the photograph 23 can be seen the terrain as well as the town of Willow in the background.

Overburden in the area is of sedimentary nature composed chiefly of clays. Bedrock was encountered in the form of shale at a depth of 49.5 feet and was experienced throughout the remaining silo excavation (see log at end of this section).

Excavation and Stockpiling Procedures:

Open-cut excavation was started on 1 July 1960. Normal excavation procedures and equipment were employed. Equipment utilized were as follows: 3-DM 21 scrapers, 2-tractor drawn scrapers, 1-dozer, 1-push cat, and 1-motor grader.

Open-cut excavation was completed 17 August 1960 to a depth of 34.5 feet.

Silo shaft excavation was commenced on 22 August 1960 from the bottom of the open-cut area. Equipment utilized in shafting were:

1-crane w/clam bucket, 2-3 cy dump trucks, 1-loader w/ripper, 1-compressor w/air hammers, points, and spades, and 1-track drill (occasionally).

Shafting sequence employed were as follows:

- 1. Excavate by use of loader w/ripper with drilling and blasting as necessary to facilitate excavation to midway to the next ring beam elevation, stockpile material behind bang-board for removal by crane and haul to stockpile area.
 - 2. Miners trim sides with air tools to neat line.
 - 3. Set ring beam, wire mesh, and gunite.

Shaft excavation was completed on 21 September 1960.

4. Unusual Conditions Encountered:

No conditions were encountered that were considered unusual. It was not necessary to waste any of the material from excavation and all will be used in backfilling operations.

Site No. 10- Hobart

1. Site Location:

Site No. 10 is located $3\frac{1}{2}$ miles west of Hobart, Oklahoma, $1\frac{1}{4}$ mile north of State Highway 9. Mean sea level of original ground at the center of the silo is 1557.3 feet.

2. Geology:

In an area of fertile wheat farmland, ground surface is relatively flat with surface drainage to the northeast. In photograph 39r can be seen the Wichita Mountain range approximately 5 miles south of the sile.

Overburden in the area is of sedimentary nature composed of clays.

At a depth of 16 feet, shale was encountered and experienced throughout
the remaining open-cut and silo excavation with occasional gypsum
partings and seams(see by log at end of this section).

Though groundwater was experienced at various elevations during excavation, quantity was considered minor and all areas were contained.

3. Excavation & Stockpiling Procedures:

Open-cut excavation was commenced on 11 May 1960. Normal excavation procedures and equipment were employed. Equipment utilized were as follows: 3-DW 21 scrapers, 1-tractor drawn scraper, 1-dozer, 1-push cat, and 1-motor grader.

Topsoil from the area was first stripped and stockpiled for use in

final grading. The remaining material was then stockpiled according to type for future backfill.

Open-cut excavation was completed on 20 August 1960 to a depth of 33.8 feet.

Silo shaft excavation was commenced on 20 September 1960 from the bottom of the open-cut area. Equipment utilized in shafting were:

1-crane w/clam bucket, 2-8 cy dump trucks, 1-loader w/ripper, 1-air compressor w/air hammers, points and spades, and 1-track drill(occasionally).

Shafting procedures were as follows:

- 1. Excavate by use of loader w/ripper with drilling and hlasting as necessary to facilitate excavation to midway to the next ring beam elevation, stockpile material behind bang-board for removal by crane and haul to stockpile area.
 - 2. Miners trim sides with air tools to neat line.
- 3. Set ring beam, wire mesh, and gunite. Shaft excavation was completed on 21 October 1960.

4. Unudual Conditions Encountered:

No conditions were encountered that were considered unusual. It was not necessary to waste any of the material from excavation and all will be used in backfilling operations.

Site No. 11 - Manitou

1. Site Location:

Site No. 11 is located 6 miles south of Snyder, Oklahoma, and 3 miles north and 1 mile east of Manitou, Oklahoma. Mean sea level of original ground at the center of the silo is 1337.5 feet.

2. Geology:

In an area land used partially for farming and partially for cattle grazing. The general area is composed of rolling hills with granite mountains 5 miles to the north. Surface drainage at the site is to the north at approximately 3 feet per 100 feet.

Overburden in the area is composed of clays. At a depth of 6.5 feet bedrock was encountered intthe form of shale. Shale was experienced from the 6.5 feet level throughout the excavation except a small strata (1' to 4' thick) of gypsum at a depth of 135 feet. Silo

was bottomed out in a zone of condlomeratis shale.

Excavation and Stockpiling Procedures:

Open-cut excavation was commenced on 13 June 1960. Normal excavation procedures and equipment were employed. Equipment utilized were as follows: 2-DW 21 scrapers, 1-tractor drawn scraper, 1-dozer, 1-push cat and 1-motor grader.

Topsoil from the area was first stripped and stockpiled for use in final grading. The remaining material was then stockpiled according to type for future backfill.

Open-cut excavation was completed on 24 June 1960 to a depth of 36.3 feet.

Silo shaft excavation commenced on 8 July 1960 from the bottom of the open-cut area. Equipment used in shafting included: 1-crane w/clam bucket, 2-8 cy dump trucks, 1-loader w/ripper, 1-compressor with air hammers, points, and spades, and 1-track drill.

Shafting sequence employed were as follows:

- 1. Excavate by use of loader w/ripper to elevation midway to next ring beam, stockpile material behind bang board for removal by crane and haul to stockpile area with dump trucks.
 - 2. Miners trim sides with air tools to neat line.
 - 3. Set ring beam, wire mesh, and gunite.
 Slope conditions of open-cut area is noticable in photograph 243.
 Silo excavation was completed on 2 August 1960.

4. Unusual Conditions Encountered:

No conditions were encountered that were considered unusual. Only a minor amount of subsurface groundwater was encountered, offering no handling difficulties. It was unnecessary to waste any of the material from excavation and all will be used in backfilling operations.

Site No. 12 - Granite

1. Site Location:

Site No. 12 is located 2 miles west of Granite, Oklahoma, on the south side of State Highway 9. Mean sea level of original ground at the center of the silo is 1585.13 feet.

2. Geology:

Surface of the ground at the site is relatively flat located in wheat farmland area. Less than 1 mile to the north are massive granite mountains as seen in photographs #31 and 361.

Overburden in the area is slight and composed chiefly of clays.

Bedrock was encountered at a depth of 3 feet and was experienced throughout the remaining excavation.

Excavation and Stockpiling Procedures:

Open-cut excavation was commenced on 30 June 1960. Normal excavation procedures and equipment were employed. Equipment utilized were as follows: 2-DW 21 scrapers, 1-tractor drawn scraper, 1-push cat, 1-dozer, and 1-motor grader.

Topsoil from the area was first stripped and stockpiled for use in final grading. The remaining material was then stockpiled according to type for future backfill.

Open-cut excavation was completed on 22 July 1960.

Silo shaft excavation was commenced on 10 August 1960, from the the bottom of the open-cut area. Equipment utilized in shafting were:

1-crane w/clam bucket, 2-8 cy dump trucks, 1-loader w/ripper, 1-compressor

w/air hammers, points and spades, and 1-track drill.

Shafting sequence employed were as follows:

- 1. Excavate by use of loader w/ripper with drilling and blasting as necessary to facilitate excavation, pile material removed behind bang-board for removal from hole by crane and hauling to stockpile by truck.
 - 2. Miners trim sides with air tools to neat line.
- 3. Set ring beam, wire mesh, and gunite. Removal of material from hole is seen in photograph 246.

Silo excavation was completed on 24 September 1960.

4. Unusual Conditions Encountered:

Groundwater was not considered excessive to the extent grouting operations were necessary for control of water to permit quality construction. However, the contractor basis a claim alleging contract documents indicate a negligible quantity of water (1 to 2 gpm) whereas quantities ranging up to 30 gpm were actually encountered. The contractor was able to handle this water flow in the silo by weep pipes and discharge pipes.

It was not necessary to waste any of the material from excavation and all will be used in backfilling operations.