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U. S. ARMY
CORPS OF ENGINEERS
BALLISTIC MISSILE CONSTRUCTION OFFICE
[CEBMCO]

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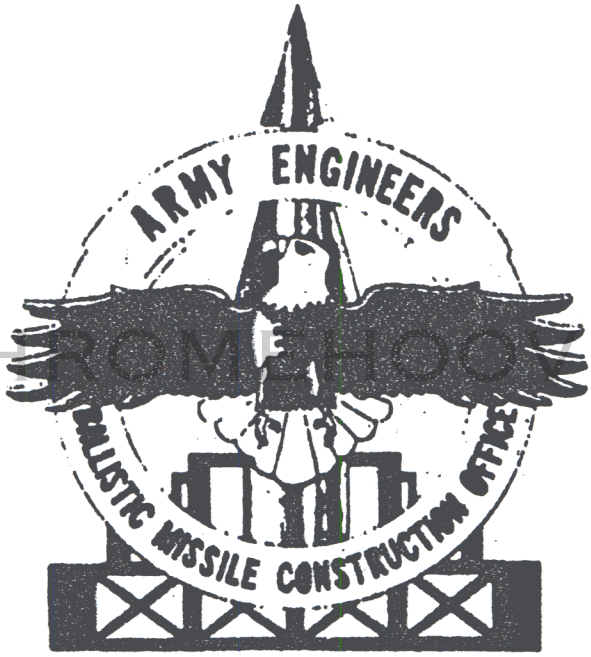

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LOWRY AREA
HISTORY

29 SEPTEMBER 1958 — 16 DECEMBER 1961

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HISTORY OF THE LOWRY AREA

29 September 1958-16 December 1961

Prepared by
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and
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Approved by:

Joe A. Clema
Colonel, Corps of Engineers
Area Engineer

LOWRY AREA, UNITED STATES ARMY,
CORPS OF ENGINEERS, BALLISTIC MISSILE CONSTRUCTION OFFICE

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NOTE: Subsequent to 16 December 1961, the construction portion of this history (pages 33 to 61) was expanded upon by Mr. Wm. P. Fulton of the Titan I Construction Directorate.

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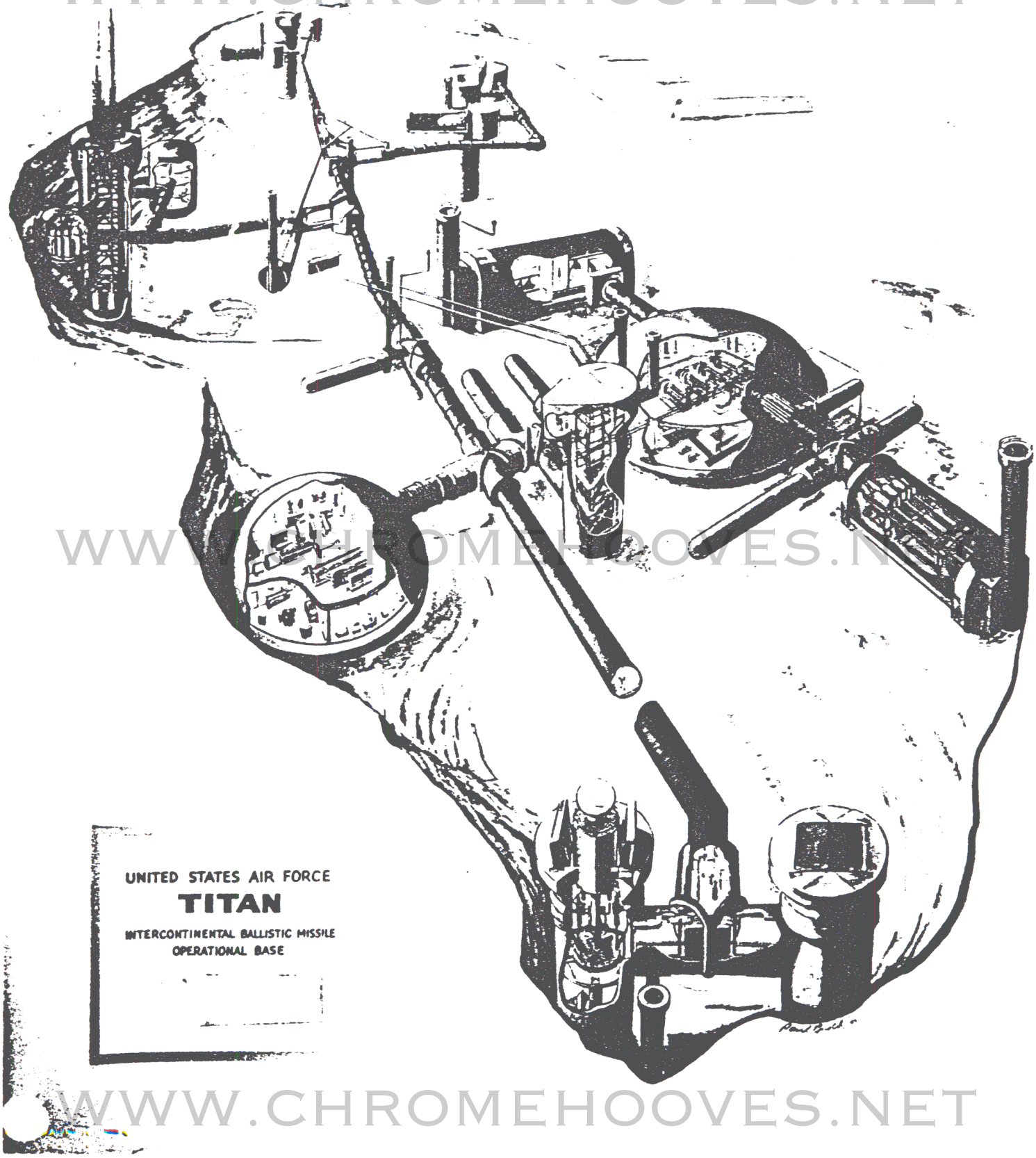

UNITED STATES AIR FORCE

TITAN

INTERCONTINENTAL BALLISTIC MISSILE
OPERATIONAL BASE

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FOREWORD

The history of the Lowry Area, U. S. Army, Corps of Engineers Ballistic Missile Construction Office had its origin in the Denver Area which was created by the Omaha District Corps of Engineers in July 1950. The Lowry Area, a field agency of the Ballistic Missile Construction Office Titan I Directorate, Los Angeles, California, was established at Buckley Air National Guard Base, Denver, Colorado, by the Office, Chief of Engineers by General Order No. 29 dated 15 September 1960.

The Area successfully completed nine construction contracts totaling approximately $115 million ahead of schedule on 11 October 1961 despite over 500 major modifications involving thousands of changes as the result of research and development and design being accomplished concurrent with the construction, the 1959 national steel strike, various local labor strikes, walkouts, and joint occupancy in congested areas caused by the concept of concurrency of installation and checkout of equipment during the construction activity. Additional work involving new modifications and support facilities were completed ahead of schedule on 10 December 1961.

The Lowry Area was unique in that the Area Engineer was also the Contracting Officer, the construction consisted of two Titan I Squadrons rather than one as in other areas, and in that these were the first two hardened Titan I ICBM operational squadrons.

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During the peak work load the maximum Area strength was eleven Army Engineer officers and 168 Corps of Engineers civil service employees. These personnel supervised construction contractors with a work force of approximately 2000 personnel.

The outstanding accomplishments of the Lowry Area have been recognized by the receipt of commendations and awards from higher headquarters. A rating of "Superior" was received in the last Engineer Inspector General inspection. The major prime construction contractor, Morrison-Knudsen Company, Inc. and Associates, was recommended for and received the Certificate of Appreciation for Patriotic Civilian Service from the Secretary of the Army and the Chief of Engineers.

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The Lowry Area had the lowest Government and overhead costs for construction of any ICBM base in the United States. Because of its fine safety program, it also earned the best safety record in the missile construction program. The major contractor was the recipient of the National Safety Council Award of Honor, the Employers Mutual Insurance Company's highest award of merit and the Corps of Engineers Ballistic Missile Construction Office Safety Award for fiscal year 1961 in recognition of the outstanding safety record.

The military and civilian personnel of the Lowry Area worked hard as a closely knit team and maintained high spirits and superior morale in their successful accomplishments. Effective on 16 December 1961, pursuant to General Order No. 3 dated 1 December 1961, all construction work having been accomplished, all modifications

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settled and finally closed out, all property and buildings released, and personnel transferred, the Lowry Area was abolished.

Joe A. Clema

JOE A. CLEMA
Colonel, Corps of Engineers
Area Engineer

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MISSION

The mission of the Lowry Area Corps of Engineers Ballistic Missile Construction Office is to supervise and prosecute the military construction, inspection, and contracts administration for the U. S. Air Force Titan I Intercontenintal Ballistic Missile (ICBM) Construction program in the Denver, Colorado vicinity.

The U. S. Air Force has the responsibility, with highest national priority, for the development and employment of the ICBM and Associate Weapons Systems. It is the responsibility of the Corps of Engineers to construct for the Air Force certain technical and operational facilities for the ICBM and Associate Weapons System. In addition, the Corps of Engineers is responsible for the design of certain items including most of the support facilities, coordination with the design agency, and review for construction feasibility designs prepared under jurisdiction of the Air Force Ballistic Systems Division (BSD). The Corps of Engineers, Ballistic Missile Construction Office, Los Angeles, California has been assigned the responsibility of coordinating with the design agency and reviewing for construction feasibility those designs prepared under jurisdiction of BSD.

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The responsibility for supervision and inspection of the construction of the Titan missile base at Lowry Air Force Base has been delegated to the Lowry Area, in coordination with the Titan I Directorate, Corps of Engineers, Ballistic Missile Construction Office (CEBMCO), Los Angeles, California. To provide for the supervision of inspection of the

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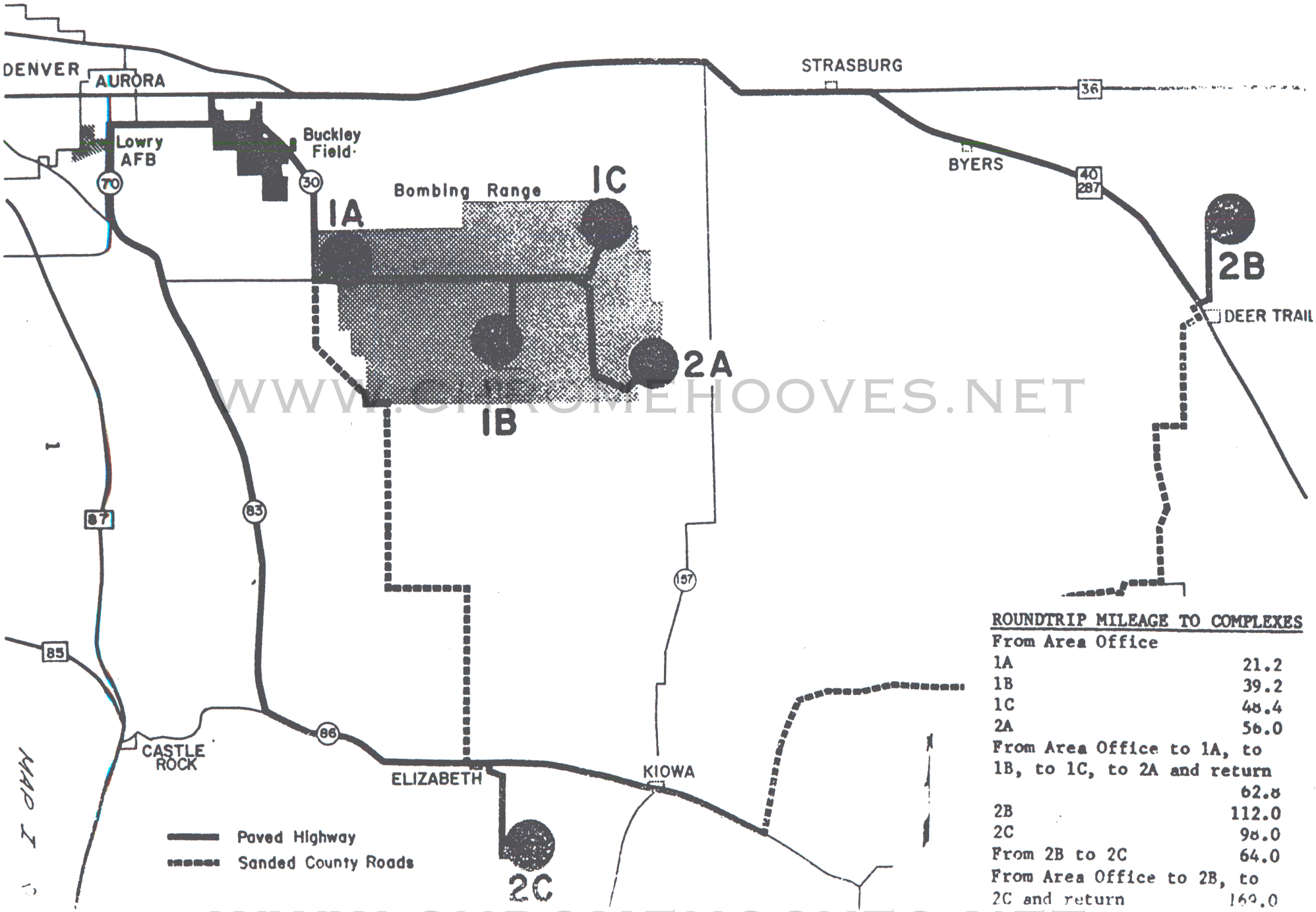

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ROUNDTRIP MILEAGE TO COMPLEXES

From Area Office	
1A	21.2
1B	39.2
1C	48.4
2A	56.0
From Area Office to 1A, to 1B, to 1C, to 2A and return	62.8
2B	112.0
2C	98.0
From 2B to 2C	64.0
From Area Office to 2B, to 2C and return	160.0

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construction and adequate opportunity for liaison between the Corps of Engineers field forces and the Air Force Site Activation Task Force (SATAF) representatives, the Lowry Area Office was established at Buckley Air National Guard Base east of Denver, Colorado.

A total of six Titan I ICBM complexes were constructed on the rolling plains extending eastward from the foothills of the Rocky Mountains, a sparsely vegetated area. The topsoil is a sandy lean clay supported by the Dawson and Laramie shale formations. Only a small amount of ground water was encountered in the excavation because the water table is located at a considerable depth. Telephone and power lines were built to the complexes from the existing lines in the vicinity.

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Four of the complexes are located on the Government reservation known as the Lowry Bombing Range, an area 15 miles east of Denver City limits formerly used by the Air Force for bombing practice. The remaining two were built near the small towns of Elizabeth and Deertrail, Colorado, on construction sites acquired from private land owners. A road network was built to the four complexes located on the bombing range. The remaining two complexes were reached from existing roads in the area. Access roads were built to each of the six complexes.

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BACKGROUND AND AUTHORITY

The Lowry Area was established by General Order 29 dated 15 September 1960 by Office, Chief of Engineers. It is an offspring from the Denver Area which was created by the Omaha District Corps of Engineers in July, 1950. The Lowry Area is a field agency of the Titan I Directorate, Corps of Engineers Ballistic Missile Construction Office (CEBMCO), Los Angeles, California. CEBMCO was created by the Chief of Engineers in the summer of 1960 to coordinate all missile construction work in the United States. It took over the responsibility for Titan I construction near Denver, Colorado from the Omaha District on 15 September 1960. The Omaha District continued to support the Lowry Area in personnel and fiscal matters. The Lowry Area program consisted of construction two hardened Titan I ICBM operational squadrons in the vicinity of Denver, Colorado, and supporting facilities at the Titan I construction sites and on Lowry Air Force Base. This consisted of nine construction contracts in the amount of nearly $115 million.

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The Area Engineer was delegated full contracting officer authority by the Chief of Engineers. This authority was modified to the extent that command control was retained by the Director, Titan I Construction Directorate, CEBMCO, Los Angeles, California, and limited by the following, all of which were subject to approval by higher authority:

a. Extensions of contract time.

b. Changes involving acceleration of work to buy back time.

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c. Approval of modifications which were of a nature that they could affect another of the Titan I construction sites.

d. The authority to enter into new contracts.

Lt. Colonel Paavo D. Carlson was designated Area Engineer and Authorized Representative of the Contracting Officer on 13 April 1959 and Successor Contracting Officer on 15 April 1960. Colonel Joe A. Clena was designated Area Engineer on 16 February 1961 and Successor Contracting Officer on 1 March 1961.

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ORGANIZATION

The Denver Area Office, U. S. Army Engineer District, Omaha, Nebraska, responsible for the construction of the Titan I ICBM facilities near Denver, Colorado, at the inception on 29 September 1958 was not adequately staffed for the mission received. Although this situation was subsequently improved, adequate staffing was not realized until after the CEBMCO take over in September 1960.

Early and complete staffing is paramount in preventing a build up of unresolved items which prevent efficient and proper management and plague all concerned until the mission is finally completed. The staffing as shown on the organization chart dated 13 December 1960 is considered adequate to supervise and administer the construction of two Titan I ICBM operational squadrons.

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ORGANIZATION CHART

DENVER AREA

15 JUNE 1959

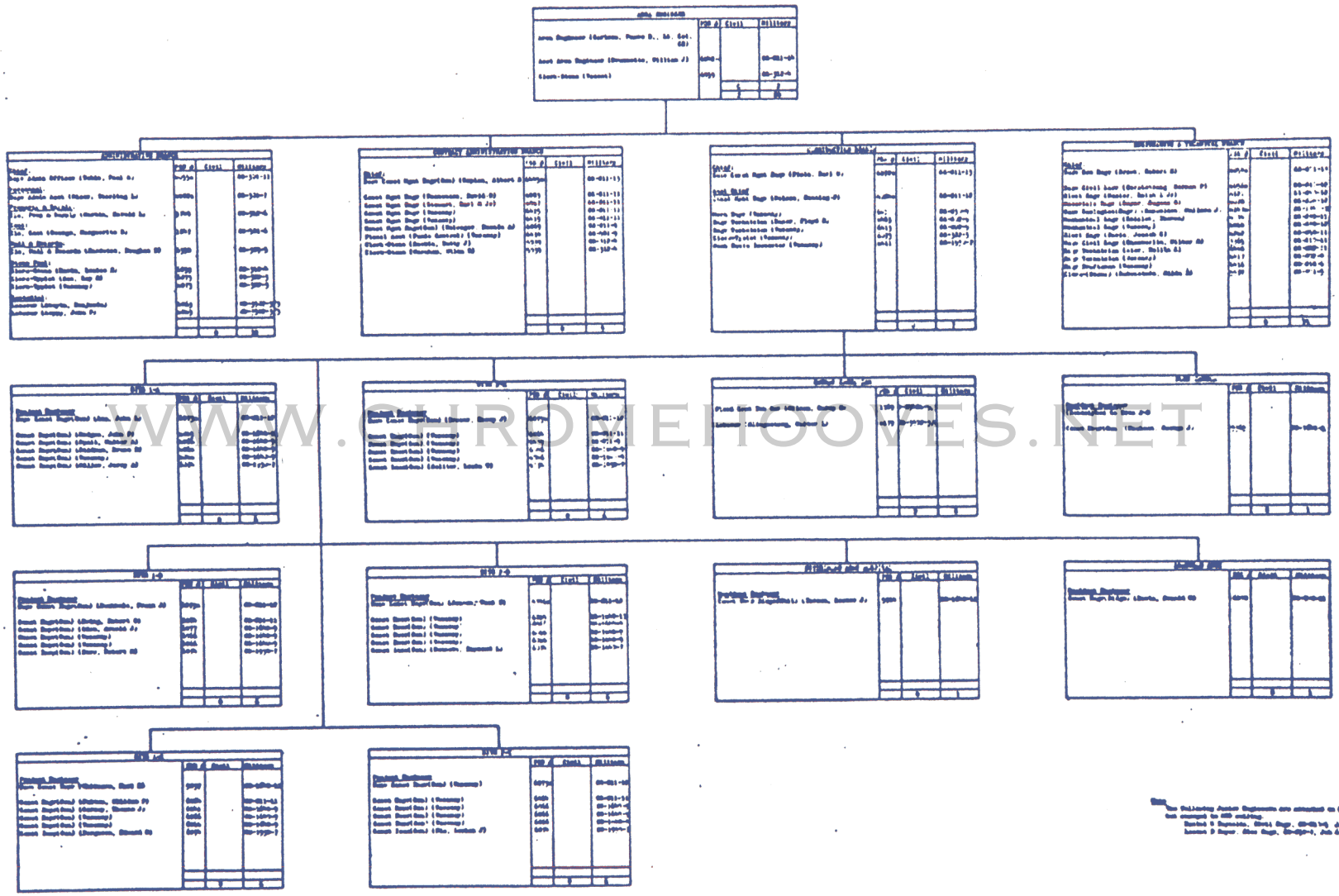

CHART NO. 1

DATE 25 June '59

RECOMMENDED

APPROVED

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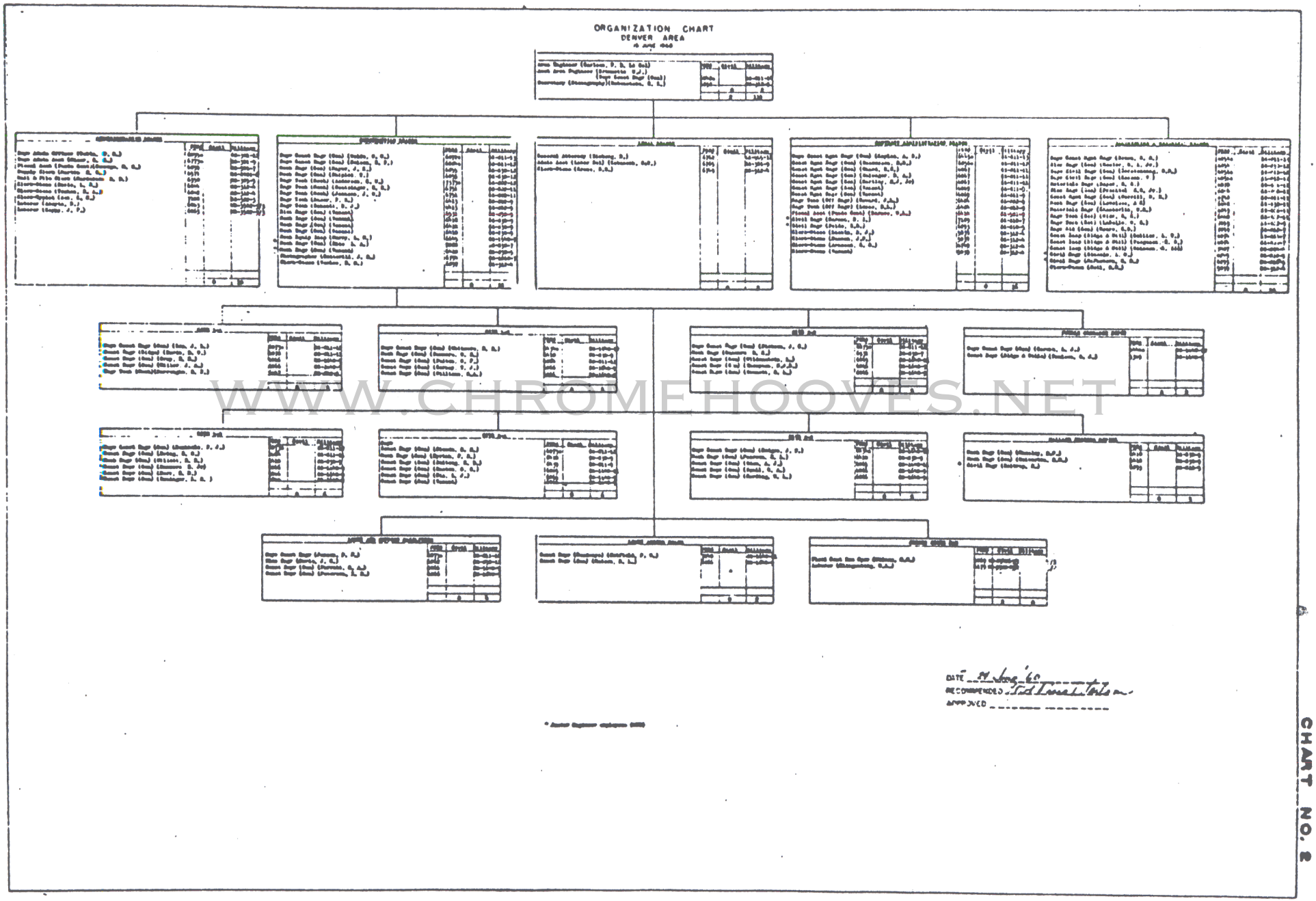

DATE May '60
RECOMMENDED
APPROVED

CHART NO. 8

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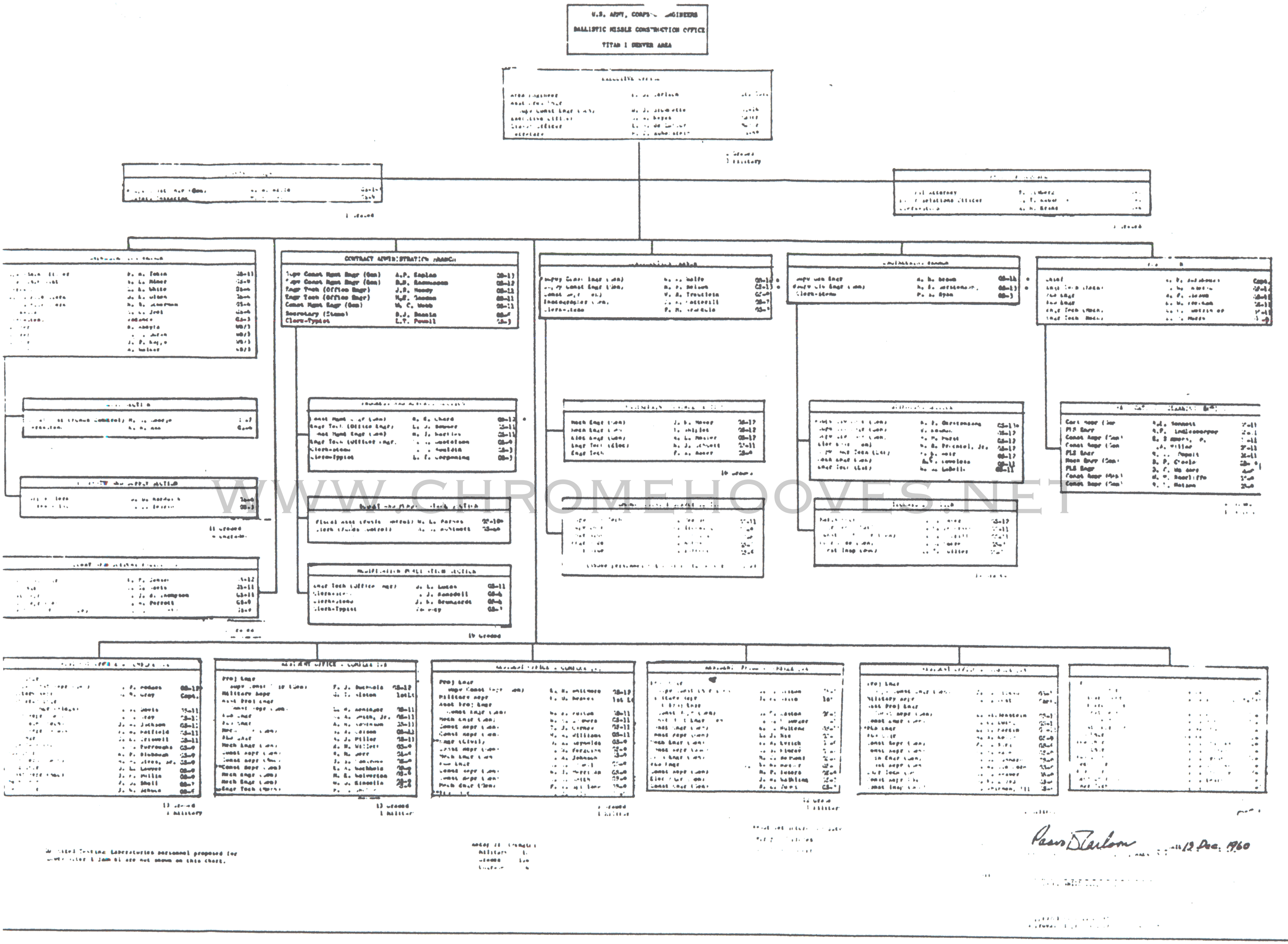

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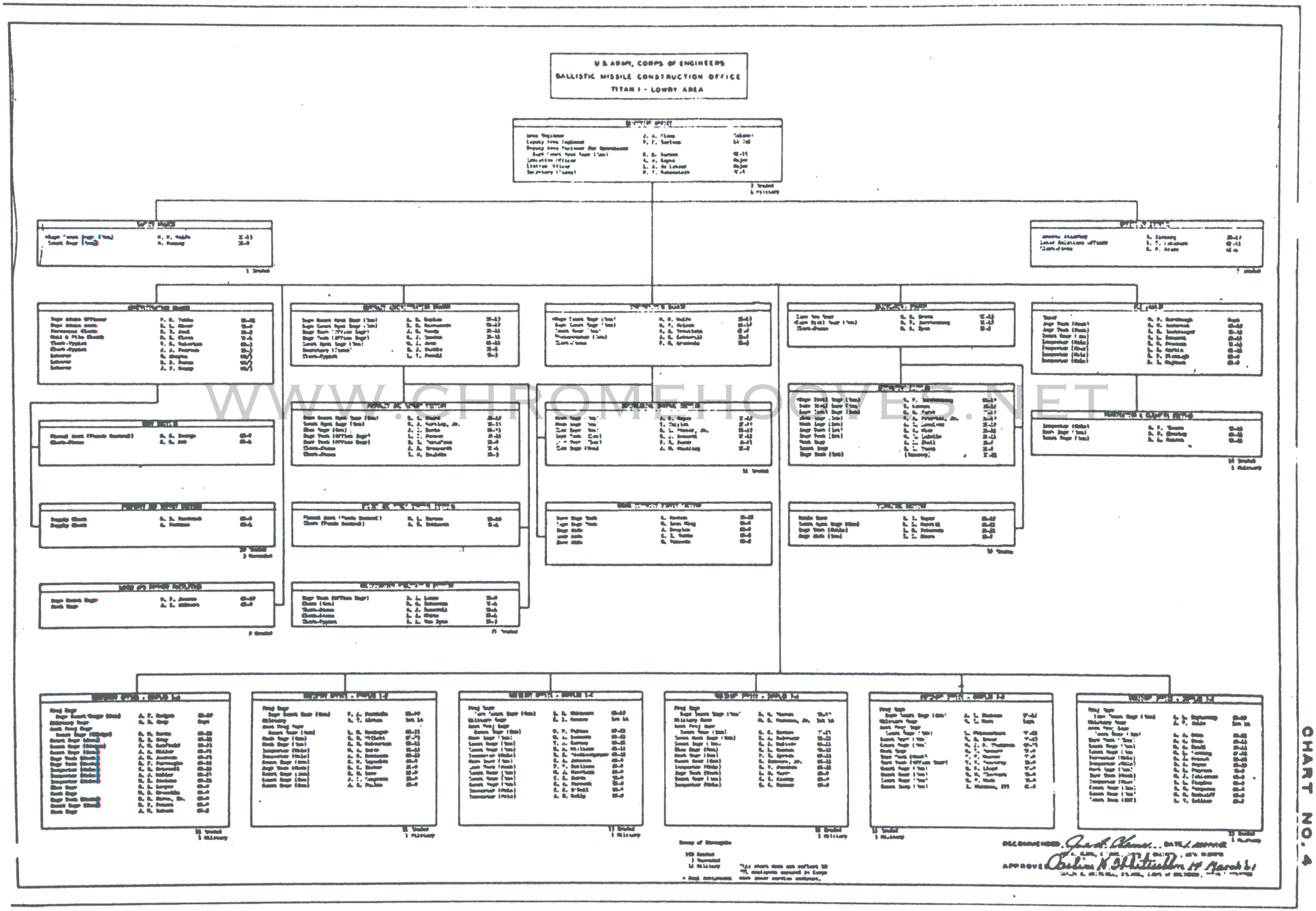

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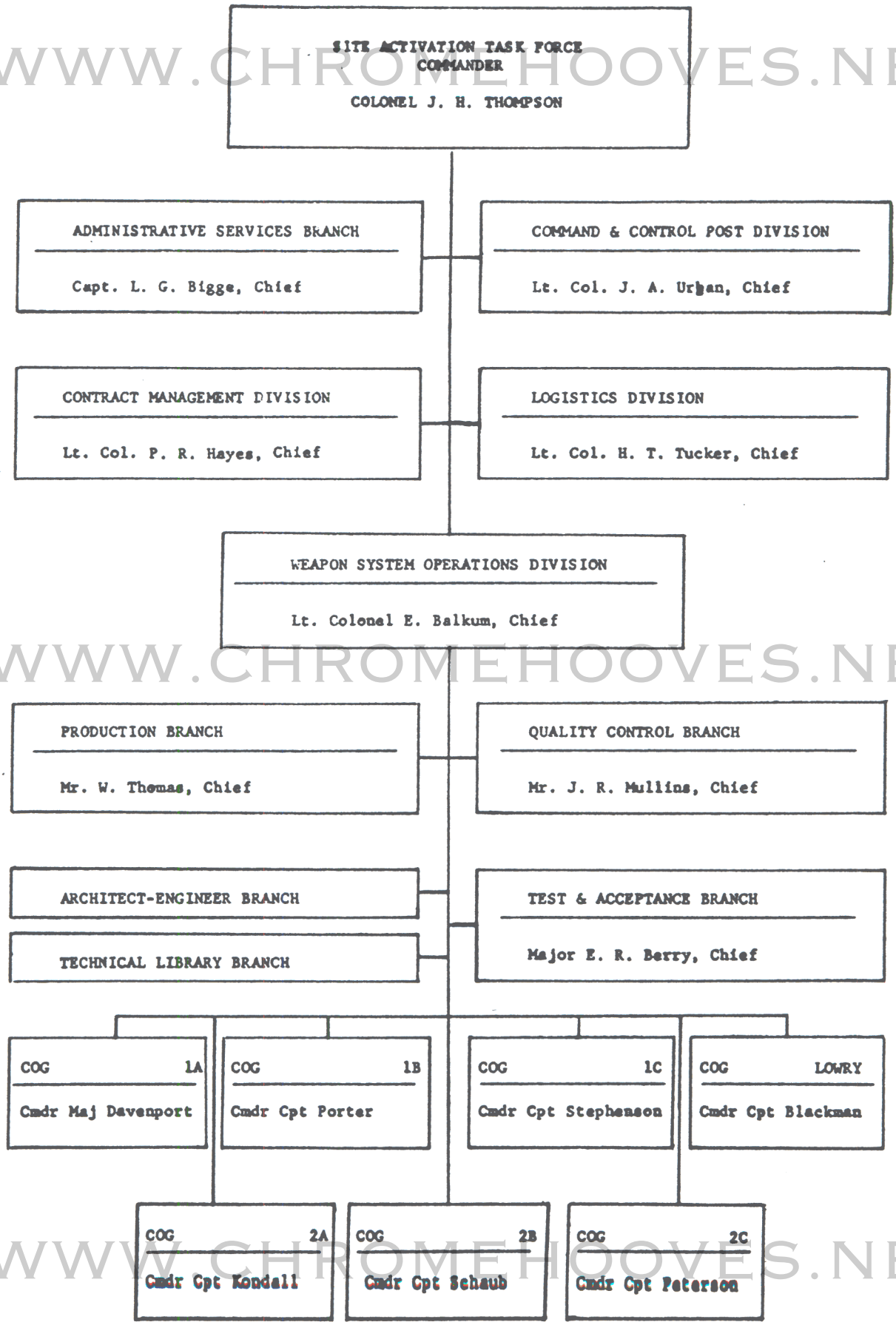

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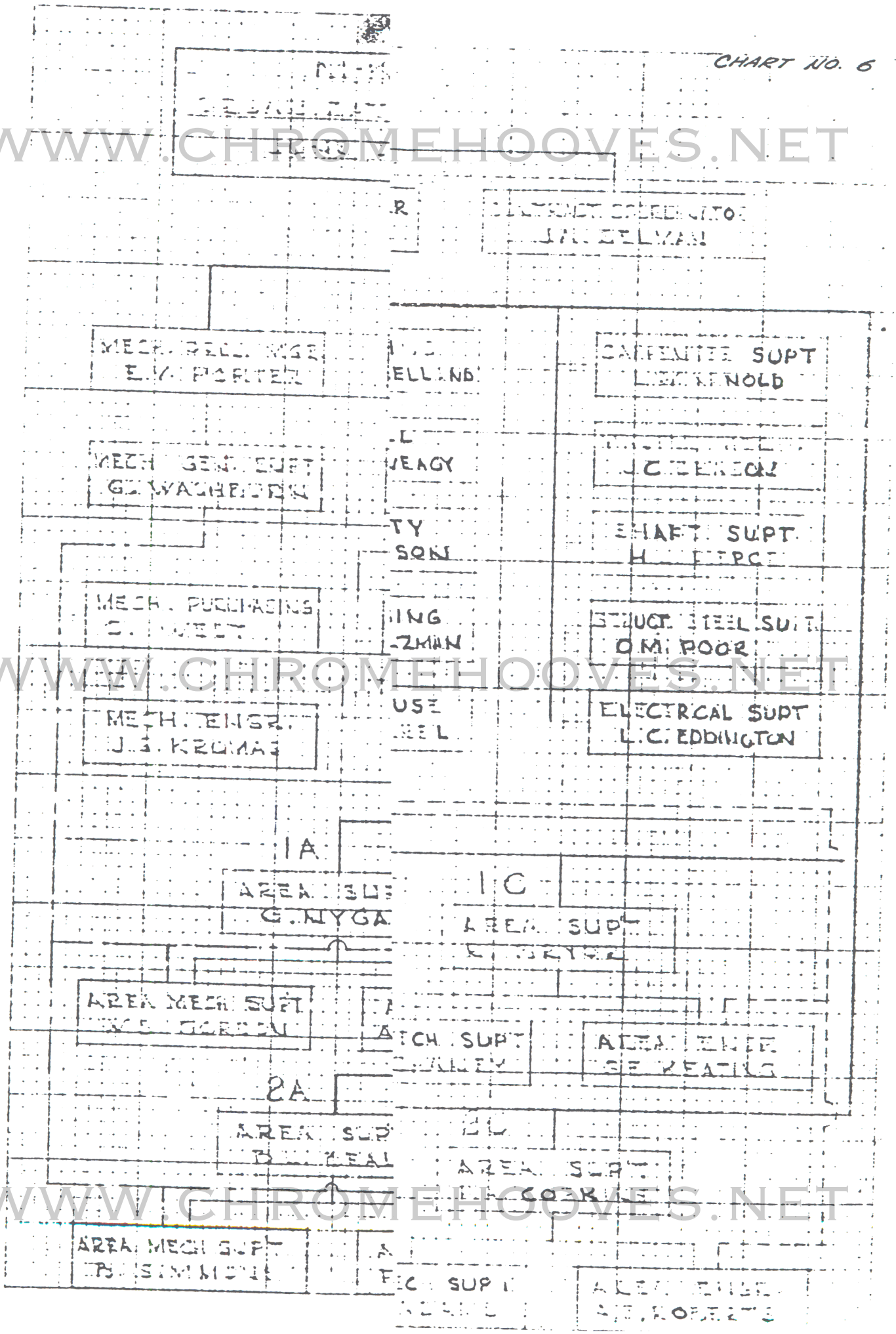
CHART NO. 5

CHART NO. 6



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RELATIONS WITH SATAF AND OTHER AGENCIES

The Lowry Site Activation Task Force (SATAF) is essentially an Air Force surveillance and coordination team. Formed in August, 1960, the SATAF is responsible to insure that the construction of facilities, the installation and checkout of the weapons system and associated equipment and the turnover of completed, operational Titan I missile launching and support facilities to the Strategic Air Command are coordinated and performed in a timely and economical manner.

The concept of concurrency utilized in the ICBM program required unusual cooperation between all agencies. The fine relations established at the Lowry project contributed greatly to the successful completion of construction and are a tribute to the personnel of the Area Engineers' office, the Site Activation Task Force, and the various facility and technical contractors.

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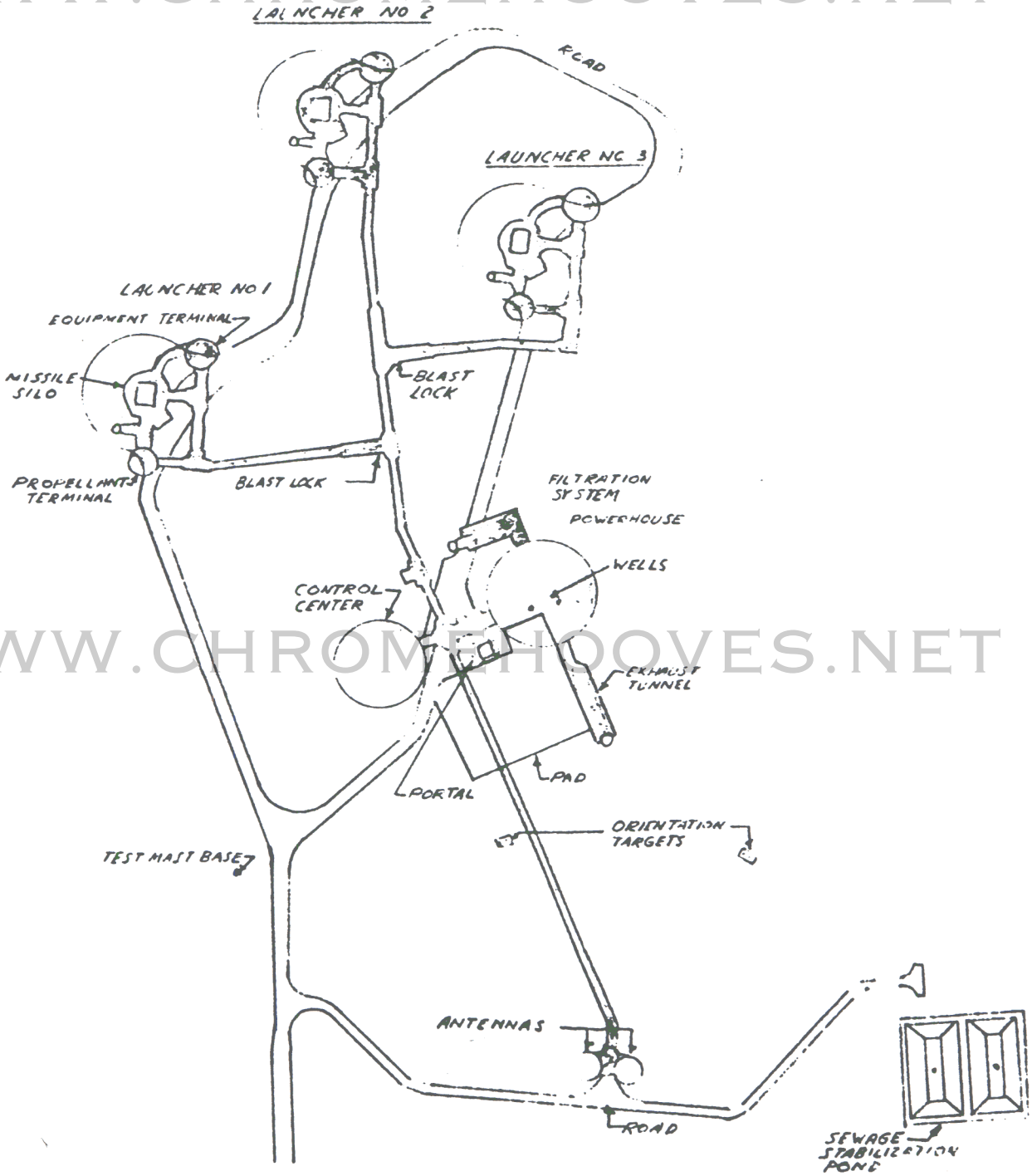

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TYPICAL COMPLEX PLAN

PLAN I

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SCOPE AND METHOD OF WORK

Each of two Titan I ICBM operational squadrons is made up of three missile launching complexes. The principal components of each complex are underground, hardened, connected by tunnels, and assure a self-contained operation. Each complex includes the following:

a. Three launch stations, each with a missile silo, supporting equipment terminal, propellant terminal and propellant system.

b. One guidance facility with two antennas and one antenna terminal.

c. One underground control center.

d. Utility and service facilities, including an underground powerhouse for the electrical generating, heating, ventilating, and air conditioning equipment.

e. Interconnecting tunnels for utility distribution and personnel access.

f. Utilities, including roads, water storage and distribution, sanitary system, exterior lighting, portal, air intake, and exhaust.

g. Water wells to provide all water for operation.

h. Access roads to each complex.

Standardized Installed Equipment for both squadrons was furnished under Contract DA-5558 and totaled $14,523,600. This equipment comprised the major mechanical items for:

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a. Propellant loading system

b. Alarm system

c. Air conditioning

d. Plant and propellant loading system control air

e. Motor Control centers

f. Electrical generating equipment

g. Annunciator alarm

h. Air conditioning and refrigeration equipment

i. Utility and hydropneumatic air equipment

The Government furnished to the contractor property including blast detectors, sensing heads for blast detectors, pillow blocks and door hinge shaft pins, and tube assemblies for missile and antenna silo doors, explosion detectors, templates for embedded items, and gases and equipment for final testing of the propellant loading systems.

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The construction is of reinforced concrete and structural steel with steel lined tunnels. An unusual requirement is the blast-proofing of elements incorporated into the work, with the major mechanical and electrical elements shock mounted to withstand all explosions except a direct hit. The open cut excavation was taken to a maximum depth of 60 feet and facilitates placing the utility and personnel tunnels near the surface, thus eliminating the need for tunneling horizontally and reduced the vertical shafting to approximately 125 feet. Controlled backfilling of preassembled steel tunnel sections provided a satisfactory tunnel facility.

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The precise technical requirements for construction of the

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propellant loading system, which represented the key to the operational capability of the complete launcher facility, provided a challenge to the contractor. Its component parts, such as pressure vessels, cryogenic vessels, valves, piping, expansion joints, and filters, had to be manufactured to permit successful operation even though subjected to temperatures varying from -297° F. to +120° F. All portions of the system and its component parts had to be absolutely cleansed of foreign particles larger than 150 microns and hydrocarbons, as the presence of these in the liquid oxygen system might result in violent explosions and void the function of the facility.

Some methods of construction were as follows:

a. All six complexes were constructed concurrently. Each complex was staffed with identical labor and equipment as far as practicable.

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b. All complexes were open cut to the elevation of the personnel tunnels (up to 60' in some locations.)

c. The missile silos were open cut to an approximate depth of 35' below original ground elevation or about five feet above the personnel tunnels. After the silos were excavated by mining methods, the concrete poured to final elevation, the material around the missile silo was excavated to the invert of personnel tunnels.

d. The shaft excavation was carried on in two silos in each complex concurrently. Excavation or mining was accomplished by using a small track tractor equipped with front and loader and a ripper on the rear. The latter was used to loosen the material and front end

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loader placed it to one side where it was removed by a clam shell. Excavation was underway in one silo while ring beams and gunite were being placed in the other.

e. Concreting of the silos was done concurrently in all silos at each complex.

f. After the walls of the silos were constructed to final grade, the tunnels and junctions were placed and fastened together in open cut. Backfilling of the tunnels and junctions proceeded as soon as the tunnels were positioned. Backfill was carefully controlled to prevent tunnel section failure.

g. Tunnel construction was carried out from both extremities of a complex towards the center; that is, construction commenced at the antenna silos and missile silos and was worked towards the control center and powerhouse.

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h. The excavation, forming, and concreting of the powerhouse and control center were accomplished concurrently with the shaft excavation for the silos.

i. Three concrete batching plants were set up by the contractor. One was located along Airline Road near Complex 1B and served Complexes 1A, 1B, 1C and 2A. One each was located on site at Complex 2B and Complex 2C. The plant near 1B dry batched all cement and aggregate which was then trucked in compartmented trucks to the four range sites and there mixed into concrete in 34 cubic foot mixers and then placed. At 2B and 2C concrete was mixed at the plant on site and dumped into special concrete trucks to be transported directly to

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the location for placement.

j. The pipe fabricating, x-ray examination and cleaning facilities were carried out in warehouses assigned to the contractor at Buckley ANG Base, at Wallace Piping Company in Denver, and at Hardeman's plant in Stanton, California.

k. The form fabricating yard was set up at Buckley ANG Base.

l. A reinforcing bar storage and bending yard was set up near the concrete batching plant along Airline Road near site of Complex 1B, which served all six complexes.

m. Security guards were stationed near the entrance to each complex and all contractor and Government personnel and visitors were required to have security passes for access to the sites.

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n. Joint occupancy between facilities construction contractor and associated contractors, the latter bringing the complex to operational completion, commenced on 1 August 1960. Joint occupancy was worked out on an incremental basis.

o. Much of the installed equipment was standardized for all complexes.

The plans and specifications for WS-107 A-2 Technical Facilities, Complexes 1A, 1B, 1C, 2A, 2B and 2C, Lowry Air Force Base, were prepared by Daniel, Mann, Johnson, Mendenhall and Associates, a California architect-engineer firm.

Support facilities include approximately 20 miles of bituminous surfaced access roads complete with drainage structures; twelve water

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wells with an average depth of 1800 ft, six with the ability to produce 165 gallons per minute and six with a capability of 85 gallons per minute; a 106'x180' Guided Missile Assembly Building of masonry construction with steel roof deck complete with utilities; a 198'x170' Technical Supply Building of masonry construction and steel roof deck complete with utilities; Nosecone Facilities, including a 77'x58' Small Arms Shop and 103'x52' Spare Parts Storage building both with steel framework and concrete block walls, a 27'x38' Storage Base Missile Cone Magazine of reinforced concrete, a 10'x41' six bay Storage Base Segregated Magazine Storage building of reinforced concrete construction, and a 13'x13' concrete block Gate House, all complete with utilities; and approximately 30,500 linear feet of 7' chain link fence complete with gates and barriers forming the perimeter of each of the missile complexes.

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