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the sandy hook proving ground 1874-1919
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GATEWAY
SANDY HOOK UNIT



NATIONAL RECREATION AREA / NEW JERSEY

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HISTORIC RESOURCE STUDY
THE SANDY HOOK PROVING GROUND
1874-1919
SANDY HOOK UNIT
GATEWAY NATIONAL RECREATION AREA
NEW JERSEY

by
Edwin C. Bearss

DENVER SERVICE CENTER
BRANCH OF CULTURAL RESOURCES
MID-ATLANTIC/NORTH ATLANTIC TEAM
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
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PREFACE

This report--Historic Resource Study, Sandy Hook Proving Ground, 1874-1919--has been prepared to satisfy the research requirements for this facility as developed in discussions with former Chief of Professional Services F. Ross Holland and his staff of the North Atlantic Regional Office and former Area Manager Dale Engquist and his staff of the Sandy Hook Unit, Gateway National Recreation Area. The goal was to: (a) provide management with a documented history of the Sandy Hook Proving Ground from its establishment in 1874 to its transfer to Aberdeen, Maryland, in 1919; (b) develop and evaluate its significance to the nation's defense during the years that the United States emerged as a world power; (c) define structures and sites important for interpreting the history of the proving ground; and (d) identify structures and activities requiring additional study.

To accomplish these goals, all primary manuscript materials in Record Groups 77 and 156 at the National Archives focusing on the Sandy Hook Proving Ground from its establishment until 1891, when it was established as a separate facility, were reviewed. For the period 1891-1919 the principal sources relied upon were the Executive Documents, the Annual Reports of the commanding officer, and the Returns for U.S. Military Posts. This was done because funding constraints allowed insufficient time for examination of the huge number of documents in Record Group 156 for those years. The New York Times index for the years 1874-1919 was used to locate articles describing proving ground activities.

Many people have assisted in the preparation of this report. Particular thanks are extended to former Area Manager Dale Engquist, former Chief of Interpretation Robert Holmes, and Historian Tom Hoffman, Sandy Hook Unit, Gateway National Recreation Area, for introducing me to this complex area and going out of their way to make my visits productive and enjoyable. Former Chief of Professional Services Ross Holland, friend and colleague for nearly two decades, and members of his

capable staff, Architect Blaine Cliver and Historian Ricardo Torres-Reyes (deceased), shared their knowledge and made administrative decisions which simplified my tasks.

Local historian George H. Moss shared his extensive knowledge of Sandy Hook, while my friend and mentor Dr. Emanuel R. Lewis imparted some of his encyclopedic knowledge of heavy ordnance and its development.

Henry Judd, former Chief Park Service Restoration Architect, and Historical Architects Blaine Cliver of the North Atlantic Regional Office and Gary Higgins formerly of the Denver Service Center toured the Proving Ground structures and "read" the fabric.

My friends at the National Archives--Tim Ninninger, Mike Musick, Dale Floyd, Richard Cox, John Matias, John Pottios, and Bobby Edwards--answered numerous questions, pulled thousands of documents, and copied hundreds. Without their help, cheerfully given, the project could not have been completed successfully.

My former immediate supervisor, John Luzader of the Denver Service Center, shielded me from frustrating distractions.

A special debt of gratitude is owed to my friends and colleagues--John Luzader, Ross Holland, Dr. Harry Pfanz, and Barry Mackintosh, the latter two of the National Park Service's Division of History, who read the manuscript in draft and made valuable comments.

My thanks also go to Harlan D. Unrau, Historian, Mid-Atlantic/North Atlantic Team, Denver Service Center, for editing the manuscript preparatory to printing.

Edwin C. Bearss



I. INTRODUCTION

A. Statement of Significance

In August 1874 steps were taken by the Army's Ordnance Department to establish a Proving Ground at Sandy Hook, New Jersey. Operating on a shoestring budget, the Ordnance people moved expeditiously, and in the fourth week of October the first round was fired from a temporary proof battery. The testing facility soon became one of the Army's most important installations.

A technological revolution in weaponry, sparked by the industrial revolution and fed by the fires of nationalism, was underway on both sides of the Atlantic. The United States at first lagged in the contest. But, in the mid-1880s, Congress, taking cognizance of the powerful modern navies being built by a number of European powers, began to make significant appropriations for the development and manufacture of powerful sophisticated rifled guns and mortars for emplacement in the nation's coastal fortifications.

The Sandy Hook Proving Ground played a vital role in this program. All the experimental guns and carriages for the seacoast defenses were tested at Sandy Hook. After a model had been accepted by the Ordnance Board and placed in production, all the guns and carriages manufactured by the Army Gun Factory, other arsenals, or private contractors were shipped to Sandy Hook to be proof fired before being sent to the site where they were to be emplaced. This practice continued for many years. All the big guns and mortars and their carriages mounted in the nation's Endicott- and Taft-period coastal fortifications from the early 1890s through World War II were developed at Sandy Hook and many were proved there. The heavy and field artillery used in the United States Army in the Spanish-American War and World War I was tested at Sandy Hook, as were various types of Gatling guns and mitrailleuses. The Life-Saving Service's Lyle gun was tested at the Proving Ground. Powders, both explosive and propellant, and fuses were tested.

The Sandy Hook Proving Ground, from its establishment in 1874 until it was phased out in 1918-19 by transfer of its activities to the

Aberdeen Proving Ground, had a key role in the development of the weapons employed by the U.S. Coast Artillery and U.S. Field Artillery during the vital years that the nation emerged as a world power.

B. Recommendations

There are a number of extant structures at Sandy Hook associated with the Proving Ground. Three of these (the 1901-19 Proof Battery, the Brick House [officers' quarters], and the Chemical Laboratory) are of First Order of Significance. The Proof Battery and Brick House are within the Sandy Hook Unit of the Gateway National Recreation Area, while the Chemical Laboratory is on Coast Guard property.

The Proof Battery, with its traverses, railroad, gantry, roadbeds, and associated structures, should be restored to its appearance, circa 1917. The foundations of the two brick structures (ammunition magazine [building No. 38] and constant temperature magazine [building No. 79]) demolished by the Army in the early 1970s should be stabilized. The fuel tank (structure No. 182) and pump (structure No. 186) should be demolished as intrusions on the historic scene. As the adjacent beach area will be developed for recreation, care should be taken in placement and design of structures to support this use so as not to intrude on the historic scene at the Proof Battery.

The Brick House was intimately associated with the Proving Ground from 1878 until 1919. When on-site the various Ordnance Boards responsible for developing, testing, and proving the heavy and much of the light artillery with which the nation fought the Spanish-American War and World War I, met and stayed in this handsome structure. Here, the boards entertained important visitors, such as the Secretary of War, and officers assigned to the Proving Ground slept, studied, ate, and relaxed. The exterior of this structure should be restored to its appearance, circa 1918. This will involve removal of the one-story addition attached to the south elevation that houses the bar. The interior of the Brick House should be adapted for use as a public center for meetings, banquets, conventions, conferences, etc., perhaps on a fee basis. In doing so,

care must be taken not to destroy the structure's integrity and historic fabric.

It is recommended that steps be taken to nominate for inclusion on the National Register of Historic Places the Chemical Laboratory (The structure housed from 1903 to 1917 the Ordnance School of Application.)

Historic Structure Reports should be programmed for the Brick House and Proof Battery.

Other extant structures associated with the Proving Ground are the laundry; powder magazine; powerhouse; machine and blacksmith shops; carpenter, plumbing, and paint shops; shelter house; warehouse No. 12; warehouse No. 13; ordnance barracks; Roman Catholic Church; and dwellings Nos. 18, 21, and 26. All these structures, except the former Roman Catholic Church, are included within the Sandy Hook Unit, Gateway National Recreation Area. They are of Third Order of Significance. It is recommended that their exteriors be maintained to reflect their appearance, circa 1918, and their interiors be given a compatible usage. The laundry (No. 6) and dwellings (Nos. 18, 21, and 26) will probably be used as quarters, while the ordnance barracks (No. 67) may be employed for environmental education.

Area Manager Engquist is to be commended for his foresight in employing the carpenter, plumbing and paint shops, shelter house, warehouse No. 12, warehouse No. 13, and the machine and blacksmith shops as the Park's maintenance area. The foundations of the coal storage house in rear of the powerhouse should be stabilized.

It is recommended that an archeological excavation be programmed at the site of the 1874-1901 proof battery. When the battery was demolished, two of the emplacements were buried. If these emplacements are extant, the 10-inch Rodman slated for transfer to Sandy Hook by the Smithsonian Institution should be mounted on one of them, provided it is of correct dimensions. If not, a platform and butt of the type used for the first Sandy Hook tests in October 1874 should be constructed.

In addition, archeological work is needed to pinpoint shells and munitions disposal areas on the firing range and other parts of Sandy Hook. These pose a serious threat to safety of visitors, construction crews, and employees.

C. Key to Numbering of Structures

<u>Building</u>	<u>Proving Ground Number</u>	<u>Current Numbers (& Names)</u>
Brick House	5	114 (Officers' Club)
Laundry	6	113 (Caddy House by O.C.)
Ammunition Magazine (foundations)	38	173 (at Proof Battery)
Powder Magazine	56	350
Dwelling	18	USCG Permit 112
Dwelling	21	USCG Permit 108
Dwelling	26	USCG Permit 104
Chemistry Laboratory	22	USCG Owns 109 (Old School House)
Roman Catholic Church	23	USCG Owns 123 (Rod & Gun Club)
Ordnance Barracks	67	102 (Old USCG Station)
Constant Temperature Magazine (foundations)	79	174 (at Proof Battery)
Powerhouse	72	124
Shelter House	27	131
Carpenter, Plumbing, and Paint Shops	70	132
Machine and Blacksmith Shop	71	125
New Warehouse	12	130
New Warehouse	13	130

II. THE PROVING GROUND: ITS FIRST SIX YEARS, 1874-80

A. A Need Results in Action

1. A Technological Revolution in Weaponry Engulfs the Nation

The Civil War had been a watershed in its influence on the technology of fortifications and weaponry. The beautifully designed and costly masonry defenses protecting the nation's ports and harbors had been made obsolete, almost overnight, by rifled artillery and the huge Rodman and Dahlgren shellguns. Steam, now used extensively to propel warships, freed them from dependence on wind, thus greatly increasing their tactical mobility and lessening the exposure of their motive power means. The addition of armor further reduced their vulnerability to fire from shore batteries.

By 1865 several European powers had evaluated the technological lessons of the Civil War and had prepared plans for construction of new--and expensive--fortifications armored with huge masses of iron. The United States, having emerged from a terrible conflict, was in no condition to begin an extensive new system of coastal defense. The Corps of Engineers, mindful of the suddenness with which the Third System masonry fortifications had been made obsolete, was hesitant for technological reasons to return "to elaborate works that might quickly become outmoded, as there was much to suggest . . . a coming period of further rapid advances in artillery." Moreover, Congress--with its attention focused on reconstruction, economic questions, and development of the west--was in no mood, for the time being, to spend great sums on the military.¹

The years immediately after the Civil War found the Corps of Engineers undertaking experiments to determine the feasibility of facing existing masonry works with armor-plate, while the Ordnance Department was engaged in designing and testing rifled guns of increased size and power. The armor studies were inclusive, though this means of

1. Emanuel R. Lewis, Seacoast Fortifications of the United States: An Introductory History (Washington, 1970), pp. 66-68.

preserving the utility of existing Second and Third System forts would have been prohibitively expensive.

Experiments by the Ordnance people appeared productive, and it was this area of development that determined the nature of the defenses for which Congress made appropriations in the early and middle 1870s. Because of their size, the projected new cannon could not be emplaced in the casemates of existing masonry forts. They were to be equipped with carriages that would permit them to be retracted below the parapet crest for loading and servicing.

Thus, as fortifications expert Dr. Raymond Lewis has written:

the inability of masonry to withstand modern weapons, the post-war shortage of funds for military purposes, and the need for emplacements large enough to receive the new armament combined in the closing years of the decade [the 1860s] to bring about a return to an inexpensive mode of permanent fortifications in which earth once again became the principal substance of protection.²

In the 1870s and 80s several advances took place in the design and production of heavy ordnance. These developments revolutionized seacoast armament, and made obsolete within a few years the huge number of Rodman shellguns and Parrott rifles positioned in the nation's forts and arsenals.

2. Congress Appropriates \$270,000 for Experiments and Tests of Heavy Rifled Ordnance
 - a. U.S. Contracts for Heavy Rifled Guns

On June 6, 1872, President Ulysses S. Grant signed into law an act making available \$270,000 "for experiments and tests of heavy rifled ordnance"; provided "this appropriation shall be applied to at least three models of heavy ordnance to be designated by a board of officers."

2. Ibid., pp. 68-69.

Secretary of War William W. Belknap moved with alacrity. On July 10 the seven-member Board on Heavy Rifled Ordnance (Col. R.H.K. Whitely, Ordnance Department; Col. George W. Getty of the Artillery; Lt. Col. Horatio G. Wright, Corps of Engineers; Lt. Col. T.T.S. Laidley, Ordnance Department; Major Truman Seymour of the Artillery; Maj. Silas Crispin, Ordnance Department; and 1st Lt. C.E. Dutton, Ordnance Department) that he had named convened in New York City. During the next six weeks the Board met a number of times and discussed and reviewed forty proposals for manufacture of breech-loading and muzzle-loading rifled guns for experiments and tests. A number of inventors and promoters made personal presentations. Some brought models with them.

Out of the proposals considered, the Board, when it adjourned on August 24, recommended to Chief of Ordnance Alexander B. Dyer that these models be "selected for experiments in accordance with the act of June 6, 1872":

Muzzle-loading guns--Dr. W.E. Woodbridge's, Alonzo Hitchcock's, and the lining of cast-iron Rodmans with wrought-iron or steel tubes.

Breech-loading guns--Friedrck Krupp's, E.A. Sutcliffe's, Nathan Thompson's, and the French and Swedish system.

Miscellaneous--H.F. Mann's and Lyman's multicharge.³

One month later, on September 24, General Dyer assembled the Board of Ordnance in Washington "to determine and fix in place, manner, and details of the guns," selected by the Board on Heavy

3. Executive Documents, Printed by Order of the House of Representatives, 3d Session, 42d Congress, 1872-73 (Washington, 1873), Serial 1558, II, 326-40.

Rifled Ordnance.⁴ The Ordnance Board, after ten meetings, on October 9 recommended to Secretary of War Belknap that the Woodbridge, Sutcliffe, Hitchcock, and Thompson guns be "made out of the money now applicable to the manufacture of heavy rifled ordnance for experiment; the manner to be determined by the respective inventor, who shall have control, and direct how their respective inventions shall" be handled. The guns were to be cast under supervision of the Ordnance Department, who would direct their manufacture. The procurement or conversion of 10-inch Rodmans and the 12-inch Krupp breech-loader, which had been recommended by the Board, were to be deferred until such time as it was ascertained whether there would be sufficient funds remaining for their acquisition. When and if procured, it was recommended that contracts should be let in this order: for four converted 10-inch Rodmans and then the 12-inch Krupp breech-loader.⁵

Delays incident to manufacture of guns of "such novel character" had to be overcome. But by June 30, 1873, Chief of Ordnance Dyer was able to report that the Woodbridge, Sutcliffe, Hitchcock, and Thompson cannon should be ready for trial during the winter. He had no doubt but what "much valuable information will result from the trials, which may possibly lead to the early adoption of a suitable rifle-gun of large caliber." Experiments on a large scale, with this in view, had been underway among the European powers for years, and were still being conducted. "with persistent energy and skill and large expenditure of money." A satisfactory solution, however, had not been reached.⁶

4. Ibid., pp. 483-84. Included were: Lt. Col. T.T.S. Laidley, Maj. J.G. Benton, Silas Crispin and T.G. Baylor, and Capt. S.C. Lyford.

5. Ibid., pp. 484-89.

6. Executive Documents, Printed by Order of the House of Representatives, 1st Session, 43d Congress, 1873-74 (Washington, 1874), Serial 1599, II, 7.

b. Chief of Ordnance Dyer Calls for Establishment of a Proving Ground

If the Act of June 6, 1872, were to be implemented, Chief of Ordnance Dyer informed Secretary of War Belknap in October 1872, facilities would have to be secured for a proving and experimental ground. The need had been felt for years, and the Department had been compelled to avail itself of "the limited extent of ground near Fort Monroe for prosecution of these important duties." As the artillery school's range was on the same reservation, space was necessarily too restricted for the operations of both. Besides, the range obtained across land was little more than a mile, and that over Chesapeake Bay seldom available, "whereas for efficient experimental purposes a range of at least six miles was indispensable."

Some central point convenient to railroad communication, with a suitable extent of level ground, should be selected, General Dyer wrote, and "purchased at small cost." Experiments with heavy ordnance could not, he cautioned, be properly conducted without the best and most improved facilities, such as every military power had found necessary to provide.⁷

The Secretary of War failed to follow up on General Dyer's recommendation. When he submitted his annual report for Fiscal Year 1873, Dyer called attention to the Act of June 6, 1872. The tests called for by Congress for heavy rifled ordnance, he wrote, "cannot be executed in the spirit of the law with our present facilities of a proving ground." To efficiently and satisfactorily test a gun, it was mandatory to fire it for accuracy. The Department's Fort Monroe proving ground had a range of less than 1,000 yards when it should have six miles. General Dyer believed a suitable range could be obtained for a small expenditure. He urged that "Congress be asked to make an appropriation for this purpose in the interest of the national defense."⁸

7. Executive Documents, Serial 1558, p. 317.

8. Executive Documents, Serial 1599, pp. 10-11.

3. General Dyer Forms a Board

On November 12, 1873, as a follow up, a Board of Ordnance officers consisting of Lt. Col. Theodore T.S. Laidley, Maj. Silas Crispin, and Maj. Thomas G. Baylor was formed and ordered to assemble at the New York Ordnance Agency on December 3.⁹ The Board's mission was to report on the best method of organizing the manufacturing operations of the Ordnance Department east of the Mississippi River, either by establishment of a grand arsenal on the

9. Theodore T.S. Laidley of Virginia was graduated No. 6 in the Class of 1842 from the U.S. Military Academy, and was commissioned a bvt. 2d lieutenant in the Ordnance Department. He served at the Watervliet and Washington arsenals from 1842-44 as assistant ordnance officer. Laidley was back at Watervliet in 1845 and in the following year transferred to the Allegheny Arsenal. After service in the Mexican War, in which he received two brevets for gallantry, Laidley in 1848, now a 1st lieutenant, returned to Watervliet as assistant ordnance officer. After duty at Fort Monroe Arsenal from 1848-50, he was placed in command of the Charleston, South Carolina, Arsenal for a few months. He commanded the Fayetteville, North Carolina, Arsenal as a captain during 1857-58. From the latter year until September 1861, he was on detail compiling and publishing a new edition of the Ordnance Manual. Laidley spent the Civil War in these successive commands--Inspector of Powder, commander of the Frankford Arsenal, Inspector of Ordnance, and as commander of the Springfield Armory. On May 3, 1866, Laidley, then a major, took charge of the New York Arsenal. Having been promoted to lieutenant colonel, he assumed command of the Watertown Arsenal in 1871.

Silas Crispin of Pennsylvania was graduated No. 3 from the U.S. Military Academy in the Class of 1850. Commissioned a bvt. 2d lieutenant in the Ordnance Corps, he was ordered to the Watervliet Arsenal. During the next 12 years, he saw service at the Washington, D.C., Arsenal (1852-54); the Allegheny Arsenal (1854-59 and 1860); the St. Louis Arsenal (1859-60); the Leavenworth Ordnance Depot (1860); and at Bellaire, Ohio. On January 1, 1862, Crispin, then a captain, was named to command the New York Ordnance Agency.

Thomas G. Baylor, a Virginian, graduated No. 7 in the Class of 1857 from West Point. He was commissioned a bvt. 2d lieutenant in the Ordnance Department and ordered to the Watervliet Arsenal. He transferred to Fort Monroe Arsenal in 1858, where he was stationed when Virginia seceded. In November 1863 he was ordered into the field as the Army of the Cumberland's chief of ordnance. From August 1864 to May 1865, Baylor served on Maj. Gen. William T. Sherman's staff. Baylor on June 27, 1865, was assigned to command the Fort Monroe Arsenal. He was promoted major on March 7, 1867. George T. Cullum, Biographical Register of the Officers and Graduates of the U.S. Military Academy, from 1802 to 1867 . . . (New York, 1879), II, 43, 256, 450-51.

Atlantic seaboard, or the enlargement of and concentration of work in one or more of the arsenals. The remainder of the nation's arsenals would be disposed of or retained as depots of deposit.

This was a pet project that General Dyer had been championing for years. It, he reported to the Secretary of War, could be accomplished without a dollar of appropriations, by authorizing sale of such of the arsenals east of the Mississippi as were no longer of any use to the country, and applying the proceeds of these sales to the purchase of a site and erection of buildings. The concentration of manufacture in one establishment was the strongest rationale in favor of economy and efficiency. Preservation of many arsenals made superfluous since the Civil War was an important item in the Department's estimates, and large sums thus expended could be profitably used in production. A "general law" should be passed giving the Secretary of War discretionary power for their sale at such times as would prove most advantageous to the government, and the proceeds to be applied as suggested.¹⁰

The Board would also report on the possible location of a powder depot and an experimental proving ground for heavy ordnance, recommending sites and their cost.¹¹

4. The Laidley Board Makes its Report

On June 17, 1874, the Laidley Board submitted its report on an experimental ground for heavy ordnance. Such a facility should combine a number of qualities. The area must be "comparatively level," of easy access, not traversed by "highways or extensive watercourses, uninhabited and sufficiently removed from any settlements to avoid any possible accident, and embrace an extension of land of seven to eight miles in length and from one-half to one mile in width." The Board

10. Executive Documents, Printed by Order of the House of Representatives, for the 2d Session of the 47th Congress, 1874-75 (Washington, 1875), Serial 1635, pp. 397-98.

11. Ibid.

deemed it desirable that the site be near the great arsenal on the Atlantic seaboard and the powder depot.

The Board had reconnoitered the beaches and flat interior lands of New Jersey and Long Island. Sites examined on Long Island included the area in and around Babylon, Deer Park, Bay Shore, and Inslip. The terrain was level and adapted in this respect, but these sites were found to be objectionable because of the "frequency of rail and wagon roads and by the rapidly increasing settlements."

On the Jersey shore, the beaches extending southward from Sandy Hook to, and including, Squan and Island beaches were level. The upper end of Squan Beach, in the vicinity of Point Pleasant and Squan Village, had the best local advantages, and was surveyed. A site was identified. The nearest rail connection was about two and one-half miles away. Construction of a connection spur would not necessitate extensive excavation or filling, and could be built at a moderate cost.

Purchase of this site, building the proposed spur and acquisition of the right-of-way, and construction of necessary improvements, it was estimated, would not exceed \$100,000. The Board, therefore, recommended to the War Department that Congress be urged to appropriate \$100,000 at its next session for this project.

If Congress refused, there was the government reservation at Sandy Hook, at the southern entrance to New York Harbor, eighteen miles from the city and in close and quick communication with it. The Hook had an available land area one to two miles in length and in breadth three-fifths of a mile. Its general features were similar to those of Squan Beach, but it was too constricted for all the proposed uses, and the Long Branch Railroad would interfere with its usefulness as an experimental firing range. It was, however, superior in geographical location and equal in other respects to the present facilities at Fort Monroe. In the interim, pending acquisition and development of the Squan Beach facility, the Board recommended that Sandy Hook be utilized, with permission of the Corps of Engineers, as an adjunct to Fort Monroe "for carrying on

such experiments and proof as it may be fitted for, and as may be deemed desirable to have conducted at this point."¹²

5. Ordnance Board Activates a New Facility

a. Secretary Belknap Approves Establishment of the Proving Ground

As it was necessary to be prepared for testing the rifled cannon authorized by the Act of June 6, 1872, the Ordnance Department had to act promptly. It was decided to establish a temporary proving facility at Sandy Hook, while waiting for Congress to act on the Laidley Board's recommendations. On August 3, 1874, Major Crispin, from his office at the New York Ordnance Agency, forwarded to Chief of Ordnance Stephen V. Benet¹³ an estimate of funds needed for "erection of suitable (temporary) appointments for an experimental and proof ground at Sandy Hook . . . , on the government reservation." To be included in the proposed facility would be a proof butt, bombproof, house for chronoscopes, platforms, and other necessary structures and appliances for the test and trial of the experimental guns being cast under the supervision of his office. Crispin's estimates called for:

Four wooden platforms	\$ 800.00
One proof butt	1,000.00
One bombproof	500.00
Building for chronoscope	500.00
Wires and other apparatus	200.00
Two wooden casemates for covering guns	1,000.00
	<u>\$4,000.00</u>

12. Ibid., pp. 415-16.

13. Stephen V. Benet had been promoted from major to brigadier general and chief of ordnance on June 23, 1874, succeeding General Dyer who had died four weeks before. Benet, a native of Florida, graduated from the U.S. Military Academy as No. 3 in the Class of 1849. Commissioned a bvt. 2d lieutenant in the Ordnance Department, he was ordered to Watervliet as an assistant ordnance officer. In 1850-52 he was on special duty in the Ordnance Department. His next assignment was assistant ordnance officer at the Frankford Arsenal, from where in 1853 he was transferred to command of the Pikeville, Maryland, Arsenal. While there he translated Jomini's Campaign of Waterloo. After duty with the Coast Survey and as assistant ordnance officer at the St. Louis Arsenal, Benet, now a 1st lieutenant, was ordered in 1859 to West Point as an instructor. On August 17, 1864, he assumed command of the Frankford Arsenal, a position he held until September 1869, when he was ordered to Washington as assistant to the Chief of Ordnance. Cullum, Biographical Register, II, 372-73.

The proposed structures would be sufficiently permanent in character either to be enlarged or improved in event of it being found desirable to occupy them--until the site selected by the Board of Arsenals was procured--as the proof and trial ground.

Ranges from 500 to 2,000 yards could be easily secured on the reservation. If deemed important, these distances could be extended within the reservation.

Three locations were under consideration. The first (A) was a good and convenient site for the proof of guns, where a "natural bluff of sand" could be modified to serve as a proof butt. The position, however, afforded no target range. The second (B) was the most convenient, and afforded a target range of about 1,200 yards. It, however, might be objected to by the Engineers as too near their buildings. The final position (C) afforded a "clear range" of from 2,000 to 3,000 yards, and was, in Major Crispin's opinion, the best site in the area.¹⁴

Chief of Ordnance Benet transmitted Major Crispin's letter and the drawing locating the sites to Secretary of War Belknap. On doing so, he urged that, if the Chief of Engineers had no objection to use of the reservation as a proving ground, authority be given to enable the Ordnance Department to establish "a proof & trial ground" on that portion of the area marked "C" on the enclosed drawing.¹⁵

14. Crispin to Benet, Aug. 3, 1874, Ltrs. Recd., Chief Engineer, Record Group 77 (Records of the Chief of Engineers), National Archives. A chronoscope is used to measure accurately very brief intervals of time in determining the velocity of projectiles.

15. Benet to Belknap, Aug. 5, 1874, NA, RG 77, Ltr. Recd., Chief Engineer. A copy of the subject plan, "Proof Sites at Sandy Hook," is on file at the Sandy Hook Unit, Gateway NRA.

Chief Engineer Andrew A. Humphreys, after reviewing the correspondence, raised no objection to the proposal.¹⁶ Whereupon, Secretary of War Belknap on August 7 approved establishment of a proving ground at Sandy Hook.¹⁷

b. Erecting the First Structures

General Benet immediately returned the correspondence to Major Crispin. In a covering letter, he cautioned, that in laying out the Sandy Hook facility care was to be exercised to confine it to the portion of the reservation indicated. Steps would be taken to place "the ground and appointments in condition for use." As soon as the 8- and 9-inch guns were ready, there would be no delay in undertaking the experiments contemplated.¹⁸

Major Crispin, if he were to proceed with establishment of the facility, needed money. On August 10 he inquired when the \$4,000 called for in the estimates of the 3d would be forthcoming. Plans were being prepared for the different structures proposed in his office.¹⁹

General Benet replied the next day. He asked Crispin and his people at the New York Agency to forward new estimates, indicating the amount needed and the account to which it should be charged.²⁰

16. Humphreys to Secretary of War, Aug. 6, 1874, NA, RG 77, Ltrs. Sent, Chief Engineer.

17. Belknap to Chief of Ordnance, Aug. 7, 1874, NA, RG 77, Ltrs. Recd., Chief Engineer.

18. Benet to Crispin, Aug. 7, 1874, Ltrs. Sent, Chief of Ordnance, Record Group 156 (Records of the Chief of Ordnance), National Archives.

19. Crispin to Benet, Aug. 10, 1874, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

20. Benet to C.O., New York Agency, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

On August 12 Major Crispin submitted the desired data. In the nine days since he had formulated his preliminary estimates, he had increased the figure from \$4,000 to \$5,000, by adding two more wooden casemates for covering guns. Four of these were now called for instead of two.²¹

Chief of Ordnance Benet on August 24 allotted for use by Capt. John G. Butler \$5,000 for construction of necessary facilities at Sandy Hook for the Proving Ground. One-half this sum would be charged to Ordnance Service and the remainder to Repair of Arsenals.²²

Lieutenant Butler moved with alacrity. A large force of laborers and a few skilled craftsmen were soon hard at work. By the fourth week of October, a frame office and instrument house had been constructed, along with a shelter for the chronoscopes. Four wooden gun platforms had been built, along with a bombproof and proof butt, and a range laid out.

The Office-Instrument House was between the northeast face of the southeast bastion of the huge masonry fort and the beach. About 100 yards southeast of the house were the gun platforms,

21. Crispin to Benet, Aug. 12, 1874, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

22. Benet to C.O., New York Arsenal, NA, RG 156, Ltrs. Sent, Chief of Ordnance. John G. Butler of Pennsylvania graduated from the U.S. Military Academy as No. 20 in the Class of 1863. Commissioned a 2d lieutenant in the 4th U.S. Artillery, he joined the Army of the Cumberland in time to participate in the battle of Chickamauga, where he received a brevet for gallantry. On January 29, 1864, Butler was assigned to the Ordnance Department and ordered to the Frankford Arsenal. In May 1873 Butler, having served at a succession of arsenals, was ordered to the New York Ordnance Agency. From September 1873 to May 1876, Butler, who was promoted captain in June 1874, was assistant to the Constructor of Ordnance. Cullum, Biographical Register, III, 9-10.

with the bombproof nearby. The proof butt was down range in the direction of the Spermaceti Cove Life-Saving Station.²³

c. First Tests

Expectations that the experimental guns would be ready for tests in the winter of 1873-74 had been dashed. By the end of Fiscal Year 1874, the Chief of Ordnance reported that the Sutcliffe breechloading cannon, four 10-inch Rodmans converted into 8- and 9-inch rifles, and possibly Mann's breech-loading cannon were nearly ready for trials.²⁴

The Board, in the months since it made its October 1872 report, had decided to proceed with conversion of four 10-inch Rodmans into rifled guns. Two of the pieces would be converted into 8-inch rifles (one to be sleeved from the muzzle and the other from the breech) and two into 9-inch rifles sleeved in similar manner. The work would be done at the West Point Foundry. By October 1874 the two rifled 8-inch Rodmans had been converted and were shipped to Sandy Hook.²⁵

On October 10, 1874, Chief of Ordnance Benet, with a temporary proving ground laid out, named Maj. Silas Crispin, T.J. Treadwell, and Thomas G. Baylor, with Capt. George W. McKee as recorder, as a Board to meet in New York City, on the 21st, or as soon thereafter as practicable. The Board was to proceed with the "trial of such of the experimental guns prepared under the 'Act of June 6, 1872,' as may be submitted to it by the Chief of Ordnance."²⁶

23. "Sketch of Shore Line of the North Eastern Part of Sandy Hook, N.J., showing line of bulkhead as built under the direction of Gen. H.W. Benham, U.S. Engrs., March to June 1878," NA, RG 77.

24. Executive Documents, Serial 1635, p. 257.

25. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 44th Congress, 1876-77 (Washington, 1877), Serial 1746, II, 55-56.

26. S.O. No. 221, Ordnance Department, Oct. 20, 1874, NA, RG 156, Orders, Ord. Dept.

The Board on October 24 reached Sandy Hook from New York City, and the first test was made on the range. This was the first in a series of experimental firing undertaken with a 10-inch Rodman smoothbore converted into an 8-inch rifle by insertion of a wrought-iron coiled sleeve. The sleeve had fifteen lands and grooves, with a twist of one turn in forty feet. Addition of the sleeve had increased the weight of the tube to 16,160 pounds. The piece was fired from an "ordinary service 10-inch wrought iron casemate carriage," on a wooden platform, with its recoil checked by friction. The axis of the gun was seven feet above the surface of the wooden platform, and it was emplaced in a wooden casemate.

The cannon was fired by 1st Gunner Sinclair and a half-dozen men. After loading the piece with thirty-five pounds of DuPont hexagonal powder and a 170-pound battering projectile, Sinclair and his men took cover in a bombproof vault, about twenty feet from the gun.

When fired, the pressure of the gasses within the powder chamber of the rifled Rodman was determined by a Rodman proton and its muzzle velocity by a Le Boulange chronograph. Between rounds, the piece was star gauged to check for erosion of the bore.

The tests were continued until two days before Christmas. By then the Board had fired 700 rounds, with battering charges, and the piece was still "sound and serviceable." It had demonstrated endurance that fully justified the recommendations of the Board and earned Chief of Ordnance Benet's approval for conversion of a "large number of smooth-bore guns . . . into rifles," as it was practicable to give "the requisite strength and consequent endurance by the insertion of a wrought-iron tube."

These tests had been so successful and satisfactory in results that they had "awakened an interest among military men abroad . . . to a surprising degree." This was especially true, General Benet wrote, when cognizance was taken of our "pigmy efforts and

effecting results with insufficient means and compare them with the extensive and elaborate trials, seemingly regardless of expense, that have been and are being, prosecuted from year to year by almost every European nation."²⁷

d. President Grant Asks Congress for \$250,000

The United States, General Benet informed Congress, had the best cast-iron gun metal known, and this plan of conversion permitted the country to utilize its own products. The wrought-iron sleeves could probably be manufactured in the nation. The combination of the results would be the production of a system of great strength and power. The successful conversion of a 10-inch smoothbore Rodman into an 8-inch rifle should be followed by a trial of a 35-ton gun on a similar plan of conversion.

Abroad, he noted, Great Britain had cast an 81-ton gun. This was only another move "in the great contest between guns and ironclads, for the hurling of a rifle-shot of 1,250 pounds, with a velocity of 1,500 feet per second cannot be considered the extreme limit of the development of artillery-power."²⁸

General Benet in December 1874 informed Secretary of War Belknap that there were currently in the nation's forts and arsenals 321 15-inch Rodmans, 1,294 10-inch Rodmans, 90 8-inch Parrotts, and 40 10-inch Parrotts. Even if reliable, when firing heavy battering shot against ironclads, of which there was doubt, they were so few in number as to constitute an unimportant item among the 4,181 guns required for the nation's forts. Rifled guns, ranging from 8- to 12-inches in caliber, with power to smash ironclads, were needed.

27. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 44th Congress, 1875-76 (Washington, 1876), Serial 1677, II, 10-11, 98-103; New York Times, Nov. 19, Dec. 14, 1874.

28. Executive Documents, Serial 1677, II, 10.

"The heaviest rifles are the guns of the present," Benet wrote, "as they will be of the future, and while smooth-bores may for some time to come play a secondary part, for want of a more powerful weapon, they must inevitably yield to the rifle . . . , as the old smooth-bore musket has given place to the breech-loading rifle in the hands of the soldier." While noting the passing of the smoothbore, he desired to call attention to the fact that the "first grand stride toward the introduction of great guns in any service was made in this country by the late General [Thomas J.] Rodman, of the Ordnance Department," whose reputation was worldwide. The 15-inch Rodman, first cast in 1861, was for its time the world's most formidable weapon, to be soon surpassed by his 20-inch gun, cast in 1864 and weighing 116,000 pounds.

The introduction of ironclads, however, called for the penetrating power of heavy rifles, and the "smashing and racking effect of a 15-inch smooth-bore must yield to the working energy of a 12-inch rifle that will pierce the thickest iron armor at long distances."²⁹

Benet asked for an appropriation of \$250,000 for converting 140 smoothbore Rodmans into rifles by lining their bores with wrought-iron or steel, the practicability of which had been recently demonstrated in the Sandy Hook trials.³⁰

General Benet forecast that by the spring of 1875 eight guns, varying in caliber from eight inches to twelve inches, and weighing from 16,000 to 85,000 pounds, would be at Sandy Hook, ready for trial. Firing of a 12-inch rifle, Benet reminded Secretary Belknap, was "expensive business"--each round fired costing about \$100. As the gun might be fired 500 times, its trial would cost \$50,000. Funds for this purpose should be appropriated. Added to this, money was needed for the carriages, depressing and others, butts and platforms, and all

29. Ibid., p. 94.

30. Ibid., p. 96.

the appliances, conveniences, and labor required for the prosecution of such "exact and important work." He knew of no military power, except the United States, that had not provided an experimental and proving ground, with every facility for conducting "trials upon a grand scale." He urged that an appropriation of \$250,000 be made for the proving ground and experiments and tests of heavy ordnance.³¹

After studying General Benet's report, the War Department incorporated it into the document President Grant transmitted to Congress on January 20, 1876. In the accompanying message, the President urged "the absolute necessity for immediate provision . . . for the procurement of heavy cannon." These constant appeals for legislation for the "armament of fortifications" should no longer be disregarded, he admonished, "if Congress desires in peace to prepare the important material without which future wars must inevitably lead to disaster."

A small \$75,000 appropriation was all that could be obtained from Congress in the interest of seacoast armament.³²

B. Facility Gradually Expands

1. 1875 and the Continuation of the Testing Program

a. Benet Names Crispin Constructor of Ordnance

A year earlier, in 1875, Congress had voted \$75,000 for conversion of smoothbores into heavy rifled guns. On June 4 Chief of Ordnance Benet wrote Colonel Crispin of this development.³³ As additional data was obtained from the tests of the steel-sleeved guns underway at Sandy Hook, the Board was to take under consideration the best methods for converting and rifling 10-inch Rodmans, and make such recommendations as will serve the nation's interest. This would enable

31. Ibid., p. 96.

32. Ibid., p. 10.

33. Crispin had been promoted from major to lieutenant colonel on April 14, 1875.

the Department to take immediate measures for a judicious expenditure of the \$75,000.³⁴

To better enable Crispin to discharge this mission, he was, on the recommendation of General Benet, appointed Constructor of Ordnance, with his duty station in New York City. As Constructor of Ordnance, Crispin was to take charge of the project, "communicating freely and fully with the Chief of Ordnance."³⁵

b. Continued Tests Prove that 10- and 15-inch Rodmans Can Be Modernized

Eighteen hundred and seventy-five was an active year at the Sandy Hook testing facility. General Benet, when he filed his annual report for Fiscal Year 1875, observed that the Department had continued its program for conversion of 10-inch Rodman smoothbores into 8-inch rifles by use of sleeves. The coiled wrought-iron tubes employed in the conversion had been imported. A trial of a gun with a sleeve of domestic manufacture had given favorable results, and proved that "our product is equal to the imported, notwithstanding the long experience in such work in English shops." Dependence could now be placed on the private enterprise and skill of American manufactures for 8-inch rifles. The American tube had withstood more than 500 rounds with battering charges, and was still serviceable.

To date, three guns (two 8-inch and one 9-inch) of this type had been satisfactorily tested. More than 500 rounds had been fired at the Sandy Hook range from the 8-inch rifle. The 9-inch gun, of the same exterior dimensions as the 8-inch, but with thinner walls and less weight, had been fired 502 times, with battering charges of forty to forty-five pounds of hexagonal powder, and 200- to 247-pound projectiles.

34. Benet to Crispin, June 4, 1875, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

35. Ibid., June 30, 1875, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

This provided a more severe test for the system than that experienced by the two 8-inch guns. The Sandy Hook tests had established that 10-inch Rodmans could be converted into 8-inch rifles, which was a source of gratification to the Department. General Benet believed forthcoming trials with 10- and 12-inch rifles would be as satisfactory.

If so, the Department would have developed a system of heavy ordnance at small expense, which would "constitute an armament for our forts capable of coping with foreign guns of equal caliber."³⁶

This would enable the government to modernize the huge number of Rodmans (321 15-inch and 1,294 10-inch) in the nation's forts and armories. To finance the program, Chief of Ordnance Benet called on Congress for an appropriation of \$950,000 in Fiscal Year 1877.³⁷

c. Construction of Additional Facilities

During the year several improvements were made at the proving ground to facilitate testing of the rifled Rodmans. A frame machine shop, costing \$2,500, was erected midway between the Instrument House and the fort's southeast bastion. A frame washhouse was built nearby with a \$300 allotment.³⁸

Colonel Crispin in December 1875 recommended that a 10-inch Parrott be mounted at the proving ground for use in conducting experiments with Parrott shells. General Benet, on approving the

36. Executive Documents, Serial 1746, pp. 9-10, 55-56. The guns tested at Sandy Hook had been converted into rifles at the West Point Foundry. The sleeve and jacket for the No. 1 10-inch Rodman were of coiled wrought-iron manufactured at Sir William Armstrong's works at Newcastle-upon-Tyne, England, and the steel sleeve and jacket for the No. 2 had been cast by the Bochum Manufacturing Company, Bochum, Germany. The 9-inch rifled Rodman had been received at the proving ground in November 1875.

37. Ibid., p. 9.

38. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

proposal, reminded Crispin that there was a 10-inch Parrott tube at the New York Arsenal but no carriage. It might be possible, however, to alter a 15-inch Rodman carriage on which to emplace the Parrott.³⁹

Several days later, General Benet, recalling that the carriage and chassis for the giant experimental Thompson rifle were at Fort Monroe, ordered them sent to Captain Butler at Sandy Hook.⁴⁰ At the same time, two Gatling guns and one carriage were sent from the New York Armory to Sandy Hook for testing.⁴¹

2. Tests, Experiments, and Other Projects: 1876-77

a. Testing Program is Diversified

The nation's centennial year found the ordnance people accelerating their program. At Sandy Hook, for the first time, there were trials and proofs of field guns, mitrailleuses, powder, and projectiles, in addition to the big guns. The large caliber experimental cannon manufactured under the Act of June 6, 1872, which had been exhibited at Philadelphia's Centennial Exposition, were taken to the proving ground and fired. Among those tested were the Mann 8.4-inch breech-loading rifle, the Sutcliffe 9-inch breech-loading rifle, and the Thompson 12-inch breech-loading rifle. The 10-inch Rodman with a sleeve of American manufacture had now fired 590 rounds. During the summer and autumn a new model five-barrel Gatling gun was tested, along with the Hotchkiss revolving cannon. A 3.15-inch Sutcliffe breech-loading and a Moffatt 3.07-inch breech-loading rifled cannon were fired.⁴²

39. Benet to Crispin, Dec. 23, 1875, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

40. Benet to C.O., New York Agency, undated, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

41. *Ibid.*, New York Armory, Dec. 30, 1875, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

42. Executive Documents, Printed by the House of Representatives for the 2d Session of the 45th Congress, 1877-78 (Washington, 1878), Serial 1797, V, xi-xii.

During Fiscal Year 1877 the Ordnance Department had continued to convert the nation's obsolete 10-inch smoothbore Rodmans into "efficient" 8-inch rifles by insertion of wrought-iron sleeves of American manufacture. This project was progressing as rapidly as the small appropriation made by Congress would permit.

There were, General Benet informed Congress, on hand in the coastal fortifications more than 1,100 of these smoothbore guns which could be economically converted into rifles for casemated batteries, where there was insufficient room to accommodate heavier metal. They could also constitute the principal armament of the smaller forts protecting shallow channels that would not admit deeper draft ships. At 1,000 yards, they would be effective against ironclads, protected by less than 8 inches of armor. As the Rodmans constituted an essential element in the nation's defenses, they could be converted "with ore from our mines and the skill and labor of our own mechanics." By use of this argument, General Benet hoped to prevail on Congress to appropriate more funds for this project.

Carriages for these guns were also necessary. Those on hand, manufactured for smoothbores, were unsuitable for rifled guns, firing 35 pounds of powder and 180-pound shot. They needed extensive alterations, i.e., numerous mechanical appliances for moving, traversing, and absorbing the recoil when fired, etc., without which the converted rifles could not be relied on for effective service. As a carriage for a gun of this weight was a complicated mechanism, made of wrought-iron and other metals, weighing at least one-half the weight of the gun, and costing a considerable sum, its development would be expensive. Necessary tests and studies had been undertaken by Colonel Crispin. His concept had been approved. Utilizing his plans, an experimental carriage had been built at the South Boston Foundry and tested at Sandy Hook.⁴³

43. Ibid.

b. Fiscal Year 1878 Testing Program

Fiscal Year 1878 was a busy year at Sandy Hook. A 12-1/2-inch muzzle-loading rifle (its tube cast at Sir William Armstrong's Newcastle works and its casing at the South Boston Foundry) was mounted at Sandy Hook. Colonel Crispin and his men fired it twenty-four times with charges varying from 60 to 120 pounds of powder, and projectiles weighing from 600 to 700 pounds. With 115 pounds of powder and a 700-pound shot, the piece had a muzzle velocity of 1,485 feet per second, with pressure of 33,500 pounds to the square inch.

General Benet pronounced this a very satisfactory result, comparing favorably with those obtained in other countries with guns of this caliber. Although unable to make an exact comparison between this gun and those employed abroad, because of differences in charges of powder and weights of projectiles, he observed that the British 25-ton gun, with 85 pounds of powder and a 600-pound shot, had given 450-foot-tons less energy; Krupp's huge rifle with 88 pounds of powder and a 664-pound projectile had given 1,254-foot-tons less; while an Italian cannon with 110 pounds of powder and a 700-pound shot had yielded about 400-foot-tons more than the United States gun.

The twenty-four rounds fired at Sandy Hook had developed no weakness in any of its parts. Testing a gun of this size was an expensive operation, but, General Benet reported, our coast defenses demand these monster rifles, and the necessary trial guns cannot be tested for endurance for less.

A 10-inch rifle, converted from a 15-inch smoothbore Rodman, had been satisfactorily fired thirty-three times and was awaiting further trials.

The plan of conversion employed was known as "the muzzle insertion, the coiled wrought-iron tube lining being inserted from the muzzle." Defective welds in the coils were the only elements of weakness, but these were grave as it was impossible to always detect them in the manufacture of the tubes. The dragging effect of the shot,

as it passed through the bore, was liable to pull the tube apart at a defective weld. This could be guarded against by inserting the lining from the breech and shouldering the tube in front of the trunnions. This prevented accidents at those points along the bore subject to the greatest strain. The 8-inch rifle, converted in this fashion, had been fired at Sandy Hook more than 700 times with battering charges and was still in good condition.

Plans for development of an 11-inch rifle by conversion of a 15-inch Rodman smoothbore had been approved by the Secretary of War. A successful test of such a gun would demonstrate to the world that the United States could "produce at a very moderate cost a rifle of largely increased power, having at 2,000 yards an energy at least 50 per cent greater than the smooth bore from which it springs." At 1,500 yards it was estimated that the projectile would penetrate 11.2 inches of iron, while a smoothbore shot only penetrated 7.5 inches of iron at that distance.⁴⁴

Other big guns tested at Sandy Hook during the fiscal year were the Woodbridge 10-inch rifle, the Thompson 12-inch breech-loading rifle, the Sutcliffe 9-inch breech-loading rifle, and the Mann 8-inch breech-loading rifle. After 10 rounds the Woodbridge was dismantled; twenty-six rounds had been fired from the Sutcliffe, eleven from the Mann, and two from the Thompson. Three machine guns (the Lyman multicharge gun, and the Lowell and Taylor Battery Guns) had been tested. The Board was impressed with the merits of the Lowell gun and recommended that a number, with all the latest improvements, be procured for trial in the field for comparison with the Gatling gun then in service. Although commending the ingenuity of the Taylor's construction, the Board did not approve of its feeding arrangement.⁴⁵

44. Executive Documents, Printed by Order of the House of Representatives for the 3d Session of the 45th Congress, 1878-79 (Washington, 1879), Serial 1847, VI, vi-viii.

45. Ibid., pp. ix-x.

c. General Benet Asks for Money to Convert Smoothbore Rodmans into Breech-Loading Rifles

Impressed by what had been accomplished, Chief of Ordnance Benet had written in 1876 that, whatever differences of opinion existed as to the merits and efficiency of muzzle- and breech-loading cannon of large caliber (the former being exclusively employed in Great Britain and the latter almost universally on the continent), the breech-loading system possessed "obvious and paramount advantages" in casemated works. This subject had not escaped the attention of the Ordnance Department.

The Board on Experimental Guns had "recognized breech-loading rifles for casemate service to be a great desideratum" on June 10, 1875. The Board had recommended that a portion of the year's appropriation should be spent on development of breech-loading guns. Money had been called for to convert two 10-inch "smooth-bore Rodman cast iron guns into 8-inch breech-loading rifles." Lack of funds for this purpose prevented any action thereon, but experiments to determine the feasibility of converting some of the smoothbore Rodmans into breech-loaders was requested.

Since then an 8-inch breech-loading rifle had been made by lining a 10-inch smoothbore with a steel-jacketed coiled-wrought-iron tube inserted from the breech. The jacket was prolonged to the rear, thus adapting it to receive its round wedge fermeture. This rifle had been fired thirty-four times at Sandy Hook with battering charges.

On April 15, 1878, General Benet had recommended an appropriation of \$117,600 for trial of experimental guns procured by the Ordnance Department under the law of June 6, 1872. Secretary of War George W. McCrary had concurred, but Congress had taken no action.⁴⁶

46. Ibid., pp. vii-ix.

Bringing this to the Secretary's attention on October 10, 1878, Benet recalled that President Grant, in a special message to Congress, on January 20, 1875, enclosing a special report from the Chief of Ordnance, had recommended an appropriation of \$250,000 "for proving ground and experiments and tests of heavy ordnance." When the "sundry civil bill" had been under consideration in the House, the President's message and the Ordnance Department's report had been quoted from in favor of such an appropriation, but the House had refused to act.⁴⁷

There were only two foundries in the nation with the facilities and experience for converting smoothbore Rodmans into rifled guns in accordance with the plan adopted. These were the West Point Foundry and the South Boston Foundry. As the Department would in all probability have to depend on these establishments in the future, it must "be in condition to keep them in sufficient orders to preserve the plant and mechanical skill without loss to the companies." To pursue this project in an orderly manner, thus avoiding the frantic rush which ensued every time there was a war scare, General Benet called the Congress' attention to the need for a large annual appropriation for this "national necessity."⁴⁸

d. Development and Testing of the Lyle Gun

Secretary of the Treasury Benjamin H. Bristow in April 1875 had requested Secretary of War Belknap to assist with experiments designed to improve the equipment employed by the Life-Saving Service. Belknap was asked to designate an officer or officers of the Ordnance Department to assist Capt. J.H. Merryman of the U.S. Revenue Marine in developing a better gun with which to shoot a line from the beach to a stranded vessel.

47. Ibid., p. ix.

48. Ibid., p. vi.

Secretary Belknap referred the subject to Chief of Ordnance Benet, who recommended that the Board on Experimental Guns be charged with prosecution of these experiments in cooperation with Captain Merryman. This arrangement was satisfactory with both Secretaries.⁴⁹

Captain Merryman and General Benet agreed that the proving ground was the most convenient site for conducting the experiments, as it was adjacent to the Sandy Hook and Spermaceti Cove Life-Saving stations and to New York City where Merryman was posted.

Informing Colonel Crispin of this assignment, General Benet wrote, "this subject is one of great importance to our maritime interests, and to the cause of humanity." The Board would give to it "every care, consideration, and study," and would report to his office the results of the investigations and trials.⁵⁰

In June 1877 Lt. D.A. Lyle of the Ordnance Department was assigned to the project. The objects of the experiments were to: (a) extend the range of the shot line; (b) determine, if possible, the proper form, caliber, and kind of gun or mortar best suited for life-saving purposes; (c) reduce the weight of such apparatus to the minimum amount consistent with efficiency; (d) secure a shot-line of such size, material, and strength as will be most valuable; (e) determine the kind and quantity of powder to be used, and the charges that can be employed with safety for the several lines; (f) secure the best form and size of faking-box; and (g) discover the best relative positions for the faking-box and gun.

Although Lieutenant Lyle laid "little claim to any great originality in the improvements and changes suggested, his ability,

49. Benet to Crispin, April 16, 1875, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

50. Ibid.

industry, and research" accomplished much of value. The extraordinary range attained by him with his improved shot-line of 694 2/3 yards was more than any range heretofore obtained in the United States or abroad with a gun of this type.

The Ordnance Department in Fiscal Years 1878-79 supervised fabrication of the gun developed by Lieutenant Lyle, along with its carriages, faking-boxes, etc.⁵¹

e. Sandy Hook Shop's Carriage Conversion Project

To facilitate the testing of guns, proving ground mechanics, previous to January 1, 1877, altered six carriages (three 10-inch carriages for 8-inch converted rifles, with friction recoil checks; one 10-inch carriage for 8-inch converted rifle, with hydraulic buffer; one 10-inch carriage for 8-inch converted rifle, with pneumatic buffer; and one 15-inch carriage for 12-inch Thompson gun, with friction recoil check).

Under authority given by the Chief of Ordnance on May 9, 1877, eight additional carriages were altered in the Sandy Hook Shop, and one-half shipped to Fort Monroe and the others to West Point. These carriages were 10-inch barbette and had been altered for 8-inch converted rifles--four with friction recoil checks and four with hydraulic buffers.

In the months following February 17, 1879, the mechanics altered seventy-five 10-inch carriages for issue to Forts Wadsworth, Schuyler, Delaware, and Point, the Benicia Arsenal, and Willetts Point.⁵²

51. Executive Documents, Serial 1847, p. xi.

52. Smith to Benet, Oct. 25, 1881, NA, RG 156, Ltrs. Recd., Chief of Ordnance. Capt. Charles S. Smith was assigned to the U.S. Ordnance Agency. The seventy-five carriages included four 10-inch barbette carriages, altered for 8-inch converted rifles, with friction recoil checks, issued to Benicia Arsenal; and seventy-one 10-inch casemate carriages, altered for 8-inch converted rifles, with friction recoil checks. These had been issued as follows: fifteen carriages to Fort Schuyler, ten to

Civilian mechanics employed at the testing facility in 1879 were paid from \$2.25 to \$2.75 per day, depending on their skills, and laborers from \$1.60 to \$1.75 per diem.⁵³

To facilitate mounting and dismounting guns being tested or proved, the Ordnance Board in 1879 acquired a sling wagon. The wagon, capable of handling ten tons, was built at the Watertown Arsenal.⁵⁴

f. Fiscal Year 1879 Brings a Cut Back in Tests

In Fiscal Year 1879 the Ordnance Board received and began testing the 15-inch Rodman, which had been converted into a 11-inch rifle. By June 30 it had been fired thirty-three times, with charges varying from seventy to eighty-five pounds, and shots weighing from 503 to 506 pounds. This was too few rounds from which to draw any inference as to its ultimate endurance. But, General Benet added, so far it seemed sound in all respects.

Lack of funds and introduction of some changes in the traverse gear of the carriage chassis of the 12 1/2-inch rifle had led to a suspension of trials for that gun.

The 10-inch rifle (converted from a 15-inch Rodman) had only been fired a few times during the past twelve months, as it had been deemed more important to apply the Department's limited resources to testing the 11-inch gun.⁵⁵

52. (Cont.) Fort Wadsworth, fifteen to Willetts Point, sixteen to Fort Point, and fifteen to Fort Delaware.

53. Crispin to Benet, June 3, 1879; Benet to Crispin, June 11, 1879; Starring to Crispin, Dec. 4, 1879; and Sinclair to Starring, March 24, 1880, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

54. Starring to Crispin, May 13, 1879, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

55. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 46th Congress, 1879-80 (Washington, 1880), Serial 1907, VI, 7-8.

C. Improvements to the Facilities and Grounds: 1876-79

1. Proving Ground Gets a Steam Launch

In February 1876 General Benet, having been apprised by Colonel Crispin of the difficulty in obtaining passage to and from New York City to Sandy Hook, contacted the Quartermaster General. He wished to know if a "suitable tug" could be transferred to his Department. If Quartermaster General Montgomery Meigs were agreeable, this subject could be referred to the Secretary of War. General Meigs' views coincided with Benet's as did those of the Secretary of War.⁵⁶

In mid-March it was suggested by the War Department that the steam launch Monroe be transferred to the Ordnance Department at Sandy Hook. Writing the Quartermaster General, Chief of Ordnance Benet learned that the launch had not been built, but was about to be put under contract to the New York Safety Steam Company.⁵⁷ Colonel Crispin would, therefore, furnish the Department with a list of special features required for the vessel: the length, tonnage, special accommodations for handling freight, etc. When these were received, they would be incorporated into the plans and construction commenced.⁵⁸

After necessary data had been provided by Colonel Crispin and the specifications revised, work was started on the vessel by the New York firm. By early October the steamer was nearing completion, and General Benet suggested to the Quartermaster General that she be christened Ordnance, which would be an appropriate name considering the duties she would perform. General Meigs was agreeable and the vessel

56. Benet to Quartermaster General, Feb. 11, 1876, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

57. Ibid., March 16, 1876, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

58. Benet to Crispin, April 17, 1876, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

was registered as Ordnance. It was May 1877 before Ordnance had been outfitted, passed her trials, and was accepted by Colonel Crispin.⁵⁹

2. Rehabilitating the Wharf

The ell-shaped Sandy Hook wharf had been constructed by the Corps of Engineers in the late 1850s before beginning work on the masonry fort. Time and weather had taken their toll. The unloading and loading of guns, carriages, and other heavy equipment by the Ordnance Department increasingly taxed deteriorating piles and timber.

In October 1876 Colonel Crispin, taking cognizance of the condition of the Engineer Wharf, wrote Chief of Ordnance Benet that it would cost \$25,000 to put it "into a thorough state of repair." As the money available made such an expenditure unlikely, it became a question of how far its use would compensate the Ordnance Board for such an outlay. To preserve the section of the wharf, which was in the poorest condition and the part which was of most benefit in conducting their tests during Fiscal Year 1877, would necessitate an expenditure of about \$1,000 before spring. This would involve driving piles and purchasing some oak planking.

Colonel Crispin had not determined to what extent the Engineer Department would consider it in its interest to cooperate in the project. To save the extreme end of the wharf, which was new, he believed the Corps might be willing to allot several thousand dollars for repairs to prevent it from being wrecked by the winter's storms.

The Ordnance Department, in his opinion, should only be responsible for "securing in a temporary manner such of the facilities of the wharf as are now used" by it.⁶⁰

59. Ibid., May 15, 1877, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

60. Crispin to Benet, Oct. 8, 1876, Consolidated Correspondence File, Record Group 92 (Records of the Quartermaster General), National Archives.

General Benet forwarded Crispin's letter to Chief Engineer Humphreys, along with a request that the Corps assist in funding repair of the wharf. If the Corps did not wish to participate, he wanted to know if it had any objections to the Ordnance Department making the repairs.⁶¹

Chief Engineer Humphreys rejected the proposal. Writing General Benet, he pointed out that the Corps had no projects at Sandy Hook requiring use of the wharf, while appropriations for "contingencies" in Fiscal Year 1877 were so limited that none could be spared for a cooperative undertaking.⁶²

General Benet thereupon transmitted the correspondence to Quartermaster General Meigs. In his covering letter, he pointed out that the wharf was necessary for delivery of cannon and other Ordnance materials transported by the Quartermaster Department. On November 6 Secretary of War James D. Cameron authorized expenditure by the Quartermaster General of \$1,000 for repair of the wharf.⁶³

The Quartermaster Department, however, failed to move on the project. Winter storms continued to batter the wharf. On May 29, 1877, Colonel Crispin was compelled to write General Benet, warning that if the wharf were not repaired, it would soon be in such bad condition "as to cut off our communications" by water with Sandy Hook. If this occurred, it would cause suspension of very important tests.

Needed repairs consisted of removal of the first stone crib and its replacement with spiles, the renewal and furnishing of necessary

61. Benet to Humphreys, Oct. 9, 1875, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

62. Humphreys to Benet, Oct. 13, 1876, NA, RG 92, Consolidated Correspondence File.

63. Ibid., Benet to Crispin, Nov. 10, 1876, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

stringers, and the replacement of rotten flooring. The crib, he noted, had collapsed, and as a consequence flooring for a distance of sixty feet had sagged below the remainder of the wharf. The wharf, he reported, was used by the Engineer and Quartermaster Departments, in addition to the Ordnance people.⁶⁴

Visiting Sandy Hook in early June, General Benet saw that Colonel Crispin had not exaggerated. Writing the Quartermaster General, he reported that the wharf was in "a very dangerous condition even for pedestrians in broad daylight, and entirely too dilapidated to risk the movement of heavy weights." If the Quartermaster Department would place the wharf in serviceable condition, General Benet would provide a large crane for use in loading and unloading heavy ordnance supplies. This crane would be available to the Engineer and Quartermaster Departments.⁶⁵

Quartermaster General Meigs was compelled to veto the proposal, because of lack of funds. Dissatisfied with this response, General Benet on July 10 reminded General Meigs that as it was the beginning of a new fiscal year, Meigs might now have it in his power to make these very much needed repairs, especially as they came under "Army Transportation" for which the Quartermaster Department was responsible. General Meigs could rest assured that "the necessity of that alone" induced Benet to again raise the subject.⁶⁶

64. Crispin to Benet, May 29, 1877, NA, RG 92, Consolidated Correspondence File.

65. Benet to Meigs, June 5, 1877, NA, RG 92, Consolidated Correspondence File.

66. Benet to Quartermaster General, July 10, 1877, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

The Quartermaster General relented. The subject was referred to Secretary of War McCrary, and he approved expenditure of \$5,875 for repair of the wharf by the Quartermaster Department.⁶⁷

Work commenced. As it progressed, it was found that the foundations were in much worse condition than anticipated, when the Ordnance Department prepared the estimates. It became evident that the project could not be completed with the \$5,875 allotted. The wharf, however, was in a too exposed condition to stop work while the question of extra funding was resolved. If it were, the next storm might destroy the entire wharf and cost the government many thousands of dollars.

On his own responsibility, Col. Langdon C. Easton, the department quartermaster, kept the men on the job. The repairs were completed during the winter, at a cost of \$8,356.09, a sum \$2,481.09 in excess of the allotment. To justify this expenditure, Colonel Easton pointed out that the wharf was nearly 900 feet long and in an area exposed to heavy seas. The Secretary of War, upon being apprised of the situation, approved the expenditure made by Colonel Easton.⁶⁸

3. Storms Threaten the Instrument House

Storms, which battered Sandy Hook during the winter of 1877-78 and threatened to sweep away the wharf, eroded the beach in front of the Instrument House. On January 4 the flood tide and an easterly wind sent breakers rolling to within twenty feet of the house's north corner, and left a perpendicular cut in the sand to a depth of four feet. Unless steps were taken to combat the beach erosion, Lt. William L. Starring, who was on site, warned Colonel Crispin that a few more

67. Benet to Crispin, Aug. 13, 1877, NA, RG 156, Ltrs. Sent, Chief of Ordnance. Repair of the wharf included the driving of 325 piles.

68. Easton to Quartermaster General, March 4, 1878, NA, RG 92, Consolidated Correspondence File.

easterly gales would send the surf crashing against the Instrument House.⁶⁹

Colonel Crispin called the attention of the Corps of Engineers to this threat to the Proving Ground.⁷⁰

The Engineers accordingly took steps to protect the beach fronting the Proving Ground and the east seafront of the masonry fort. A sandbox bulkhead was constructed parallel to the shoreline for nearly 1,300 feet and connected with the jetties previously erected. The engineer in charge of Sandy Hook believed the bulkhead would give the necessary protection against further encroachment by the sea.⁷¹

4. Quartering Personnel and Construction of the Officers' Quarters

a. Use of the Engineer Barracks as Quarters

In 1876 Colonel Crispin notified General Benet that it was important that additional and better accommodations be provided at Sandy Hook for the personnel involved in conducting the tests. He urged the Department to contact the Chief Engineer and secure his

69. Starring to Crispin, Jan. 5, 1878, NA, RG 156, Ltrs. Recd., Chief of Ordnance. William L. Starring of Illinois graduated from the U.S. Military Academy as No. 41 in the Class of 1865. Commissioned a 2d lieutenant in the 18th U.S. Infantry, he served on the western frontier at such posts as Forts Lyon, Laramie, Philip Kearny, and Sanders. He returned to the Military Academy in September 1869 as Assistant Instructor in Infantry Tactics. Starring transferred to the 2d U.S. Artillery in January 1871, and in September 1872 reported at Fort Stevens, Oregon. Lieutenant Starring transferred to the Ordnance Department in November 1875, and on November 20, 1876, entered on duty as Assistant to the Constructor of Ordnance and as officer in general charge of Experimental Duties at Sandy Hook. Cullum, Biographical Register, III, 50.

70. Crispin to Benet, Jan. 8, 1878, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

71. Executive Documents, Printed by Order of the House of Representatives for the 3d Session of the 45th Congress, 1878-79 (Washington, 1879), Serial 1844, III, 15.

approval for occupation of quarters in the Engineer Barracks by the Ordnance people.⁷²

Located at Sandy Hook, on the cove southeast of the wharf, were the Engineer Barracks and House. These structures had been erected in the late 1850s and early 1860s to house the labor force employed constructing the fort.

General Benet, on referring the correspondence to Chief Engineer Humphreys, asked that the request be given favorable consideration. If General Humphreys were agreeable, Benet suggested that the buildings to be turned over for temporary use by the Ordnance Department be determined by the superintending engineer for Sandy Hook in consultation with Colonel Crispin.⁷³

Chief Engineer Humphreys was agreeable. On April 21 he directed Lt. Col. John Newton to turn over to Colonel Crispin "such buildings as may be agreed upon between them for use of the Ordnance Department." It was understood that the buildings would be returned when needed by "the Engineer Service at that post."⁷⁴

The Ordnance Board accordingly occupied as offices and quarters space in the Engineer buildings from the spring of 1876 until the winter of 1877-78. On February 13, 1878, Chief Engineer Humphreys notified General Benet that Col. H.W. Benham, who had replaced Newton as superintending engineer responsible for Sandy Hook, was about to commence operations for combating beach erosions. Consequently, rooms occupied by the Ordnance Board, their assistants,

72. Crispin to Benet, undated 1876, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

73. Benet to Humphreys, April 18, 1876, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

74. Humphreys to Benet, April 26, 1876, NA, RG 77, Ltrs. Sent, Chief Engineer.

and employees in the Engineer buildings would have to be vacated and turned over to Colonel Benham.⁷⁵

General Benet alerted Colonel Crispin to the situation. He was to meet with Colonel Benham and make as satisfactory arrangements as possible for joint occupancy of the buildings. It was understood in respect to the Engineer's House that the Corps desired occupancy of two bedrooms and the sitting room, but no accommodations for dining and cooking.⁷⁶

b. Construction of the Officers' Quarters

Knowledge that the Board would soon be evicted from its quarters caused the Ordnance Department in June 1878 to allot from its appropriation for Fiscal Year 1879, \$12,500 for construction of quarters for the Ordnance Board at Sandy Hook.⁷⁷ On July 11 the War Department approved the building plans.⁷⁸

Several weeks earlier, Colonel Crispin had written Chief of Ordnance Benet regarding the projected quarters. As there was a large quantity of granite on hand suitable for foundations, he desired General Benet to contact the Chief Engineer for a permit to allow the

75. Ibid., Feb. 13, 1878, NA, RG 77, Ltrs. Sent, Chief Engineer.

76. Benet to Crispin, Feb. 13, 1878, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

77. Ibid., July 3, 1878, NA, RG 156, Ltrs. Sent, Chief of Ordnance. The Board at this time included Lt. Col. S. Crispin, and Maj. T.J. Treadwell and F.G. Baylor, with Capt. F.H. Phipps as recorder. Lt. W.L. Starring was attached to the Board, and often conducted the experimental and other firings.

78. Benet to Crispin, July 11, 1878, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

Ordnance Department to use approximately 1,500 cubic feet. The stones, none of which were dressed, were scattered about the grounds.⁷⁹

General Benet referred the request to Chief Engineer Humphreys. If the stone were available and could be used, he noted, it would enable us to accomplish the project more satisfactorily with the limited funds available. General Humphreys asked Superintending Engineer Benham to comment on the Ordnance Department's request.⁸⁰

General Benet meanwhile had advised Chief Engineer Humphreys that, since Congress had made an appropriation for quarters for the Ordnance Board at Sandy Hook, his Department had selected a site 650 feet south of the masonry fort as a suitable location for the structure. The site was removed from the "firing ground, and about the same distance from the fort as the engineer buildings." General Benet wanted to know if the engineers had any objection to the site.⁸¹

In accordance with procedures, General Humphreys sought the opinion of his superintending engineer at Sandy Hook. Colonel Benham made a personal reconnaissance of the area on July 17. He was accompanied by Colonel Crispin. The Ordnance officer pointed out the rough granite he wished to use for the quarters foundations and the proposed site. He told Benham that the building would be brick with a stone foundation and cellar.

Colonel Benham explained to Crispin that the 5,000 feet or more of rough stones for which he was responsible must be used

79. Crispin to Benet, June 26, 1878, NA, RG 77, Ltrs. Recd., Chief Engineer.

80. Benet to Chief Engineer, July 12, 1878, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

81. Benet to Humphreys, July 13, 1878, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

for protection of the site against beach erosion. The wooden jetties had been "mostly, if not wholly destroyed." Within the past month, he had employed part of the rough stone for filling the "long sand-box-bulkhead, where a break had occurred." If the Ordnance Department needed the stone and did not have time to procure it, he would turn that on hand over to Colonel Crispin as a loan to be replaced as early as convenient.

When they evaluated the site, Colonel Benham told Crispin that, unfortunately, it was in the dead angle of the fort's salient, and thus outside the direct line of fire from the masked wall. Even the fire that might be borne upon it from the pan coupe of the south front would be obstructed by a projected caponniere. Consequently, a direct approach on this salient by the foe would be masked by the proposed quarters, which were to be located on the highest ground in the area. Its cellar walls of stone would form a breast-height wall for a counter-battery directed against the weakest part of the fort. Moreover, as it was to be built of brick, the quarters would be difficult to destroy on short notice.

A better location from a military point of view would be at a site 150 yards west of and a little north of the one desired by the Ordnance people. It was on the same ridge, at an elevation of not more than two feet below the site chosen by Colonel Crispin, and within the "limit of direct fire from the southwest lines of the fort." Here the enemy would not be able to use the structure to screen a direct approach. Even if erected on this site, the quarters should be of wood with cellar of minimum size.

Colonel Crispin, in justifying the selection of his preferred site, argued that it was the highest and best site for a dwelling in the area. Benham agreed, except for its relation to the defense of the fort. Crispin also claimed that a brick building was more comfortable than a frame structure and was necessary for warmth during the cold Sandy Hook winters.

When he forwarded his report to Chief Engineer Humphreys, Colonel Benham wrote:

I greatly regret not to be able to report more favorably as to the character and site of a building, apparently desired and determined upon by the officers of another Department; but a conscientious discharge of my duties would not allow me to act otherwise. For it is obvious that the immediate exterior of large defensive works, does not admit the same domestic constructions for the usual comforts and conveniences, that are expected, and are unobjectionable in ordinary barrack grounds, or ordnance parks.⁸²

Chief Engineer Humphreys, however, did not concur with Colonel Benham's views. On July 19 he recommended to the Secretary of War that the site selected by the Chief of Ordnance for the quarters be approved. If an enemy secured a beachhead on Sandy Hook, the quarters would be destroyed by the garrison.⁸³

As soon as the Secretary of War had approved the site, General Benet notified Colonel Crispin. The Ordnance Board was to proceed with construction and endeavor to get the building under a roof before winter. Stone for the foundation and basement, in view of the position taken by Colonel Benham, would be provided for from the appropriation for quarters. Work would be done either by contract or day labor, whichever was deemed in the government's best interest.⁸⁴

Work on the quarters did not progress as rapidly as planned. Although they were occupied by June 30, 1879, for the purpose

82. Benham to Humphreys, July 18, 1878, NA, RG 77, Ltrs. Recd., Chief Engineer. Benham accompanied his report with a drawing of Sandy Hook on which he located and identified the site selected by Colonel Crispin and the one he recommended. A copy of this drawing is on file at the Sandy Hook Unit, Gateway NRA.

83. Humphreys to Secretary of War, July 19, 1878, NA, RG 77, Ltrs. Sent, Chief Engineer.

84. Benet to Crispin, July 25, 1878, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

intended, and provided good accommodations for the officers and "others interested in the important labors at all times in progress," there remained a number of details still requiring attention.⁸⁵

c. Other Improvements to the Grounds: 1878-79

In Fiscal Year 1879 construction was commenced on the two-story frame quarters for the superintendent (master mechanic) for which an allotment of \$5,700 was made by the Chief of Ordnance. Upon completion of the superintendent's quarters and the brick quarters for the Ordnance Board, the Ordnance Department in November 1879 surrendered to Colonel Benham one-half of the space occupied since the mid-1870s in the Engineer House and barracks.⁸⁶

During the late 1870s there were erected for use of the Proving Ground a stable, carriage shed, and wagon shed. These frame structures cost \$4,000. In 1879 the grounds were graded.⁸⁷

When he made his report for Fiscal Year 1879, General Benet noted that to make the Proving Ground what it should be would require additional facilities for the storage of powder and other ordnance property, as well as accommodations for the mechanics and laborers employed at the site. To meet these needs, he called on Congress for a modest appropriation.⁸⁸

85. Executive Documents, Serial 1907, p. 6.

86. Crispin to Benet, Nov. 17, 1879, NA, RG 156, Ltrs. Recd., Chief of Ordnance; Executive Documents, Serial 1907, p. 6.

87. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Chief of Ordnance.

88. Executive Documents, Serial 1907, p. 6.

III. THE ARMY PUSHES ITS SEARCH FOR AND TESTING OF UP-TO-DATE ORDNANCE

A. Operations at the Proving Ground in 1880

1. Benet Urges a Liberal Annual Appropriation

The 2d Session, 45th Congress, appropriated \$400,000 for Armament of Fortifications. This, General Benet trusted, was an "indication of a liberal policy on the part of Congress toward this indispensable arm of the national defense." Congress, in making available this sum, included an item "for the manufacture of four improved breech-loading twelve-inch rifled guns." Contracts had been let, and the first of the four guns was to be delivered in sixteen months, the second in eighteen months, the third in twenty months, and the fourth in twenty-two months.¹

The design contemplated guns of cast iron, with wrought-iron tubes and steel breech-receivers of the Krupp system. The receivers were ordered from Europe, but when delivered and carefully tested, the metal was found to be substandard and they were rejected. Further work on the contracts for the four guns was suspended by General Benet, pending receipt of the report of the Getty Board and congressional action on the Board's recommendation.²

When he made his annual report for 1880, Chief of Ordnance Benet complained that the money anticipated from year-to-year appropriations was so uncertain as "to quantity" that foundries were not "justified in running the risk of making such ample preparations of plant as the increased size of modern ordnance" required. Two years to complete four guns was the best that could be done by the nation's foundries although they had been given all the assistance the Ordnance Department could provide. General Benet, to alleviate this situation,

1. Executive Documents, Printed by Order of the House of Representatives for the 3d Session of the 46th Congress, 1881-82 (Washington, 1882), Serial 1956, VI, xi-xii.

2. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 47th Congress, 1882-83 (Washington, 1883), Serial 2095, VI, 6.

urged that Congress increase the previous year's appropriation and make it a continuing one.³

2. Tests and Trials at Sandy Hook

In Fiscal Year 1880 tests of the 11-inch muzzle-loading rifle had continued at Sandy Hook. Four hundred and one rounds had now been fired from the piece, twenty-seven with ninety pounds of powder and 495-pound projectiles; 174 with ninety pounds of powder and 543-pound shot; and three with ninety-five pounds of propellant and 540-pound projectiles. This trial, General Benet informed the Secretary of War, afforded "additional evidence of the strength of this system of gun construction, which has been so successfully proven in the test of the 8-inch rifles."⁴

Trials of the 8-inch breech-loading rifles had led the Ordnance Board to conclude that "the endurance of this system of gun construction, and the endurance as well as the successful manifestation of the breech mechanism" warranted the Department "in their adoption for future new construction, as well as in the future conversion of smoothbores into rifled guns." General Benet concurred with this view.⁵

Tests with a 3-inch rifled field piece having demonstrated the advantage of providing a cannon with a powder chamber, an 8-inch rifle had been chambered. Preliminary Proving Ground trials had proceeded so satisfactorily that General Benet had ordered the firing of 100 rounds with maximum charges of fifty-five pounds of powder and 180-pound shot. These tests disclosed that with pressures entirely within the limits of safety, the increased velocity due to chambering had boosted the power of the 8-inch rifle by about one-third. This increase in power was accompanied by more accuracy.⁶

3. Executive Documents, Serial 1956, pp. xi-xii.

4. Ibid., p. xii.

5. Ibid.

6. Ibid., pp. xii-xiii.

Several years having passed since any test firings had been done with the experimental guns, General Benet in the autumn of 1880 asked Congress for \$117,000 for a comprehensive test of the guns then at Sandy Hook (the 10-inch Woodbridge, 12-inch Thompson, 9-inch Sutcliffe, 8-inch Mann, and Lyman multi-charge guns) acquired under the Act of June 6, 1872. As of June 30, 1880, the Woodbridge had fired ten rounds, the Thompson two rounds, the Sutcliffe twenty-six rounds, the Mann eleven rounds, and the Lyman three rounds.⁷

3. Altering Casemate Carriages for Rifled Rodmans

The limited appropriation made by Congress in Fiscal Year 1880 for seacoast armament was employed by the Department in the conversion of 10-inch smoothbore Rodmans into 8-inch rifles, and securing carriages for these guns.

Alteration of casemate carriages for the 8-inch converted rifles, which was done at the Sandy Hook Proving Ground, had progressed satisfactorily during the fiscal year. The carriages enabled the Department to provide for the guns which had been converted. Seventy-five 8-inch rifles now occupied emplacements in the nation's coastal forts. Though the number was small, and the guns of "inadequate power for the more important positions," they provided powerful batteries for "our existing casemates of contracted dimensions."⁸

B. Armament Program and Proving Ground in 1881-82

1. Study Results in a Program

a. Getty Board Makes Its Report

The 1st Session, 47th Congress passed and President Rutherford B. Hayes signed on March 3, 1881, an act providing for the President to select a board consisting of one engineer officer, two ordnance officers, and two artillery officers, whose duty it would be to

7. Ibid., p. xiv.

8. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 47th Congress, 1879-80 (Washington, 1880), Serial 1907, VI, 6-7.

examine all inventions of heavy ordnance and improvements of heavy ordnance and projectiles presented to them, including guns then under construction or converted under direction of the Ordnance Bureau. This board was to make detailed reports to "the Secretary of War, for transmission to Congress, of such examination, with recommendation as to what inventions" were "worthy of actual test, and the estimated cost of such test."⁹

Named to the "Board to Make Examination of all Inventions of Heavy Ordnance and Improvements of Heavy Ordnance and Projectiles" were Col. George W. Getty and Maj. John Mendenhall of the Artillery, Col. Zealous B. Tower of the Engineers, and Col. J.G. Benton and Maj. A.R. Buffington of the Ordnance Department. Getty was named chairman, while 2d Lieutenant Frank E. Hobbs of the Ordnance Department was selected as recorder.

The Getty Board convened on July 13, 1881, at New York City's Army Building. On two occasions from October 11-18 and again on November 29, the Board met at Sandy Hook. While there on October 18, the Board watched as the 10-inch Woodbridge burst on its eighty-third round, ten of which rounds had been fired at Frankford Arsenal before its transfer to the Proving Ground.¹⁰

On May 18, 1882, the Getty Board made its report to Secretary of War Robert Todd Lincoln. It recommended construction and trial of these cannon: (a) the Lyman-Haskell accelerated or multi-charge 6-inch gun; (b) Dr. W.E. Woodbridge's wire-wound cast-iron breech-loading 10-inch gun; (c) the plan submitted by Chief of Ordnance Benet for a cast-iron breech-loading 12-inch gun, hooped with steel; (d) the plan submitted by General Benet for a cast-iron breech-loading 12-inch gun, hooped and tubed with steel; (e) the plan submitted by the

9. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 47th Congress, 1881-82 (Washington 1883), Serial 2014, VI, 7.

10. Executive Documents, Serial 2095, pp. 139-208.

Chief of Ordnance for a cast-iron 12-inch muzzle-loading rifled-mortar, hooped with steel; (f) W.P. Hunt's plan of a steel breech-loading 10-inch gun; (g) Dr. Woodbridge's plan for a brazed steel-wire breech-loading 10-inch gun; (h) the plan submitted by the Chief of Ordnance for a steel-wire breech-loading 8-inch gun; (i) Dr. Woodbridge's plan for a steel breech-loading 10-inch gun, wire-wound and soldered; and (j) a wire-wrapped breech-loading steel 9-inch rifle, after the Schultz plan, submitted by Colonel Crispin. The recommendations of the Getty Board were referred to Congress on May 29 by Secretary of War Lincoln.¹¹

The United States Senate had also become involved in efforts to rationalize the heavy ordnance industry and to provide the nation's warships and seacoast defenses with modern armament to cope with those being developed by the European powers. The Senate had recently named a select five-man committee, headed by Senator John A. Logan of Illinois, to "take into consideration the subject of heavy ordnance and projectiles for the armament of the Navy and the seacoast defenses." The committee had been instructed to report to the Senate at its next session. This made it incumbent on General Benet to await congressional action before entering on the manufacture or conversion of any additional heavy cannon.¹²

b. Benet Calls for Action

While waiting for Congress to act, Chief of Ordnance Benet made his position clear in his Annual Report for 1882 to Secretary of War Lincoln. With the pressing need for seacoast armament, he wrote, it seemed expedient "to take every advantage of our own resources to help provide our wants." It would be to the nation's interest to manufacture rifled guns of moderate power even from cast-iron, provided the cast-iron was suitably strengthened with steel hoops, or better, with hoops on the exterior and a steel tube on the interior. Such guns, however, were very heavy in proportion to their power. Substitution of

11. Executive Documents, Serial 1907, p. 6.

12. Ibid.

steel wire for hoops appeared to be an advantageous modification, and its trial, as recommended by the Getty Board, promised important results. A similar plan, involving experimental cast-iron guns, was underway in France.

For the manufacture of rifled mortars, cast-iron, strengthened with steel boxes, could be used to advantage. In the mortars, Benet continued, great strength was not needed, as the propellant charge employed was small. But, as their fire was comparatively uncertain, it was necessary that what they lacked in accuracy could be made up by the number deployed. The cheapness and ease of production of mortars were essential requirements, while the small charge and short bore admitted of employing a comparatively light weapon.

The material out of which "full-power" guns must be cast, General Benet informed the Secretary, was steel. All the European powers had adopted it. Even those that had spent more millions than the United States had "thousands in effort to determine on the most reliable metal for gun construction" were abandoning cast- and wrought-iron, either "single" or in combination with other metals, and were "devoting their attention to steel, and steel alone." The tremendous strides in gun manufacture made during the past two years in development of cannon of great strength and power pointed to the conclusion that "encouragement should be given in every way possible to the manufacture of steel in large masses suitable for this purpose."

So far, "tentative" efforts had done little to encourage the hope that steel guns for coastal defense could be produced in the United States. The deployment of wire-wound guns, if they proved as successful as recent experiments in the United States and abroad indicated, would greatly simplify the problem. It would limit the size of the steel masses used, while the wire could be procured from domestic manufacturers. Under the most favorable circumstances, General Benet cautioned, the nation "is in no condition . . . to undertake such constructions wholly out of home products, and the subject is of

sufficient importance to arrest the attention and receive the careful attention of Congress."¹³

c. Congress Appropriates \$400,000 for Weaponry

The Logan Committee's conclusions were embodied in an act making appropriations for fortifications, etc., signed by President Chester A. Arthur on March 3, 1883. The act provided \$400,000 for armament of seacoast fortifications.

Included was a broad spectrum of military hardware ranging from heavy guns to howitzers for flank defense, carriages, projectiles, fuses, powder, and implements; their trial and proof; and all necessary expenses incident thereto, "including compensation of draughtsmen on gun construction . . . for conversion of 10-inch smoothbore cannon into rifled guns." Funds were also provided for casting and testing two 12-inch cast-iron rifled breech-loading guns. These were in lieu of "such of the cannon," the construction of which had not been commenced as provided for by the "act making appropriations for fortifications and other works of defense, and for the armament thereof for the fiscal year ending June 30, 1881, and for other purposes," approved May 4, 1880.¹⁴

Under the provisions of the 1883 act, Chief of Ordnance Benet approved contracts for: (a) converting fifty 10-inch Rodman smoothbores into 8-inch rifles by lining them with coiled-wrought-iron tubes; (b) manufacturing two 12-inch cast-iron breech-loading rifles, one of which was to be lined as far as the trunnions with a steel tube wrapped with wire; (c) casting one 12-inch cast-iron mortar, banded with steel hoops; (d) manufacturing one 10-inch cast-iron breech-loading rifle, wrapped with steel wire, and one 12-inch cast-iron breech-loading rifle, tubed, and banded with steel hoops;

13. Ibid., pp. 6-7.

14. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 48th Congress, 1883-84 (Washington, 1884), Serial 2186, VI, 5.

(e) the tubes, hoops, etc., for one 8- and one 10-inch steel rifle; (f) testing the "devices for breech-loading guns" submitted by H.F. Mann and Theodore Yates; and (g) for altering twenty-five carriages for 15-inch smoothbore guns to permit the use of increased powder charges.¹⁵

2. Improvements and Tests

a. Permanent Platforms for Proof Battery

On November 11, 1881, Lt. Col. Thomas G. Baylor replaced Colonel Crispin as President of the Ordnance Board. Having been a member of the Board since its establishment, Baylor was familiar with his duties and responsibilities.¹⁶

Earlier in the year, the Board had determined to replace the temporary gun platforms in the proof battery with permanent ones of concrete. Two hundred and fifty cubic yards of broken stone were required for the project. Captain Starring, the officer in charge of the Proving Ground, knew that the Engineers had on hand at the Hook more than enough broken stone. Perhaps, he inquired, it might be made available for the project.¹⁷ General Benet accordingly contacted the Chief Engineer, informing him that the Ordnance Department desired to use the stone for construction of "solid platforms upon which to test guns," which would be of interest to the Engineers.¹⁸

15. Ibid., pp. 5-6.

16. Colonel Crispin remained a member of the Board, while continuing as Constructor of Ordnance. Colonel Baylor also wore two hats. He was commander of the New York Arsenal from June 1876 to May 1886.

17. Starring to Crispin, April 6, 1881, NA, RG 77, Ltrs. Recd., Chief Engineer.

18. Benet to Wright, April 7, 1881, NA, RG 77, Ltrs. Recd., Chief Engineer.

Colonel Benham, on learning through channels what was intended, directed the fort keeper to "measure, point out, and place at the disposition" of Captain Starring 250 cubic yards of broken stone.¹⁹

b. 1881 Tests of Three Big Breech-Loading Rifles

The permanent platforms were ready, when the Ordnance Board assembled at Sandy Hook in September 1881. Mounted in the proof battery were two 8-inch and one 11-inch breech-loading rifles. These pieces had been converted respectively from 10-inch and 15-inch Rodman smoothbores, with their steel breech receivers cast on the Krupp principle.

The No. 1 8-inch rifle promptly burst. On October 2 the 11-inch breech-loading rifle burst on the second round. The indicated pressure was 37,008 pounds to the square inch. It had burst at the same point as the No. 1 8-inch rifle. Reporting what had occurred to Chief of Ordnance Benet, Colonel Baylor announced that tests were continuing with the No. 2 8-inch breech-loading rifle.²⁰

Tests on this rifle were commenced on October 3 and continued until December 30, when the piece burst on the 127th round. This was the 22d projectile fired with a 55-pound powder charge. The rupture was tangential and violent, the tube being sundered into many pieces.²¹

A study of the shattered tubes disclosed that the fractures began at the front corner of the slot for the breech-block, next to the cast iron, and passed around the walls of the breech receiver in a

19. Benham to Wright, April 12, 1881, NA, RG 77, Ltrs. Recd., Chief Engineer.

20. Baylor to Benet, Oct. 2, 1881, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

21. Starring to Benet, Oct. 3, 1881, and Baylor to Benet, Dec. 30, 1881, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

plane transverse to the axis. A thorough examination of the metal and fractures led the Board to the conclusion that the ruptures were caused by defective design, aided perhaps by the character of the steel.

The No. 2 8-inch breech-loading rifle, unlike the other two guns, had the sharper corners in the breech slot rounded off to prevent the beginning of a rupture of those angles. It had lasted 127 rounds, with charges of fifty and fifty-five pounds, of which twenty-two rounds were with a violent powder entailing high pressures--an excellent record. When it burst, it went all to pieces, showing that the parts gave equal support to the system, and proving the excellence of the combinations of metals, when of suitable quality and non-faulty design.²²

In January 1882 Captain Starring asked for instructions as to what disposition was to be made with the three guns which had burst during the recent tests. He also requested information whether the 10-inch Woodbridge gun, which had burst while the Getty Board was observing its trial, was to be transferred to the Board on Heavy Ordnance and Projectiles for disposal.²³

General Benet directed Starring to drop the Woodbridge gun from his returns, along with the No. 2 8-inch rifle. The 11-inch rifle and 8-inch gun No. 1 would be retained on the returns.²⁴

3. Funding Operations in the 4th Quarter of Fiscal Year 1882

As the Proving Ground was administered by the Ordnance Board, it was funded through the New York Arsenal. In the early spring of 1882, the commanding officer of the arsenal, Colonel Baylor, who was also president of the Board, advised General Benet that for service of the Proving Ground in the last quarter of the current fiscal

22. Executive Documents, Serial 2095, p. 7.

23. Starring to Benet, Jan. 25, 1882, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

24. Benet to Starring, Jan. 27, 1882, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

year, he needed \$7,000 from the appropriation for Armament of Fortifications. This money would be used for the salaries of clerks, foremen, mechanics, and laborers employed in connection with experiments, alterations of carriages, trial and proof of guns, etc.; the pay of watchmen; and for the purchase of materials for "all purposes in connection with the experiments."

The sum of \$750 was requested from the appropriation for Repair of Arsenals. This would be employed for the repair and preservation of the public buildings and grounds at Sandy Hook.²⁵

Chief of Ordnance Benet, after reviewing the estimates and evaluating them in relation to the Department's nationwide responsibilities, asked Colonel Baylor whether his figures could not be reduced without detriment to the service. Calling attention to the March returns of men employed, Benet expressed a desire that in the interest of economy the work force be "largely reduced."²⁶

Colonel Baylor, taking cognizance of his superior's views, agreed to lay off five mechanics and two temporary clerks. This would reduce the figure asked for under Armament of Fortifications for the quarter by \$850.²⁷

Like many installations administered by another agency, the Proving Ground frequently lost money when funds were shuffled. On April 17, 1882, Colonel Baylor called to General Benet's attention that his estimate for Sandy Hook for the fourth quarter of Fiscal Year 1882 called for expenditure of \$750 to be charged against the appropriation for Repair of Arsenals. At the moment there was \$730

25. Baylor to Benet, April 4, 1882, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

26. Benet to C. O., New York Arsenal, April 14, 1882, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

27. Baylor to Benet, undated, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

available for maintenance of the Proving Ground, in addition to this sum, making a total of \$1,480 to be expended in this quarter. As there was no need for this kind of money at Sandy Hook for maintenance, Colonel Baylor requested authority to spend \$1,000 of it on expansion of the office at the New York Arsenal. This, with the \$50 recently allotted for fitting up rooms for draughtsmen in the arsenal building, would be sufficient to fund the project. The \$480 remaining in the Sandy Hook account would suffice for all essential repairs there until July 1, 1882.²⁸ Chief of Ordnance Benet was agreeable and the money was reprogrammed as Colonel Baylor had suggested.

4. Additions to and Improvements of the Test Instruments

To increase the efficiency of the testing facilities, Colonel Baylor determined, in the late winter of 1882, to construct additional permanent data gathering stations. They would be of two types--those for range tables and those for obtaining initial velocities, when firing under high angles.²⁹

On February 18 Chief of Ordnance Benet approved the expenditure of \$620 for improving the experimental facilities.³⁰

When completed the new facilities included velocity frames for taking velocities when the gun was elevated to 10 degrees. The first of these frames was twenty feet in height with one set positioned a mile down range from the battery, and the other set (forty feet high) at a range of 3,000 yards. One frame was fifty feet in front of the respective target and the other fifty feet to the rear. The instruments were positioned in bombproofs near the targets. The one at the mile target required 335 yards of wire and the other at the 3,000 yard target 670 yards of wire.

28. Ibid., April 17, 1882, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

29. Ibid., Feb. 16, 1882, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

30. Benet to Baylor, Feb. 18, 1882, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

A level line from the proof battery was run down range, with a post positioned every 100 yards. The posts were eight feet tall, six inches square, with the tops planed, painted, and marked with the number of yards from the proof battery. At a point on the beach 2,000 yards down range from the proof battery was erected a frame house for taking ranges with plane tables.³¹

In the late autumn of 1882 the Proving Ground received a new Breger Chronograph. This supplemented and improved on the Le Boulange chronographs previously in use. To mount the Breger, a new iron pedestal, similar to the two received from the Frankford Arsenal in June 1877, was requisitioned.³²

5. Two Guns are Added to the Proof Battery for Testing Canister

Colonel Baylor, to carry on experiments with canister fired from 8- and 10-inch Rodman smoothbore guns, asked authority to take one 8-inch gun and carriage and one 10-inch gun and carriage from the Sandy Hook fort and mount them in the proof battery.³³ Although the request was approved, Baylor was unable to get his 10-inch gun and carriage. When he applied for it, Ordnance-Sergeant James Coleman told him that all the fort's 10-inch carriages had been transferred by Ordnance-Sergeant A. Kock to the Ordnance Department in 1879 for alteration to mount 8-inch rifles. The Board was accordingly compelled to outfit one of its 10-inch carriages for the canister tests.³⁴

31. Sinclair to Starring, Feb. 9, 1882, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

32. Starring to Baylor, Dec. 28, 1882, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

33. Baylor to Benet, Mar. 31, 1882, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

34. Adj. Gen. to C. O. Div. of the Atlantic, April 15, 1882, and Coleman to Baylor, April 19, 1882, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

C. Proving Ground in 1883

1. Colonel Baylor Asks for \$2,625 for Maintenance

The President of the Ordnance Board was charged with preparing estimates for funds required at the Proving Ground for each ensuing fiscal year. These estimates were submitted for approval to the Chief of Ordnance. On July 10, 1882, Colonel Baylor, having become President of the Board the previous November, submitted his estimates of funds required for service at the Proving Ground for Fiscal Year 1883 to be charged against the appropriation for Repair of Arsenals. He called for:

<u>Item(s)</u>	<u>Facility</u>	<u>Amount</u>
Inside shutters or blinds lower story	Officers' Quarters	\$ 140.00
Inside shutters or blinds upper story	Officers' Quarters	75.00
Fence around quarters, general repairs, painting, fitting waterpipes, etc.		600.00
Painting, putting in force pump and drain pipe in battery room, well for same, and general repairs	Instrument House	400.00
Lumber, paint, nails, etc.	Machine Shop	150.00
Lumber, lime, cement, glass, paint, etc.	Mens' Quarters	700.00
Materials and labor for stables		50.00
Contingencies		<u>500.00</u>
		\$2,625.00 ³⁵

General Benet reviewed and approved an allotment of \$2,625 for Sandy Hook to be charged against the annual appropriation for Repair of Arsenals.

35. Estimate of Funds, Fiscal Year 1883, July 13, 1882, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

2. Work Accomplished During the Year

Fiscal Year 1883 was a busy one at the Proving Ground. Work undertaken was charged to three accounts in addition to Repair of Arsenals. Projects charged to Armament of Fortifications consisted of: (a) experimental firings and work on experimental guns, gas-checks, sights, etc.; (b) preparation of ammunition for experimental firings; (c) moving, mounting, and dismounting guns and carriages; (d) proving guns; (e) making, erecting, repairing, and painting wooden and iron targets; (f) erecting and repairing of bombproofs; (g) recovering projectiles from butts and resabotting same; (h) testing metals; (i) repairing, altering, and cleaning gun carriages and parts of same; (j) assembling and disassembling gun carriages; (k) drilling and fitting vents and sights to guns; (l) repairing, painting, and cleaning utensils and tests; (m) repairing workshops, Instrument House, magazine, and coalshed; (n) cleaning and overhauling guns, carriages, and other stores on hand; (o) hauling stores from and to the wharf and examining the same; (p) hauling sand, gravel, lumber, etc., for repair and filling of sand butts; (q) repairing roads and plank walks, grading grounds, and shoveling snow; (r) office duties (drawings, plans, etc.); (s) taking velocities and care of electrical instruments; (t) policing and care of public animals; (u) photographing guns and carriages, etc.; (v) repairing steamer Ordnance, wharf, and crane; (w) hauling materials and labor for protection of the beach front; (x) moving office, Instrument House, and instruments; (y) rearranging wires and painting telegraph poles; (z) making and altering patterns; and (aa) repairing velocity frames.

Charged to the account for Ordnance Service was altering and painting a carriage for the 6-inch Lyman-Haskell gun.

Ordnance Stores were debited for drilling elevating props and fitting bolts to same for issue; forging sights; fitting vents to guns at other posts; making arcs and indices; fitting chains to and other work on the Fort Hamilton 20-inch gun carriage; and fitting arcs and indices to carriages, sights to guns, and cleaning vents of 15-inch guns at Fort Hamilton.

The appropriation for "Repair of Arsenals" had been used to fund the repair and painting of public buildings, gasometer, pumps, etc., and irons of the Governor's Island wharf.

Fabricated in the Sandy Hook machine shop had been fifteen elevating arcs and indices for 8-inch converted rifles; twenty 8-inch wire canisters; three 8-inch service canisters; twenty-four priming tubes for 12-inch muzzle-loading rifles; one gun cradle; one velocity frame; one wooden platform for 12-inch mortar carriage; one fulcrum for 12-inch seacoast mortar bed; twelve bolts for iron targets; twenty-four wooden shutters for Officers' Quarters; one impression block; one pattern for crosshead; two patterns for U-plates; and one pattern for Wood 3-inch gun.³⁶

3. Proving Ground Adds a 15-inch Rodman to Its Inventory

In August 1883 Captain Starring transferred from the fort's returns to his one 15-inch Rodman, No. 114, one tompon, one 4-inch pintle, and one crane. The huge 50,000-pound gun was being used by the Ordnance Board for experiment firing.³⁷

4. Proof Battery Gets a Mobile Bombproof

A new bombproof (20x7x6 feet) was constructed at the Proving Ground in rear of the guns. To provide mobility, it was positioned on ten white oak rollers.³⁸

36. Annual Report, Fiscal Year 1883, Sandy Hook Proving Ground, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

37. Starring to McKee, Aug. 31, 1883, NA, RG 156, Ltrs. Recd., Chief Engineer.

38. Baylor to Benet, Mar. 19, 1883, and Benet to Starring, Mar. 31, 1883, NA, RG 156, Ltrs. Recd. and Ltrs. Sent, Chief of Ordnance. Materials for the bombproof included 18 pieces 12" x 12" x 7'; 8 pieces 12" x 12" x 8'; 20 pieces 12" x 12" x 20'; 20 pieces 12" x 12" x 12'; 15 pieces 3" x 12" x 20'; 35 pieces 3" x 12" x 15'; 5 rolls of roofing paper; 200 pounds of 8-inch spikes; 1 barrel of pitch; and 10 white oak rollers 8" x 8'. The cost of materials and labor was \$431.70.

D. Beach Erosion Continues to Plague the Army

A nor'easter in September 1880 sent surf pounding across the beach fronting the masonry fort, endangering the frame building occupied by the Signal Service north of the Ordnance Department's Instrument House. Relaying this news to Washington, the officer in charge warned that the next nor'easter would probably carry it away, as the Engineers' jetties were proving to be inadequate.

Chief Signal Officer William B. Hazen accordingly requested permission from the Chief Engineer to utilize the southwest angle of the fort as a site for construction of a new signal office.³⁹

When asked by the Chief Engineer for his comments on the problem confronting the Signal Service, Colonel Benham agreed that the Southwest Bastion was the best possible position for a signal station at the post. Moreover, he saw no objection to use of the bastion for that purpose.⁴⁰

Before anything was done to follow up on this plan, Chief Signal Officer Hazen learned that he could not wait for an appropriation. With the station in danger of being undermined by the next storm, he asked authority to have the building moved from its present location some 150 to 200 yards to a site north of the Western Union Telegraph Company's office. Meanwhile, he desired permission for his men to occupy the building formerly used by his Service belonging to the Engineers but currently unoccupied.⁴¹

39. Chief Signal Officer to Chief Engineer, Sept. 29, 1880, NA, RG 77, Ltrs. Recd., Chief Engineer.

40. Benham to Chief Engineer, Oct. 4, 1880, NA, RG 77, Ltrs. Recd., Chief Engineer.

41. Chief Signal Officer to Chief Engineer, Dec. 9, 1880, NA, RG 77, Ltrs. Recd., Chief Engineer.

Maj. Gen. Horatio G. Wright, who had succeeded General Humphreys as Chief Engineer, informed General Hazen that he had no objection to either the relocation of the Signal Service facility, or the temporary occupation of such building or rooms as Colonel Benham might designate.⁴²

During the winter of 1880-81, the signal station was moved about 100 yards to the northeast, and relocated in lee of the southeast face of the northeast bastion.

The continuing encroachment by the sea also worried officers of the Ordnance Department. In June 1881 William L. Starring, who had been promoted and assigned to the Ordnance Board, complained to his superiors that the beach near the Instrument House, the Western Union Signal Tower, and the fog horns was being rapidly washed away. The autumn's nor'easter had compelled the Signal Service to remove its quarters. A storm the week before had cut away another ten feet of beach from beyond the Western Union Tower and along the shore in the direction of the fog horns. If the surf cut through the bank as it was trying to do, the footings of the fort's northeast face and considerable ground in front of it would be flooded. A large part of the wooden breakwater built by the Engineers in 1877 had been smashed by storms during the last four years, leaving the beach fronting the Proving Ground unprotected.⁴³

An Atlantic storm in the first week of January 1883 undermined the Instrument House's porch. Reporting what had occurred, Colonel Baylor warned that unless moved promptly the entire building would be engulfed. Colonel Benham, when apprised of the situation,

42. Wright to Hazen, Dec. 21, 1880, and Hazen to Wright, Dec. 30, 1880, NA, RG 77, Ltrs. Recd. & Sent, Chief Engineer.

43. Starring to Baylor, June 11, 1881, NA, RG 77, Ltrs. Recd., Chief Engineer.

explained that the Corps of Engineers had no funds with which to protect the beach. Accordingly, Baylor asked General Benet for authority to move the house "forward in direction of the sand butt."⁴⁴

General Benet gave Baylor carte blanche to use his discretion in the matter. Colonel Baylor soon had a force employed and shifted the structure southeast about thirty feet.⁴⁵

E. 1884 Brings an Increased Work Load

1. Ordnance Contracts

a. Casting the Guns, Tubes, and Forgings

By the end of Fiscal Year 1884 work was underway on the \$400,000 of ordnance contracts awarded by General Benet the previous year. Contracts for the cast-iron 12-inch rifles and mortars had been signed with the South Boston Foundry. The foundry, not having manufactured any cast-iron guns for a number of years, experienced difficulties at the outset in working up the iron to a proper standard before castings could be made. There were also delays while awaiting receipt of necessary steel forgings purchased abroad. But by June 30, 1884, one 12-inch breech-loading cast-iron tube had been cast. The body for the 12-inch muzzle-loading rifled mortar had been cast and finished, and hoops of suitable quality procured from Midvale Steel Company of Nicetown, Pennsylvania. South Boston machinists were now hooping the mortar.

The body for the 10-inch breech-loading rifle, cast-iron, wrapped with steel wire, had been cast and readied for application

44. Baylor to Benet, Jan. 11, 1883, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

45. Benet to Baylor, Jan. 11, 1883, NA, RG 156, Ltrs. Sent, Chief of Ordnance; "Comparative Map Showing Shore Changes of Sandy Hook, New Jersey, from 1860 to 1883, compiled & drawn under direction of Major G.L. Gillespie." A copy of this drawing is on file at the Sandy Hook Unit, Gateway NRA.

of the wire. The wire winding would be done at Watertown Arsenal under supervision of Dr. Woodbridge.⁴⁶

The tube for the steel wire 10-inch breech-loading rifle; the tube and jacket for the steel 8-inch breech-loading rifle; the tubes for two 12-inch cast-iron rifles; two 12-inch rifle breech bushings, and four trunnion hoops had been ordered from Sir Joseph Whitworth & Co., Manchester, England. This order had been placed on May 29, 1883, with a promise that the forgings would be delivered within five months.⁴⁷

Billets for the wire wrapping were purchased from Otis Iron & Steel Co., Cleveland, Ohio. The accepted billets were sent to Trenton Iron Company, Trenton, New Jersey, where they were rolled into rods one-half inch square, then annealed and drawn into wire .15 of an inch square. Bars for the longitudinal staves of the 10-inch steel-wire breech-loading gun were also manufactured by Otis Iron & Steel. These bars were annealed at the Washington Navy Yard, and shipped to Jones & Laughlin in Pittsburgh to be cold rolled to a size of 3.4 inches square.⁴⁸

The Department had contracted for steel forgings (hoops, breech-blocks, etc.) for the steel 8-inch breech-loading rifle; the 12-inch muzzle-loading rifled mortar; and the 12-inch rifle, cast-iron, hooped and tubed with steel with Midvale Steel. The hoops were made from open-hearthed steel, either rolled or hammered into shape, depending on their size.⁴⁹

46. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 48th Congress, 1884-85 (Washington, 1885), Serial 2282, VII, 7-8.

47. Ibid., pp. 9-11.

48. Ibid., pp. 8-9.

49. Ibid., pp. 11-12.

b. Converting Fifty 10-inch Rodman Smoothbores into Rifles

Reporting on the conversion into 8-inch rifles of the fifty 10-inch Rodmans as authorized by Congress in 1883, General Benet noted that heretofore the lining tubes had been of coiled wrought-iron manufactured by the West Point Foundry Association. Most of these tubes had been inserted through the breech. With a view to widening the field for competition, as well as simplifying the construction, a scheme for inserting the lining through the muzzle was adopted, and a 10-inch gun converted on this plan, the tube being furnished by Midvale Steel.

The conversion was done at the South Boston Foundry, and the gun shipped to Sandy Hook for trial by the Board for Testing Rifled Cannon, etc., appointed under the Act of July 5, 1884. This gun was test-fired 500 times during a two-month period.

Satisfied by the results, General Benet invited proposals for furnishing materials for, and converting fifty 10-inch Rodman smoothbores into 8-inch rifles by "lining either with coiled wrought-iron or forged steel tubes."⁵⁰

The contract for rifling the fifty smoothbores was awarded to West Point Foundry as low bidder, and the manufacture of the tubes to Midvale Steel.⁵¹

c. The Mann and Lyman-Haskell Rifles Fail Their Tests

The 6.5-inch Mann gun was received in early August 1884 at Sandy Hook. It had been made by lining a 10-inch smoothbore cast-iron gun with a tube of Whitworth fluid-pressed steel, and

50. Ibid., 12-14. The Board for Testing Rifled Cannon included Colonel Baylor, Majs. F.H. Parker and George W. McKee, and Capts. Charles Shaler and D.A. Lyle.

51. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 49th Congress, 1885-86 (Washington, 1886), Serial 2374, VII, xix-xx.

"applying" the Mann breech mechanism, also made of Whitworth steel. The piece had been manufactured at the South Boston Foundry.

Trial of the gun, with H.F. Mann in attendance, began in September. The largest charges employed were from thirty-seven to forty pounds of powder, with 109-pound projectiles. At the twenty-fourth round, the breech of the gun was blown off

the massive steel cross-head being fractured about 3 inches from its left tenon, and with the breech screw was thrown as a single fragment 54 feet to the rear, passing through a heavy timber screen; the cast-iron⁵² breech-block proper was broken into a number of fragments.

The Board for Testing Rifled Guns, of which Colonel Baylor was president, accordingly reported that the Mann breech-loading rifle was unsatisfactory in its endurance and should not be "put to use in Government service."⁵³

Tests of the Lyman-Haskell multi-charge gun at Sandy Hook were suspended after the thirty-third round because of the appearance of a crack in the inner tube. The gun was repaired by addition of steel hoops to the chase portion surrounding the crack. Trials were then resumed under supervision of Haskell.⁵⁴ On the fifty-third round the cast-iron casing gave way, cracking lengthwise. Permanently disabled, the gun was removed from the proof battery.⁵⁵

2. Construction of the Carpenter Shop-Storehouse

a. Plans Are Made and a Site Selected

The 1st Session, 48th Congress, appropriated \$2,500 for construction of a carpenter shop-storehouse at Sandy Hook. On

52. Executive Documents, Serial 2282, pp. 14-16, 293-303.

53. Ibid., p. 15.

54. Ibid., p. 16.

55. Executive Documents, Serial 2374, p. xxi.

September 25, 1884, Chief of Ordnance Benet called upon Colonel Baylor for data on the character and dimensions of the proposed building to be erected for storage purposes from the recent congressional appropriation. In addition, he desired to know what buildings at the Proving Ground required repair as well as the character of the repairs and alterations projected.⁵⁶

Replying, Colonel Baylor reported that the building for storage purposes was to be a covered wooden shed, 150 feet in length and 25 feet in width. Fifty feet of this frame structure was to be a carpenter shop and the remainder used for storage.

Needed repairs to the mechanics' and laborers' quarters included new floors, reshingling, weatherboarding, enlarging the kitchen, and coating the walls with a yellow wash.

It was desirable to reshingle a portion of the quarters occupied by the clerk and superintendent, to make slight repairs to the machine shop, paint the lower floor of the Instrument House, and repair old leaders and woodwork on its porch.

Repairs to the two-story brick Officers' Quarters, erected in 1878-79, would include alterations and additions to the plumbing, slight general repairs, and repainting floors of halls and uncarpeted first floor rooms.⁵⁷ General Benet approved these projects on September 30.⁵⁸

56. Benet to Baylor, Sept. 25, 1884, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

57. Baylor to Benet, Sept. 26, 1884, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

58. Benet to Baylor, Sept. 30, 1884, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

b. Engineers Voice Concern and Raise Questions

Maj. George L. Gillespie, who had replaced Colonel Benham as engineer responsible for the defenses of Sandy Hook, was disturbed to see Ordnance Department workmen erecting a large building near the southeast bastion of the masonry fort. In addition, he heard that Colonel Baylor proposed to build a second frame structure at the Hook, at an as yet undetermined location. If it were deemed best to locate the latter building within the fort's perimeter, the Ordnance people would seek the concurrence of the Chief Engineer. When he reviewed the 1874 documents regarding establishment of the Proving Ground, Major Gillespie concluded that the Ordnance Department could erect no buildings at Sandy Hook without consent of the Engineers. He, therefore, contacted the Chief Engineer.⁵⁹

When asked to comment on the subject by the Chief of Ordnance, Colonel Baylor reported that the correspondence of August 1874 had given their Department "a sort of general authority" to use the reservation at Sandy Hook as a proving ground. The area shown on the 1874 map merely indicated "the positions of the firing batteries, proof butt, bombproof and house for the Chronoscopes." In addition, the subject correspondence had referred to "other necessary structures and appliances for the test and trial of experimental guns."

No other authority had been requested or obtained for the buildings which it had been found necessary to erect in subsequent years to facilitate operations at the Proving Ground, with exception of the brick Officers' Quarters. Several structures had been built since, but no special authority had been asked for or requested. The Ordnance Department had deemed the endorsements to Colonel Crispin's letter of August 3, 1874, to convey sufficient authority.

59. Gillespie to Newton, Nov. 29, 1884, NA, RG 77, Ltrs. Recd., Chief Engineer. The carpenter shop, a frame building about 150 feet long by 20 feet wide, paralleled the fort's southeast land front.

To settle all questions of jurisdiction that might arise in the future, Colonel Baylor recommended that the Secretary of War be requested to grant to the Ordnance Department control of that part of the reservation determined to be essential to the successful operation of the Proving Ground.⁶⁰

Major Gillespie countered that the Corps had no desire to restrict the Ordnance Department in its operations at Sandy Hook. But, he added, regulations charged the superintending engineer to see that the portion of the reservation set apart for Ordnance purposes be "clearly defined, so as to avoid any possible conflict of authority between the two Departments."

As Gillespie interpreted the agreement of August 1874, the Ordnance people were to confine their activities to Area C, as shown on the map (Area C paralleled the Atlantic beach from a point southeast of the fort to a point opposite the Horse Shoe). No extension so far as he knew had been asked for or granted. Moreover, it was likely that in the near future modern defenses for protection of Lower New York Bay would be commenced at Sandy Hook. These works and their sites had not been determined upon, but economy, if nothing else, would, in Major Gillespie's opinion, dictate that no new buildings be erected near the northern point of the Hook without consultation with the Chief Engineer.

The necessary buildings and fixtures for the Proving Ground, except the quarters and barracks, were grouped near the southeast bastion. If war came, the Proving Ground, being under the guns of an enemy fleet anchored off the Hook, would be untenable. It would have to be transferred elsewhere and the buildings demolished. Consequently, Gillespie argued, the present occupancy of a portion of the

60. Baylor to Benet, Dec. 26, 1884, NA, RG 77, Ltrs. Recd., Chief of Ordnance.

reservation as a Proving Ground could be regarded as temporary and no change in existing jurisdiction was desirable.⁶¹

Chief Engineer John Newton, who in 1884 had replaced General Wright as Chief Engineer, backed Major Gillespie. Although anxious and ready to "render to the Ordnance Department every assistance" in his power, he could not recommend any general transfer of the reservation now committed to the charge of his Department, as suggested by Colonel Baylor. Army regulations, he reminded General Benet, prohibited construction of buildings within a half-mile of a fort, except under superintendence of the Engineer Department and by authority of the Secretary of War. Thus, Chief of Ordnance Benet was requested to indicate the portion of the reservation desired for a Proving Ground.⁶²

General Benet promised to erect no further buildings at Sandy Hook until the site selected could be referred to the Chief Engineer for approval.⁶³

c. Structure is Built

Work on the carpenter shop-storehouse was allowed to continue and was completed before the end of Fiscal Year 1885. During this same period, workmen repaired and painted the quarters, workshops, Instrument House, magazines, and coal shed, and repaired water pipes, wharf, and plank roads and walks.⁶⁴

61. Gillespie to Newton, Jan. 24, 1885, NA, RG 77, Ltrs. Recd., Chief Engineer.

62. Newton to Secretary of War, Jan. 28, 1885, NA, RG 77, Ltrs. Sent, Chief Engineer.

63. Benet to Baylor, Feb. 4, 1885, NA, RG 77, Ltrs. Sent, Chief Engineer.

64. Annual Report, Sandy Hook Proving Ground, Fiscal Year 1885, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

3. Replacing Two Proof Battery Platforms

On May 19, 1884, Colonel Baylor requested authority to construct at the proof battery two platforms for tests of carriages and guns of less than 12-inch caliber. The need was critical as the two wooden platforms currently in use and under cover had become "almost unserviceable."

He proposed to build the new platforms of concrete and timber, because these materials provided more durable and stronger structures. It was estimated that materials for each platform would cost \$697 and labor \$275, making the total allotment required \$1,944.

One of the platforms could probably be finished by June 30, but if there were sufficient funds at hand, Colonel Baylor believed it advisable to purchase the materials now, to enable his men to commence work on the project in early July.⁶⁵

Chief of Ordnance Benet had to veto the project as the appropriation for Repair of Arsenals for Fiscal Year 1885 had already been obligated.⁶⁶

Colonel Baylor, however, obtained his platforms from another source. In August he learned that there were seventeen front-pintle platforms for 15-inch guns at Governor's Island surplus to that post's needs. If two of these platforms could be transferred to Sandy Hook, Colonel Baylor reasoned, he could supply current needs without waiting for an allotment.⁶⁷

65. Baylor to Benet, May 19, 1884, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

66. Benet to Baylor, June 2, 1884, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

67. Whipple to Baylor, August 7, 1884, NA, RG 156, Ltrs. Recd., Chief of Ordnance. Charles W. Whipple of New Hampshire was graduated No. 21 in the Class of 1868 from the U.S. Military Academy. Commissioned a 2d lieutenant in the 3d U.S. Artillery, he was ordered to Fort Adams,

The platforms, constructed of yellow creosoted pine, were in storage. Since it was better to have them in service rather than keep them stored with the prospect of decaying or becoming obsolete, two of the platforms were shipped across the bay to Sandy Hook and positioned in the proof battery.⁶⁸

F. 1885 Program Tests Several New Weapons Being Developed by the Ordnance Department

1. Tests, Trials, and Experiments

a. 12-inch Muzzle-Loading Mortar Passes its Tests

The 12-inch muzzle-loading rifled mortar, manufactured by the South Boston Foundry, reached the Proving Ground on March 12, 1885. The mortar was fired 44 times under supervision of the Ordnance Board to enable it to determine the forms of the sabot and nature of powder suitable for testing the piece.⁶⁹

On July 9 the Testing Board assumed responsibility for the mortar. The trial began, and the charge for the weapon was fixed at fifty-two pounds and the weight of the shell at 610 pounds.

With regard to accuracy of fire, "some of the targets made" were excellent, equalling the best results attained in Europe with seacoast breech-loading mortars. There, however, was a great want of uniformity. By October 16, 1886, the weapon had been fired 381 times, and when star-gauged showed no enlargement of the bore.

67. (Cont.) Rhode Island. After serving in various posts, Whipple was promoted to 1st lieutenant and transferred to the Ordnance Department on July 19, 1875. He served as Assistant Ordnance Officer at the Centennial Exhibition in Philadelphia in 1876. In January 1878 Whipple was ordered to the West Point Foundry as Constructor of Ordnance. Six and one-half years later, in July 1883, Lieutenant Whipple entered on duty with the Ordnance Board. Cullum, Biographical Register, vol. III, 114.

68. Mercer to Chief Engineer, Aug. 12, 1884, NA, RG 77, Ltrs. Recd., Chief Engineer.

69. Executive Documents, Serial 2374, pp. vi-ix.

Satisfied with the results, the Department placed under contract a cast-iron 12-inch breech-loading mortar, hooped with steel, similar to the one under test, except as to such details of chambering, rifling, and type of projectile as were peculiar to breech-loaders. The body for this mortar was to be cast at the South Boston Foundry, and the hoops and forging for the breech mechanism at Midvale Steel.⁷⁰

b. A 12-inch Breech-Loading Rifle is Found Wanting

A 12-inch breech-loading cast-iron rifle was received at the Proving Ground in April 1885. After being subjected to the firing proof of five rounds with charges of 150 pounds of powder, as specified in the contract, additional firings were made under supervision of the Ordnance Board. These were to determine the character of the powder and details of the rotating band best suited for testing the gun.⁷¹

Trial of the big breech-loader commenced on November 11, 1885, when the Ordnance Board turned the gun over to the Testing Board. On the fiftieth round, erosions were observed in the bore. These increased in number and in "gravity of character" as the firings continued. By the 137th round, the erosions had become so pronounced "along the front slope of the powder chamber and in the shot recess" that the Board, deeming the gun unsafe, suspended the tests.⁷²

c. Destruction of Two More Guns

At least two guns burst during the year's tests. On August 16, 1884, F.H. Snyder, having secured permission from Colonel Baylor, tested his dynamite shells. The projectiles were fired from a

70. Executive Documents, Printed by Order of the House of Representatives of the 2d Session of the 49th Congress, 1886-87 (Washington, 1887), Serial 2465, VI, 11-12, 139-87.

71. Executive Documents, Serial 2374, p. ix.

72. Executive Documents, Serial 2465, VI, 9-10, 113-38.

24-pounder gun, the bore of which had been reamed to six inches. The shell consisted of a brass head screwed to a wooden base, and contained 8½ pounds of dynamite. The first shot was fired down range with a 2-pound powder charge. After traveling about 200 to 250 yards the projectile broke, scattering "the dynamite in fragments over a distance perhaps 100 yards in length."

Lt. Charles W. Whipple, who was in charge of the proof battery, refused Snyder's request to repeat the experiment. The gun was then pointed toward the sea, given an elevation of thirteen degrees, and loaded. This time the piece burst when fired. The breech, from a point twelve inches from the bottom of the bore, was thrown twenty-five yards to the rear, and the muzzle from in front of the trunnions was hurled forward eleven and a half yards. The remainder of the 24-pounder was scattered "in every direction within a radius of about 100 yards, small fragments striking the water like canister shot."⁷³

Ten months later, on June 17, 1885, a 8-inch rifle burst, while firing a steel shell filled with explosive gelatine. Once again, no one was injured.⁷⁴

2. Other Projects Accomplished

In addition to these important trials, employees of the Proving Ground found much to keep them busy in Fiscal Year 1885. Charged to "Armament of Fortifications" were these projects: (a) experimental firings and work on experimental guns, gas checks, vents, pressure plugs, breech-blocks, and experimental shells; (b) moving, mounting, and dismounting guns and carriages; (c) repair of beds and parts for platforms; (d) assembly of platforms; (e) making, repairing, altering, and breaking up platforms; (f) proof of guns;

73. Whipple to Baylor, Aug. 20, 1884, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

74. Baylor to Benet, June 17, 1885, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

(g) making, erecting, repairing, moving, and painting iron and wooden targets; (h) hauling materials to targets; (i) erecting and repairing bombproofs and butts; (j) repairing bands and banding projectiles; (k) recovering projectiles from sand butts; (l) cleaning and resaboting or rebanding projectiles; (m) cleaning projectiles; (n) splitting projectiles for samples and test specimens; (o) testing metals; (p) cleaning guns and their parts; (q) assembling, and taking apart gun carriages; (r) drilling and fitting vents and sights to guns; (s) preparing and repairing implements for guns and carriages; (t) repairing, painting, and cleaning implements, machines, utensils, and tools; (u) overhauling powder and other stores on hand; (v) hauling stores from and to wharf, and verifying quantities; (w) removing to and arranging stores in new storehouse; (x) cleaning magazines; (y) excavating for and erecting butts; (z) hauling sand, gravel, lumber, etc., for repairs to and filling of sand butts; (aa) laying plank roads; (bb) grading and clearing grounds and shoveling snow; (cc) care of and repair to instruments, electrical apparatus, and lines; (dd) altering pedestal for velocimeter; (ee) painting steamer Ordnance; (ff) repair of gang-planks and dockboards; (gg) repair of office furniture, velocity frames, and their parts; (hh) overhauling and covering instrument wires; (i) making and altering patterns; (jj) fabricating and repair of iron parts for platforms, sand butts, wharf, cradles, targets, etc., and (kk) making steel shield for 3.2-inch breech-loading rifle.⁷⁵

Charged to the appropriation for Ordnance and Ordnance Stores was the repair and overhaul of gun carriages, fitting sights, and bushing guns, and altering cannon and their parts at the New York Harbor forts. The powder barrels at Fort Hamilton and the ordnance and ordnance stores at the Sandy Hook fort had been repaired and overhauled.⁷⁶

75. Annual Report, Proving Ground, Fiscal Year 1885, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

76. Ibid.

There had been fabricated in the machine shop a copper vent piece for a 10-inch gun, thirteen coiled wire canisters for a 3.2-inch breech-loading rifle, three wrought-iron canister cases for an 8-inch rifle, one gun shield (Sanger) for a 3.2-inch breech-loading rifle, and two gas checks (De Bange) for a 3.2-inch breech-loading rifle.⁷⁷

3. New Construction at the Proving Ground

Despite the difficulties raised by the Corps of Engineers when the carpenter shop-storehouse was constructed, the Ordnance Department added three more structures to the Proving Ground's facilities during the year. They were: (a) a one-story frame watchman's house, costing \$200; (b) a \$300 frame latrine; and (c) a \$1,500 frame, one-story shell storehouse. In 1886 a frame, single-story bath house was built with a \$500 allotment.⁷⁸

4. Funding the Program and Operations

a. Wage Rates for Civilian Labor Force

Although the testing facility had been in operation for more than a decade, no enlisted military personnel had been assigned to its staff. The Proving Ground and tests were still administered by the Ordnance Board. From time to time, enlisted men from the New York Arsenal were detailed to Sandy Hook, where they reported to the member of the Board permanently assigned to Sandy Hook. Except for these officers and men, the Proving Ground was staffed by civilian mechanics and laborers. The number on the payroll varied, depending on the season of the year and funding. For example in the summer of 1881 there were thirty-six men on the Proving Ground payroll. In the opinion

77. Ibid.

78. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance. The watchman's house (Building No. 35), although relocated from the original to the new proof battery, was standing in 1919. The latrine (Building No. 46), although relocated to the new proof battery, was also extant in 1919, and the shellhouse (Building No. 40) was relocated to the new proof battery in 1901.

of Colonel Baylor, no reduction could be effected until after the endurance tests of the 11-inch breech-loading rifle.⁷⁹

The men's pay varied depending on their skills and length of service. Captain Whipple (who had replaced Captain Starring as Assistant to the Board and officer in charge of the Proving Ground) in July 1885 recommended that the pay per day of these men be raised:

Henry Melbus from \$3.00 to \$3.25

Hugh Reilly from \$2.75 to \$3.00

H.S. Williams from \$2.75 to \$3.00

William Dougherty from \$2.25 to \$2.50

Frank White from \$2.00 to \$2.25.⁸⁰

To justify these raises, Colonel Baylor informed General Benet that Melbus was an excellent mechanic, very ambitious, and a long-time employee with the kind of experience in the varied work required of him. He would, if he left the facility, be almost impossible to replace.

Reilly had been earning \$3.75 a day on his previous job. He had proved a "fair mechanic and was exceedingly useful." Williams was in charge of the machine shop's engine and was a first-rate man. His wages, Colonel Baylor wrote, should be increased to those paid other mechanics as he worked as a mechanic, when not on duty at the engine.

Dougherty was an assistant to the blacksmith when required, and frequently did rough work in the machine shop, such as

79. Baylor to Benet, July 28, 1881, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

80. Whipple to Baylor, undated, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

drilling, chipping, or planing. In addition, he was one of three or four men on the payroll capable of taking charge of a gang and handling the big guns.

White was a superior workman, far in advance of the average laborer. He was usually placed in charge of one of the plane tables during range finding and of other similar work.

Wages at Sandy Hook, Colonel Baylor reminded General Benet, were slightly above (twenty to twenty-five cents per day) those paid for similar work in New York City. This increase was allowed to compensate in some fashion for the extra expense to which the men were subjected by having to pay their board while at the Hook, while having to provide at the same time for families living elsewhere.⁸¹

Chief of Ordnance Benet, after reviewing the correspondence, approved new pay scales for certain of the Sandy Hook employees:

E.F. Maurer, draughtsman	\$1,500 per annum.
Henry Melbus, machinist	\$3.25 per day.
Hugh Reilly, machinist	\$3.00 per day.
H.S. Williams, engineer	\$3.00 per day.
W. Dougherty, blacksmith-laborer	\$2.50 per day.
Frank White, laborer	\$2.25 per day. ⁸²

b. Baylor Juggles the Funds

Colonel Baylor, in assessing his Proving Ground responsibilities for the second quarter of Fiscal Year 1885, called for an

81. Baylor to Benet, July 6, 1885, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

82. Ibid., July 15, 1885, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

allotment of \$10,615 from the appropriation for Armament of Fortifications. The Department, with limited funds available, only released \$5,000. On being notified of the reduction, Colonel Baylor complained that this action made it "impossible to carry on the work contemplated at the Proving Ground." He would be compelled to reduce his force to such an extent that the experimental work must be severely limited.

His estimate for the quarter had been predicated on funding these activities:

Payment of men hired at the Hook for three months, taking the number currently on the payroll as the base	\$ 6,885.00
Pay of clerks, draughtsmen, and translator	1,800.00
Manufacture of cartridge-bags	100.00
Travel expenses	50.00
Mess hall	800.00
Forage	180.00
Oil and gasoline	50.00
Tools, brooms, etc.	100.00
Ironmongering, etc.	500.00
Sundries	<u>150.00</u>
	\$10,615.00

Five extra laborers had been recently hired, he reported, to repair sand butts, transfer guns, etc.⁸³

On October 28, 1885, Chief of Ordnance Benet had good news for Colonel Baylor. The allotment would not be increased, but

83. Ibid., Oct. 27, 1885, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

the remittance could be divided and charged against several appropriations rather than all to Armament of Fortifications.⁸⁴ To fund the Proving Ground operations at the desired scale, Baylor divided the needed \$5,615 between the appropriations for Repairs of Arsenals and Ordnance and Ordnance Stores.

84. Benet to Baylor, Oct. 28, 1885, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

IV. THE DAWN OF THE ARMY'S MODERN WEAPONRY SYSTEM

A. Endicott Board's Report Has Far-Reaching Repercussions

1. U.S. Adopts a New Weapons System

The Sandy Hook tests, commencing in 1885 and continuing through the next decade, heralded a revolution in weaponry and seacoast fortifications. During the previous decade Congress had ceased appropriating funds for construction of coastal defenses. While the handsome and costly masonry fortifications and earthen and masonry barbette batteries deteriorated, "critical advances" were taking place in the design and manufacture of heavy ordnance. These developments, as we have seen, involved the first large-scale use of steel for guns and the perfection of breech-loading. Soon to come would be the introduction of far more effective propellants.¹

While the Ordnance Department was slowly developing, perfecting, and testing a new weapons system for seacoast defense, there was alarm about the increased power and armament of the warships being built by European naval powers. This concern by the Congress, public, and military caused President Grover Cleveland in 1885 to form a special board chaired by his Secretary of War, William C. Endicott. The Endicott Board was to review the coastal defense problem and to make recommendations for a new program based upon the weapons being developed and tested by General Benet and the men of his Ordnance Department.

The program formulated by this joint Army-Navy-civilian group and presented in 1886 called for "an enormous number of defensive works, including many with armored turrets and casemates, to be armed with weapons of unprecedented size and firepower." Called for were fortifications at twenty-six coastal sites, plus three on the Great Lakes, along with floating batteries, torpedo boats, and submarine minefields. As Dr. Emanuel Lewis has written:

1. Lewis, Seacoast Fortifications, p. 75.

Aside from the fact that the overall proposal carried with it a cost estimate that alone rendered it unrealistic, its details concerning the dispositions, types, and quantities of weapons--drafted while the new ordnance was still at a fairly early stage of development--were necessarily put forth in some ignorance as to the actual performance of the production models, some of them five years away.²

The major armament of the Endicott System of seacoast defenses would consist of 8-, 10-, and 12-inch guns, the largest having an effective range of eight to nine miles, with projectiles weighing up to 1,070 pounds. These were flat-trajectory weapons "whose firing angle, though limited to about fifteen degrees elevation, gave them sufficient range to match or outshoot the guns of contemporary battleships." Most of these weapons, when perfected, would be emplaced on disappearing carriages.

A second class of heavy armament, and the first perfected by the Ordnance Department, was the 12-inch mortar. Short-barrel weapons with a high angle of fire, such mortars were to be installed in units of eight to sixteen and fired simultaneously. Their 700-pound projectiles descended almost "vertically in a shotgun-like pattern on the lightly armored decks" of warships.

The proposed submarine minefields within harbor entrances would be protected against penetration by minesweepers and torpedo boats. This led to development of a third class of Endicott System armament--the rapid-fire guns of from 3- to 6-inch caliber.³

2. Congress Authorizes an Army and a Navy Gun Factory

The Endicott Board also endorsed establishment of Army and Navy gun factories for manufacture of heavy modern ordnance.

2. Ibid., p. 58.

3. Ibid., pp. 79-83.

Congress in 1886 accordingly enacted legislation authorizing the Navy Department to begin construction of a Gun Factory at the Washington, D.C., Navy Yard. A bill for establishment of a similar facility for the Army at the Frankford Arsenal had passed the Senate, but failed to obtain concurrence of the House.⁴

The subject was reconsidered by the 1st Session, 50th Congress, in 1888, and legislation was passed and an appropriation voted on September 22, 1888, for establishing an Army Gun Factory at the Watervliet Arsenal.⁵

B. Ordnance Department Staffs the Proving Ground with Enlisted Men

1. Organization of the Ordnance Detachment

Failure by the 3d Session, 49th Congress, to enact its regular Fortifications Bill caused serious problems for the Ordnance Department and its operations pertaining to the armament for fortifications in Fiscal Year 1887. Adversely effected was the program involving the completion and test of the experimental guns under construction, the further development of powders and explosives, and the alteration of carriages for mounting existing guns.⁶

On August 6, 1886, General Benet complained to Secretary of War Endicott that failure of Congress to pass the Fortifications Bill had necessitated discharge of all the civilian employees at the Proving Ground and would practically shut down operations. Mechanics and laborers, with years of experience in handling guns and explosives and performing technical tasks, were lost to the Department at a critical time.

To carry on limited operations, provide necessary guards for protection of the public property, and care for the animals, he asked

4. Executive Documents, Serial 2465, pp. 7-9.

5. Executive Documents, Serial 2720, pp. 14-15.

6. Executive Documents, Serial 2465, pp. 7-9.

authority to station temporarily at the Hook fifteen enlisted men belonging to the Ordnance Corps. These men would be drawn from the various arsenal detachments, and therefore would not increase the number allowed for the service of the Department.⁷

The officer in charge had established the number of men needed, when he called for one sergeant, three corporals, and eleven privates 1st class for duty at Sandy Hook. Three of these men would be assigned general guard duty, one to take care of the public horses, one to be a "cleaner & painter," and ten to handle the guns, prepare powder, put up targets, and for general police of the grounds.⁸

Secretary of War Endicott approved the proposal, and General Benet telegraphed the commanders of the National Armory, and the Watertown, Watervliet, Springfield, Frankford, and Allegheny arsenals. They were alerted that a detachment was being organized for temporary duty at the Proving Ground. Men comprising the detail must be "good men in every respect, preferably unmarried."

They were to make inquiries and report how many soldiers in their detachments met these requirements, giving their names and grades. As the duty would be temporary, the men would rejoin their detachments, whenever the emergency passed. The loss of men detailed would not weaken their detachments, because they would be allowed to enlist replacements, if they desired.⁹

7. Benet to Endicott, Aug. 6, 1886, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

8. McAllister to Benet, Aug. 6, 1886, NA, RG 156, Ltrs. Recd., Chief Engineer.

9. Benet to C.Os., Watertown, Watervliet, Frankford, and Allegheny Arsenals, Aug. 6, 1886, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

On August 7, Capt. J. C. Clifford of the Frankford Arsenal notified General Benet that there were ten men in his Ordnance Detachment who could be sent to Sandy Hook.¹⁰

The fifteen men (three from the Allegheny Arsenal, four from the Frankford, five from the Springfield, and two from the Watervliet) selected for duty at the Proving Ground arrived on August 17. On November 1, in response to a recommendation made by General Benet, the Secretary of War approved an increase of the detachment to twenty enlisted men.¹¹

2. Reinforcing the Detachment

Although the assignment of an Ordnance Detachment to Sandy Hook was supposed to be temporary, the weeks and months soon became a year. Once again, as in 1886, Congress in 1887 failed to enact a Fortifications Bill for funding certain operations of the Ordnance Department in Fiscal Year 1888. The Sandy Hook Ordnance Detachment would be called on to remain at the Proving Ground. In January 1888 the Proving Ground commander, Lt. Col. Alfred Mordecai, obtained from the Commissary General an increase in the bread ration allowed the Ordnance Detachment to twenty-two ounces per man. The present ration, he had argued, was insufficient, the men being obliged to subsist on short rations several days each month. The troops' gardens had been destroyed by flood tides. Even without destructive storms, the gardens had been marginal, because the "sea sand" was "unsuitable for raising vegetables."¹²

10. Clifford to Benet, Aug. 7, 1886, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

11. Endicott to Benet, Nov. 1, 1886, NA, RG 156, Ltrs. Recd.; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

12. Mordecai to Commissary General, January 31, 1888, NA, RG 156, Ltrs. Recd., Chief of Ordnance. Alfred Mordecai, a son of Maj. Alfred Mordecai, was graduated from the U.S. Military Academy as No. 9 in the class of 1861. Commissioned a bvt. 2d lieutenant in the Topographical Engineers, young Mordecai participated in the battle of 1st Manassas. He

On February 7, 1888, Colonel Mordecai asked that the detachment be reinforced. An increase in strength would enable its commander to turn out simultaneously two details, thus expediting the necessary labor associated with experimental firings. If the Department were agreeable, Mordecai urged that only men willing to be transferred be sent, and that no promises be made as to their work or the possibility of returning them to their former stations, if they did not like duty at Sandy Hook.¹³

General Benet was sympathetic to the request. Accordingly, orders were issued for the commanding officer of the National Armory to transfer five men to the Proving Ground. The men involved could be either transferred or enlisted and then transferred.¹⁴

The men reported for duty on February 13, increasing the strength of the Sandy Hook detachment to twenty-five. Nine months later, on November 7, the Ordnance Detachment was reinforced to thirty-five.¹⁵ It remained at that number for two years, not being again increased until after establishment of the Proving Ground as a separate facility.¹⁶

12. (Cont.) was ordered to West Point in September 1861 as Professor of Mathematics. He served as Inspector of Ordnance at the West Point Foundry from June 1862 to June 1863. Promoted to 1st lieutenant of Ordnance, Mordecai spent the remaining war years in the field. Mordecai commanded the Watervliet Arsenal from November 1881 until May 24, 1886, when he was ordered to the New York Arsenal. Cullum, Biographical Register, II, 817-18.

13. Mordecai to Benet, Feb. 7, 1888, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

14. Benet to C. O., National Armory, Feb. 8, 1888, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

15. Buffington to Benet, Feb. 14, 1888, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

16. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

Although Congress had passed a Fortifications Bill for Fiscal Year 1889, the Department determined to retain a detachment at the Proving Ground, because by now the men were well trained in their duties.

3. Duties Undertaken by the Detachment

Men of the Ordnance Detachment handled a wide variety of details involving the experimental firing of field, siege, seacoast, and rapid-fire guns, under supervision of the officer in charge or the assistant proof officer. They were responsible for care and assembling of mounts for guns used in proof work; construction of sand butts, targets, and velocity screens, and repair of same; care of instruments and sights; assemblage and care of breech mechanisms; and assisting the machinists in star-gauging guns. They were charged with the mechanical maneuvering of the heavy guns and carriages in areas where they could not be handled with machinery; pointing guns and carriages in the proof battery; and general police of the proof battery and gun park. They looked after the care and preparation of fixed ammunition for field guns, powder charges, and primers and fuses of all kinds; weighing and gauging shot and shell for proof work; and loading shells with high explosives and making igniters and cartridge-bags. They also pulled the usual guard and police details expected of all Army enlisted men.¹⁷

4. Quartermen the Detachment

The detachment was quartered in the frame Engineer barracks near the wharf. In Mid-August 1890 the Corps of Engineers notified Colonel Mordecai that with construction of the reinforced concrete Endicott batteries at Sandy Hook, some, if not all, of the Engineer buildings presently occupied by the Ordnance Department would be needed by October 1.

17. Ibid.

With the Ordnance Detachment on order to vacate the Engineer barracks, steps would have to be taken to provide new quarters. Mordecai urged that the new quarters be capable of accommodating 100 men. If such a structure were erected by the Quartermaster Department, it would ultimately become available for the permanent artillery garrison whenever it was assigned to Sandy Hook.¹⁸

General Benet, after reviewing the correspondence, asked Mordecai to provide him with information on the character of the proposed barracks and the number of men to be accommodated.¹⁹ In his reply, Mordecai informed Benet that plans for a barracks, estimated to cost \$12,000, had been prepared some years earlier, but they had been destroyed in the Instrument House fire.²⁰

C. 1886 Brings Tragedy

I. Improvements to the Proof Battery, Butts, and Walks

On March 27, 1886, several days before the beginning of the final quarter of Fiscal Year 1886, Colonel Baylor notified the Department that the weather had turned spring-like and was favorable for outdoor operations. Thus, he wanted to add two mechanics and eight laborers to the Sandy Hook payroll. The increased force would be employed to: (a) construct concrete platforms for the 8- and 10-inch rifled columbiads currently on hand; (b) repair the butt in rear of the target; (c) make and place shields between adjacent guns in the proof battery; (d) repair boardwalks to the 3,000-yard-target and elsewhere; and (e) fabricate bushings and vent twenty-two 15-inch Rodmans emplaced in the

18. Mordecai to Benet, Aug. 18, 1890, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

19. Benet to Mordecai, Aug. 20, 1890, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

20. Mordecai to Benet, Aug. 23, 1890, NA, RG 156, Ltrs. Recd., Chief of Engineer.

New York Harbor forts. They would also rebuild the sand butt for the 12-inch rifle. This butt had nearly disappeared and had to be enlarged to shield the Sandy Hook Life-Saving Station, Sandy Hook Lighthouse, and keeper's quarters. As soon as these projects were completed, the ten men would be laid off.²¹

2. Storage of Large Quantities of Powder Causes Problems

In late March Captain Whipple alerted Colonel Baylor that storage space for powder other than in the magazines, already filled to capacity, was needed. To compound his problem, shipments of Brown prismatic powder was being received in 15,000-pound lots. The first two lots had been placed in the old storehouse in the fort; the third was slated for the magazine, which was poorly suited for powder to be employed in experiments. There were no facilities for storing the fourth consignment, which was "awaiting suitable weather for transportation to the Hook." With \$1,000 he could erect within 30 days a storehouse of 1,000-barrel capacity.²²

Colonel Baylor, on transmitting Whipple's request to the Department, urged that authority be given to erect a temporary magazine. The requisitioned Brown prismatic powder was accumulating much more rapidly, he fretted, than had been anticipated.²³

Not having any funds to allot for construction of emergency storage facilities, General Benet contacted the officer in charge of the U. S. Powder Depot to ascertain if he were prepared to receive for

21. Baylor to Benet, Mar. 27, 1886, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

22. Whipple to Baylor, Mar. 30, 1886, NA, RG 156, Ltrs. Recd., Chief Engineer.

23. Baylor to Benet, Mar. 31, 1886, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

storage a "few hundred barrels of powder." He was but cautioned that it would be impractical to do so until after the railroad, now under construction, was completed and the trains were running.²⁴

On learning from Colonel Baylor that there were 500 barrels of powder at Sandy Hook that could be removed if space were found for the 455 boxes of Brown prismatic powder about to be shipped by DuPont & Co., General Benet wrote Lt. Col. Alfred Mordecai at the Watervliet Arsenal.²⁵ Mordecai responded that in the arsenal magazine there was space for 600 additional barrels of powder. General Benet, on April 23, accordingly notified Colonel Baylor that he was to ship 500 barrels of powder to Colonel Mordecai at Watervliet. Before being forwarded, the powder was to be "carefully overhauled and tested."²⁶

Before loading the 500 barrels aboard the vessel chartered to take it up the Hudson to Watervliet, Colonel Baylor had the Sandy Hook magazines "overhauled." Lot No. 1, 500 barrels of DuPont Hexagonal powder, was selected for transfer,²⁷ and Lot No. 2, being experimental and not needed for additional tests, would be sold. Lot No. 3 was in very small lots, not likely to be used again.²⁸

24. Farley to Benet, Apr. 6, 1886, NA, RG 156, Ltrs. Recd., Chief of Ordnance. Joseph P. Farley, a major in the Ordnance Department, commanded the Dover, New Jersey, Powder Depot.

25. Baylor to Benet, Apr. 10, 1886, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

26. Benet to Baylor, Apr. 23, 1886, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

27. Baylor to Benet, May 15, 1886, NA, RG 156, Ltrs. Recd., Chief of Ordnance. Lot No. 1 had been manufactured during the years 1875-81.

28. Ibid. Lot No. 3 totaled 10,070 pounds of these types of powder-- Hazard's Cubical, Laflin & Rand Cannon, Oriental hexagonal, English prebble large again, Fossano progressive, and Fossano mammoth.

3. Colonel McAllister Replaces Colonel Baylor

Colonel Baylor was relieved as President of the Ordnance Board on May 15, 1886, and ordered to Rock Island, Illinois, to take command of the arsenal. As President of the Ordnance Board, he had been responsible for the Proving Ground since November 11, 1881. His replacement as President of the Board was Col. Julian McAllister, who did not report to his duty station at the New York Arsenal until June 28, and did not assume his duties until July 1. In the interim first Capt. Charles Shaler and then Lt. Col. Alfred Mordecai commanded at the arsenal.²⁹

4. Foreign Officers Tour the Facility

Activities at the Proving Ground were of interest to foreign powers. In July 1886 the Brazilian cruiser Almirante Barroso made a goodwill visit to New York Harbor. In connection with the visit, the Brazilian charge de affairs contacted Secretary of State Thomas G. Bayard, and asked that Capt. Saldanha da Gama and his officers be afforded a tour of the Proving Ground and allowed to watch the firing.

Secretary Bayard relayed the request to Secretary of War Endicott, who in turn forwarded the correspondence to Chief of Ordnance Benet, with a request that he give instructions whereby the Brazilians be given an opportunity to witness gunnery practice at Sandy Hook.³⁰

29. Returns from U.S. Military Posts, 1800-1916, NA, Microcopy M-617. Julian McAllister of New York was graduated No. 4 in the Class of 1847 from the U.S. Military Academy. He was commissioned a 2d lieutenant in the 2d U.S. Artillery. After service in the Mexican War, he was transferred to the Ordnance Department in April 1848, and ordered to the Watervliet Arsenal. In 1858 he was sent to the Pacific Coast as assistant ordnance officer at Benicia Arsenal. During the Civil War, McAllister, then a captain, wore two hats--commander at Benicia and Ordnance Officer, Department of the Pacific. From September 1864 to April 1867, he was Inspector of Ordnance and Projectiles, with headquarters in New York City. McAllister, now a major, resumed command of the Benicia Arsenal in June 1867, a post he held until June 1886, when he was assigned to command the New York Arsenal. Cullum, Biographical Register, II, 307-8.

30. Endicott to Benet, July 21, 1886, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

General Benet issued orders for Colonel McAllister to communicate with Captain da Gama and invite him and his officers to tour the Sandy Hook facility.³¹ The Brazilians spent July 27 at the Proving Ground.³²

5. Proving Ground Suffers Its First Fatalities

a) Another Gun Bursts and Triggers a Proposal

An experimental 8-inch steel breech-loading rifle was shipped from the West Point Foundry to Sandy Hook for trial in June 1886. The tube and jacket had been purchased from Sir Joseph Whitworth & Co., and the hoops and forgings for the breech mechanism from Midvale Steel.³³

Among the guns undergoing test firings in the proof battery at this time was a Yates gun, with a Yates breech-loading mechanism incorporated into a 10-inch Rodman smoothbore. It was fired with 35-pound powder charges and 181-pound projectiles. On March 26, during the 312th round, the gun burst with great violence into many fragments, demolishing the carriage.³⁴

Although no one was injured, Captain Whipple's attention was called to the "insufficient arrangements now provided at the Proving Ground for the protection of life and property." While gun crews and others employed about the proof battery were "generally . . . safely covered by the bombproof and butts," valuable property was exposed. Worse, mechanics in the workshop (whom it was inconvenient to interrupt at their employment), employees of the Signal Service, and

31. Benet to Endicott, July 22, 1886, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

32. McAllister to Benet, July 29, 1886, NA, RG 156, Ltrs. Recd., Chief Engineer.

33. Executive Documents, Serial 2465, p. 13.

34. Ibid., pp. 21, 82-111.

personnel of the Western Union Telegraph Company, living with their families in rear of the guns, were much exposed. Fragments from bursting guns had been hurled northwest to the steam foghorns and southwest to the brick Officers' Quarters.

Nothing, except mounting the guns properly "casemated," would insure absolute protection, Captain Whipple admitted. But the danger would be lessened by construction of a permanent shield fifteen to seventeen feet high, consisting of six feet of sand-bound heavy timbers, between the roads leading to the Instrument House and machine shop. A similar shield, extending from the road leading to the Instrument House and covering the toolshed near the beach, was needed. A third permanent shield, twenty-five feet long, would be placed in front of the small magazine. Also called for was a movable shield which could be rolled across either road as needed. Finally, two small mobile timber shields would be positioned on either side of the gun to be fired. Captain Whipple estimated the cost of the six shields at \$2,800.³⁵

b) Deaths of Lieutenant Medcalfe and Private Knox

Colonel Baylor endorsed the proposal. If there were no funds available at this time, the project was to be included in the allotments for Fiscal Year 1887. Before any action could be taken there was a major accident at the Proving Ground. On October 21, 1886, 1st Lt. William M. Medcalfe and Pvt. 1st Class Joseph Knox were killed and three men (Sergt. John Abbott and Cpls. George Clark and Walter Goodino) wounded by the bursting of a 12-inch shell. The young lieutenant who had been assigned to duty with the Ordnance Board 27 months before and Private Knox became the testing facility's first fatal casualties.³⁶

35. Whipple to Baylor, Apr. 29, 1886, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

36. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance; Returns from U.S. Military Posts, 1800-1916, NA, Microcopy M-617. The injured enlisted men were evacuated to Governor's Island for hospitalization. William M. Medcalfe, a

Five days after the fatal accident, Colonel McAllister closed down all testing and proof work until "certain changes, improvements, and repairs, some of which are necessary and others desirable, may be made in and about the Battery, Butts, and Targets." In addition, there were a number of tools and appliances that were needed and should be obtained. With the number of men on the payroll and the funds on hand much of the needed work could be accomplished by mid-December, he forecast.³⁷

D. Two Lean Years

1. Colonel Mordecai Replaces Colonel McAllister as President of the Board

Colonel McAllister's tenure as President of the Ordnance Board was brief. On January 3, 1887, he died of septicemia at Governor's Island. He was succeeded as President of the Board by Lt. Col. Alfred Mordecai.³⁸

2. Proving Ground Operates on a Tight Budget

The failure of Congress for the second consecutive year to enact its annual appropriation bill for Armament of Fortifications embarrassed the Department. Consequently, in Fiscal Year 1888 General Benet and his people effected "but little" toward providing guns,

36. (cont.) native of Maryland, had graduated from the U.S. Military Academy as No. 8 in the Class of 1876. Commissioned a 2d lieutenant in the 4th U.S. Artillery, he was ordered to the San Francisco Presidio. After four years at various western posts, Medcalfe was transferred to West Point as Assistant Professor of Mathematics. On March 18, 1881, he was promoted 1st lieutenant and transferred to the Ordnance Department. After serving successively at the Springfield Arsenal and the Cleveland Foundry, he was on September 18, 1884, assigned to the Board for Testing Rifled Cannon. Since then Medcalfe had specialized in studies connected with the manufacture and manipulation of steel, and as an inspector of powders. Cullum, Biographical Register, III, 255-56.

37. McAllister to Benet, Oct. 26, 1886, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

38. Returns from U.S. Military Posts, NA, Microcopy M-617.

carriages, powder, etc., for coastal defense. The limitations imposed by Congress on the appropriation for Ordnance Service further hampered the Department in conducting tests at the Proving Ground.³⁹

3. Tests and Experiments in Calendar Year 1887

The President of the Ordnance Board was now required to submit weekly progress reports on the experimental and proof work at Sandy Hook. Typical of these were two submitted in 1887. During the week ending April 30, Colonel Mordecai reported that, in addition to the Ordnance Detachment, there were five civilians employed at the Proving Ground. They were: A. G. Sinclair, foreman, who had spent six days superintending general work and repairs to and blocking up a 15-inch carriage; H. A. Sinclair, electrician and machinist, who had been employed one day overhauling velocity instruments, one and a half days bookkeeping, and had been suspended three and a half days; M. F. Merchant, clerk, had put in six days in general office work and preparation of firing and star gauge records; Henry Melbus, machinist, had worked six days repairing a 15-inch carriage, the breech mechanism of No. 2 3.2-inch breech-loading rifle, and making templets for mortar parts; and Robert Reckling, laborer, seven days as a janitor.

At Sandy Hook there were twenty-one tests in progress. Included were: (a) firing tests of a 12-inch breech-loading mortar and a 12-inch cast-iron breech-loading rifle. Both guns had been at the Proving Ground since 1885, and 403 rounds had been fired from the mortar and 137 from the rifle. (b) Flank defense of torpedo lines, which had involved firing 143 rounds from an 8-inch Rodman smoothbore, had been tested. (c) An experiment involving storage of paper powder barrels in a damp magazine, underway since July 1884. (d) Sanger's field gun shield was undergoing tests for endurance against small-arms fire and shells. (e) Fuses for 3.2-inch shrapnel steel shells were being tested. (f) Tests with a range table for a 3-inch muzzle-loading rifle had

39. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 50th Congress, 1887-88 (Washington, 1889), Serial 2538, VII, 60.

been completed. (g) Twenty-seven samples of DuPont's powder for 8- and 15-inch guns had been received and reported upon. (h) Since July 1886 twenty-five rounds had been fired in experiments with a modified 3-inch Eureka sabot. (i) In the same period forty-nine rounds had been fired from an 8-inch steel breech-loading rifle. (j) To test the old model Hotchkiss point percussion fuse, thirty rounds (fifteen recapped and fifteen modified) had been fired. (k) A number of projectiles (fuses and bursting charges) for 3-inch muzzle-loading rifles had been received at Sandy Hook. (l) In September 1886 five 8-inch Eureka chilled shot had been received. (m) Thirteen 8-inch muzzle-loading converted rifles, landed at Sandy Hook in September 1886, had been moved to the Proving Ground and placed on skids ready for proof. (n) In October 1886 a shipment of obturating electric primers had been received. (o) Two barrels lined with waterproof paper for packing powder were undergoing tests. (p) Several 3.2-inch steel field guns had been painted in February for comparative tests. (q) During the last week of April 1887, five rounds had been fired from the Dynamite Company's gun. (r) A Malet hydraulic field gun carriage had been received in March 1887. (s) Although a number of rounds of 3.2-inch Sawyer's canister were on hand, none had been fired during the week ending April 30.⁴⁰

On reviewing the report, Chief of Ordnance Benet raised a question. Noting that the only experimental work reported was the firing of five rounds with the Dynamite Gun Company's projectile, he commented, "this seems to be rather a small result" for one week's work.⁴¹

Replying, Colonel Mordecai explained that, during the week in question, the Ordnance Board had not been in session for want of a quorum, Captain Shaler being on leave. This had necessitated a

40. Progress Report, Experimental and Proof Work, Apr. 30, 1887, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

41. Benet to Mordecai, May 3, 1887, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

suspension of many tests and experiments. Others had been suspended because there were no projectiles on hand. Among those in this category were tests involving modification of 3-inch Eureka sabots; old model Hotchkiss point percussion fuses; projectiles, fuses, and bursting charges for 3-inch muzzle-loading rifle shells; and 3-inch Sawyer's canister shells. Experiments with obturating electric primers had been suspended because there was no powder on hand.⁴²

In rebuttal the Department pointed out that no application had been received from the Board for additional 3.2-inch Sawyer's canisters. If the obturating electric primers were tested in the same gun (No. 1 8-inch breech-loading converted rifle) as other primers of this type, General Benet chided, it would expedite matters.⁴³

When he submitted his report for the week ending December 31, 1887, Colonel Mordecai listed only one civilian employee--Mathew Powell, a watchman.

Twenty-one tests or experiments were in progress at Sandy Hook. Although no rounds had been fired in months, the 12-inch muzzle-loading rifled mortar and the 12-inch breech-loading cast-iron rifle were still undergoing tests for the Board for Testing Rifled Cannon.

Tests underway in April and still in progress involved: (a) Sanger's field gun shield; (b) fuses for 3.2-inch steel shrapnel; (c) range table for 3-inch muzzle-loading rifle; (d) modification of 3-inch Eureka Sabot; (e) old model Hotchkiss point percussion fuses; (f) projectiles, fuses, and bursting charges for 3-inch muzzle-loading rifles; (g) waterproof paper for packing powder; (h) Malet hydraulic field gun carriage; and (i) 3.2-inch Sawyer's canister.

42. Mordecai to Benet, May 4, 1887, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

43. Benet to Mordecai, May 6, 1887, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

In the months since June 1887, these tests and experiments had been added to the Proving Ground's busy schedule: (a) Michaelis' "cushioned" gun and carriage; (b) Armstrong fuses; (c) Gatling gun (ten barrels, long); (d) Gatling gun (six barrels, short); (e) 12-inch breech-loading rifled mortar; (f) Flagler's combination fuses; (g) West Point Foundry Association Projectiles; and (h) proof of five 8-inch muzzle-loading converted rifles.⁴⁴

Among the most interesting tests made in 1887 were those with the Stevens dynamite shell. Repeated firings had been made with this shell, charged with explosive gelatine, from a 7-inch muzzle-loading rifle.⁴⁵

4. Manufacture and Testing of Experimental Guns in Fiscal Year 1887

On October 15, 1887, General Benet reviewed for Congress the status of the manufacture and tests of the experimental guns contracted for:

The 12-inch breech-loading rifle, cast-iron, tubed with steel, had been cast and was ready to receive its tube. The breech mechanism had been fabricated but not fitted. No work had been done on the piece in more than a year.

The 12-inch breech-loading rifle, cast-iron, hooped and tubed with steel, had been completed. Contracts with the South Boston Foundry for these two guns, though extended once for more than a year, had expired June 30, 1886. The management of South Boston Foundry now looked to Congress for a special appropriation to reimburse it for any expenditures incurred, which was covered by its contract.⁴⁶

44. Progress Report, Experimental and Proof Work, for Week ending December 31, 1887, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

45. Executive Documents, Serial 2538, p. 13.

46. Ibid., pp. 6-7.

No work had been done on the two 10-inch breech-loading wire-wrapped guns during the last twelve months.⁴⁷

The tube, jacket, and trunnion hoop for one 10-inch breech-loading, steel-hooped rifle, had been ordered from Sir Joseph Whitworth & Co.; the hoops from Cambria Iron Works; and the chase hoops, with the breech mechanism forgings, from Midvale Steel.⁴⁸

On receipt the tube had been rough-bored, turned, and annealed at the Washington Navy Yard, before being shipped to the Watertown Arsenal. Longitudinal bars, for giving end strength to the gun, had been cold-rolled by Jones & Laughlin.⁴⁹

General Benet, to his embarrassment, had reported twelve months before that there only remained to be applied four layers of wire, after which the gun would be finished on the outside, final bored and rifled, and the recess for the block threaded.

Completion of a monstrous 10-inch wire-wrapped steel gun, Benet cautioned, was a slow process, because of the "novelty and manifold detail of the construction."⁵⁰

The 12-inch breech-loading mortar under contract to the South Boston Iron Works had been completed and sent to the Proving Ground for trial. Tests would be made of the piece's accuracy and endurance to enable the Department to decide the relative merits of the breech-loader vs. the muzzle-loader.

47. Ibid.

48. Executive Documents, Serial 2465, pp. 12-13.

49. Executive Documents, Serial 2374, p. xv.

50. Executive Documents, Serial 2465, pp. 12-13.

As differences in cost between the two models would not be great, and "owing to the uncertainty at best of vertical fire the question of accuracy of fire" was of paramount importance in selecting a system for adoption by the United States. Because of the large numbers of 12-inch mortars required for coast defense, and with several manufacturers capable of supplying the 12-inch muzzle-loader previously tested at Sandy Hook, General Benet urged an annual appropriation of \$500,000 for procurement of 12-inch rifled mortars of a similar type. They could be either breech-loading or muzzle-loading, depending on which were found to be superior in the Sandy Hook tests.

The carriage used for the Sandy Hook trials had been unsatisfactory. It, according to the Board, did not resist the downward thrust "well," when the mortar was fired at a high angle. A special adaptation of the carriage had been required to relieve the shock on the platform. In the Russian army, this problem had been overcome by the Raskasoff carriage, and even more satisfactorily in the Italian service by the Elwick carriage. Funds were needed to enable the Department to procure and test various types of mortar carriages and to adopt for the service the one best adapted to "our mortars."⁵¹

5. Manufacture and Testing of Experimental Guns in Fiscal Year 1888

Although no funds were available for Armament of Fortifications in Fiscal Year 1888, the Department was able by utilizing the proceeds from sale of unserviceable and obsolete materiel to proceed with the manufacture of one 8-inch breech-loading rifle, "composed entirely of American steel"; of one 10-inch breech-loading gun, of which the tube, jacket, and trunnion-hoop were purchased from Sir Joseph Whitworth; and of 25 3.2-inch steel field guns. This work was done at the newly established Watervliet Gun Factory.⁵²

51. Executive Documents, Serial 2538, pp. 6-7.

52. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 50th Congress, 1888-89 (Washington, 1889), Serial 2633, VII, 5.

The manufacture of the two 12-inch breech-loading rifles (on which work had been suspended for nearly two years, because of the failure of the contractors to complete them within the time specified in the lifetime of the appropriation) had been resumed. To break the impasse, Congress had been compelled to reappropriate the money. One of the guns had been completed and shipped to the Proving Ground.⁵³

At Sandy Hook in Fiscal Year 1888 test firings of the 8-inch breech-loading rifle had been conducted "as rapidly as it was possible to procure suitable powders and as other important work would permit." There had been considerable delay caused by failure of powder manufacturers to "reproduce or duplicate powders which had been accepted as satisfactory." Two hundred and three rounds had been fired from the piece, with no ill effects beyond some visible erosion marks on the front slope of the powder chamber and the bottom of the rifled bore.⁵⁴

The breech-loading 12-inch rifled mortar had been subjected to preliminary firings by the Ordnance Board. These had the object of determining suitable kinds and weights of charges, covering all ranges from one to six miles, without exceeding the prescribed limits of pressure, and ascertaining the best form of banding for the projectiles. So far, 193 rounds had been fired from the piece, of which 78 were with charges of from fifty to eighty pounds, with an average pressure of about 28,000 pounds. The present mounting of the mortar, as regards both carriage and platform, was so unsatisfactory that the firings for accuracy at long range had been postponed.⁵⁵

53. Ibid., p. 8.

54. Ibid., p. 6.

55. Ibid., pp. 6-7.

Preliminary firing tests had been made with a 5-inch breech-loading siege rifle and a 7-inch breech-loading rifled steel howitzer.⁵⁶

E. Steps Are Taken to Give the Nation a Modern System of Coastal Defense Weapons

I. Congress Passes Landmark Legislation

President Cleveland signed into law on September 22, 1888, an act which provided for a Board of Ordnance and Fortifications to consist of the commanding general of the Army and an officer each of the Engineers, Ordnance, and Artillery, to be selected by the Secretary of War. This Board, under the direction of the Secretary, was empowered to "provide suitable regulations for the inspection of guns and materials at all stages of manufacture to the extent necessary to protect fully the interests of the United States."

An appropriation of \$500,000 was to be employed for: (a) completion of the experimental guns now being fabricated by the Ordnance Department and for testing the same; (b) manufacture or purchase and testing of cannon and carriages, including disappearing carriages; (c) alteration of carriages on hand; (d) purchase of projectiles, powder, fuses, and implements, their trial and proof; (e) experiments in means of protecting torpedo lines; and (f) compensating draughtsmen while employed in the Army Ordnance Bureau on ordnance construction, and for the necessary expenses of ordnance officers, while on temporary duty at the Proving Ground at a rate of \$2.50 per diem. Of the \$500,000, not more than \$100,000 was to be expended for providing increased facilities for manufacture of projectiles and for examining, testing, and experimenting with pneumatic or other dynamite guns, gun-carriages, aerial torpedoes, dynamite shells and ammunition, and batteries for coast defense.

56. Ibid., p. 7.

Seven hundred thousand dollars was made available for construction of necessary buildings and facilities, machine tools, and other fixtures for the Army Gun Factory to be erected at the Watervliet Arsenal.

One million five hundred thousand dollars was appropriated for purchase of "rough-finished, oil-tempered, and annealed steel for high-powered coast-defense guns" of 8-, 10-, and 12-inch caliber, in quality and dimensions conforming to specifications.

Two hundred and fifty thousand dollars was made available for the purchase of materials for and the manufacture of 12-inch breech-loading cast-iron rifled mortars, similar to the one now at the Sandy Hook Proving Ground.⁵⁷

2. Board of Ordnance and Fortifications Acts

Secretary of War Endicott promptly designated the members of the Board of Ordnance and Fortifications. In addition to the Army's commanding general, John M. Schofield, they were Col. Henry L. Abbot of the Engineers, Col. Henry W. Closson of the Artillery, and Lt. Col. Alfred Mordecai of the Ordnance Department. The Board, on assembling on October 30, examined plans, specifications, and forms submitted to it by the Ordnance Department for fabrication of steel for 8-, 10-, and 12-inch forgings; for construction of 12-inch breech-loading rifled mortars; and the detailed estimates called for under Section 3 of the recent appropriation bill. On November 6, 1888, the Board returned the documents pertaining to the steel forgings and the rifled mortars, recommending their approval. Secretary Endicott gave his sanction three days later. On November 13 the Department, having received clearance, called for proposals. The bids for the mortars were opened on December 15 and the forgings on December 20.

57. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 51st Congress, 1889-90 (Washington, 1890), Serial 2720, VII, 9-10.

Builders Iron Foundry of Providence, Rhode Island, received the contract for providing twenty-nine rough turned and bored cast-iron "bodies" for 12-inch mortars, and Midvale Steel for an equal number of sets of forgings for trunnion hoops and breech mechanisms. Subsequently, the number of mortar bodies and forgings was increased from twenty-nine to thirty.

Builders Iron Foundry, as low bidder, was awarded the contract for finishing and assembling the thirty 12-inch breech-loading mortars on July 29, 1889.⁵⁸

Bethlehem Iron Co. was given the contract for twenty-three sets of steel forgings for 8-inch rifles, twenty-three sets of steel forgings for 10-inch rifles, and fifteen sets of steel forgings for 12-inch rifles. The only other bidder had been Midvale Steel.⁵⁹

Under Section 3 of the Act of September 22, 1888, allotments were made by the Board to cover completion and testing of these guns: (a) 12-inch breech-loading steel rifle; (b) 10-inch breech-loading, steel, wire-wrapped rifle; (c) manufacture and test of a 3.6-inch steel breech-loading field gun; and (d) tests of a 5-inch siege breech-loading rifle and a 7-inch siege breech-loading howitzer (both of steel). Funds were also obligated for: procurement of two types of carriages for 12-inch breech-loading mortars; a carriage for a 12-inch breech-loading rifle to be mounted as a gun lift; powder and projectiles for issue and tests; alteration of carriages; expenses of Proving Ground; and draughtsmen employed in the Ordnance Office on gun construction.

Allotments were also made for the manufacture of one disappearing carriage for a 10-inch breech-loading rifle and for completion and test of a Woodbridge 10-inch wire-wrapped, breech-loading rifle.

58. Ibid., pp. 10-14.

59. Ibid., pp. 10-13.

With the \$45,000 budgeted, two 12-inch mortar carriages were ordered--one from Easton & Anderson of the Erith Iron Works, Manchester, England, and the other from Sir Joseph Whitworth & Co. The first was to be completed by October 1, 1889, and the other by November 1, 1889. The foundations for these carriages were to be positioned before their delivery to Sandy Hook. A 12-inch gravity return gun carriage was ordered from France's Le Creusot Works.⁶⁰

Section 6 of the act had appropriated a sum, not to exceed \$500,000, to fund "needful and proper purchases, investigations, experiments, and tests, to ascertain with a view to the utilization by the Government, the most effective guns, including multicharge guns and conversion of Parrott and other guns on hand," etc. The Secretary of War was authorized to purchase from this appropriation or cause to be manufactured such guns, carriages, armor-plate, etc., as in the judgment of the Board were necessary.

The Board, from this sum, allotted \$15,000 for working drawings, manufacture, and mounting of a King's disappearing carriage for a 10-inch gun; \$3,870 for purchase of a 6-pounder Driggs rapid-fire gun and 500 rounds of ammunition; and \$15,000 for experiments with high explosives.⁶¹

3. Congress Votes Additional Funds for the Program

On March 2, 1889, President Cleveland signed an act making further appropriations for "fortifications and other works of defense." On the recommendation of General Benet, the Board of Ordnance and Fortifications made these allotments totalling \$125,000 for tests of experimental guns procured under the Act of September 22, 1888; gun platforms at the Proving Ground; projectiles for field, siege, and seacoast guns; siege gun powder; and fuses.

60. Ibid, pp. 18-19.

61. Ibid., pp. 20-21.

One hundred thousand dollars was allotted for alteration of barbette carriages, including 10-inch smoothbore Rodmans to adapt them to service of 8-inch muzzle-loading rifles and 15-inch Rodmans to adapt them to current service conditions.

Twenty thousand dollars was allotted for procuring necessary instruments and other materials for the proper installation of instruments to facilitate annual heavy artillery practice.

Forty-three thousand two hundred and seventy-three dollars were programmed for the manufacture of forty cassions and ten combination battery wagons and forges for the 3.2-inch field gun.

For repairs and improvements at the Proving Ground there was budgeted: (a) \$5,500 for repair of dock and dredging; (b) \$3,800 for relaying roads and walks; (c) \$2,000 for repairs to Officers' Quarters; (d) \$2,600 for repair to foreman's quarters and soldiers' barracks; (e) \$500 for repairs to Instrument House; (f) \$1,000 for repairs to shops and storehouse; (g) \$4,000 for machinery for shops; (h) \$600 for clearing ground about range; and (i) \$5,320 for laying narrow gauge tramway to proof butts and targets.⁶²

62. *Ibid.*, p. 21. Six months before, Colonel Mordecai had called for an expenditure of \$25,000 to improve the physical facilities at the Proving Ground. A breakdown of his figures called for:

Repair of dock and dredging	\$ 5,500
Rebuilding board roads and walks	3,800
Repair of officers' quarters	2,000
Repair of foreman's quarters	800
Repair of soldiers' barracks	1,800
Repair of office	500
Repair of shops	500
Repair of storehouse	500
Machinery for shops	4,000
Clearing grounds about range	600
Beach tramway and handcar	5,000
	<hr/>
	\$25,000

Mordecai to Benet, Oct. 15, 1888, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

4. Fiscal Year 1889 Tests and Experiments

In Fiscal Year 1889 experimental work at the Proving Ground was retarded by bad weather, the necessity for making repairs, and increasing the facilities for carrying on a greatly increased workload. There had also been delays caused by procurement in obtaining powder that fulfilled contract requirements.

The 8-inch breech-loading rifle had been fired an additional sixty-one times. It was still in sound condition, but was much eroded in the shot chamber, and for the length of the bore to about a caliber and one-half in front of the "origin of the riflings."⁶³

The breech-loading mortar had been fired thirty-three times, with charges up to eighty-two pounds, giving a muzzle velocity of 1,200 feet per second and yielding a pressure of about 31,000 pounds per square inch in the chamber. Further firings had been suspended, until such time as the new carriages were received from abroad. The old platform and carriage had become impracticable to make satisfactory and accurate firings from.

The 5-inch breech-loading siege rifle and the 7-inch breech-loading siege howitzer had been turned over to the Board for Testing Rifled Cannon.⁶⁴

The 12-inch cast-iron tubed breech-loading rifle had been emplaced and tests would begin as soon as the gas check, now being manufactured, was received. Sufficient projectiles had been stockpiled to test it and the 12-inch hooped rifle, along with 30,000 pounds of brown prismatic powder.⁶⁵

63. Executive Documents, Serial 2720, p. 25.

64. Ibid., pp. 26-27.

65. Ibid.

On October 5, 1889, a 12-inch breech-loading cast-iron mortar, manufactured by the South Boston Iron Works, burst into a number of fragments while undergoing tests on the twentieth round. No damage occurred beyond demolition of the mortar and carriage, as the weapon had been surrounded by high and heavy sandbag traverses.⁶⁶

F. Program Makes Progress

I. General Benet Reports Satisfactory Progress on the Contracts Awarded Under the Act of September 22, 1888

By terms of the contract with Bethlehem Iron, the company was required, under penalty, to deliver eighteen sets of 8-inch forgings during the year ending April 30, 1891. The first set was delivered before April 30, 1890, and by October two more sets had been delivered. General Benet had been assured that by the end of the year another nine to ten sets would be ready. Moreover, General Benet forecast that by December 31 nine or ten sets would be delivered. Many of the forgings for the first set of 10-inch forgings were on hand.

By June 30, 1890, Midvale Steel had completed and shipped twelve sets of steel forgings to Builders Iron Foundry for assembly and twenty-two sets of forgings for the 3.2-inch steel field piece.

Builders Iron Foundry had nearly finished their first 12-inch breech-loading mortar, while work on eight others was underway. It was anticipated that at least twelve of the thirty mortars contracted for would be ready for proof by June 30, 1891.⁶⁷

In Fiscal Year 1890 there had been completed at the Army Gun Factory one 8-inch steel breech-loading rifle; one 10-inch breech-

66. Ibid.; Mordecai to Benet, Oct. 5, 1889, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

67. Executive Documents, Serial 2536, VII, 15-17.

loading steel rifle; one 10-inch cast-iron breech-loading rifle, wire-wrapped; one 3.6-inch steel breech-loading field gun; and one 3.6-inch steel breech-loading mortar and carriage. The 8-inch breech-loading steel rifle was of the approved type for the new seacoast guns, and was entirely of American steel manufactured by Midvale Steel. It weighed about fourteen and a half tons and had a bore length of thirty-two calibers. It consisted of a tube and jacket, assembled by rear insertion and a single row of hoops over the breech portion. The breech-block was seated in a sleeve, screwed into the jacket at the rear and securely keyed. The gun had been mounted on a special proof carriage at the Proving Ground, and the first test firing done in December 1889.⁶⁸

The 10-inch steel breech-loading rifle weighed about twenty-nine tons and its bore length was thirty-two calibers, two calibers less than the approved type. This weapon's tube, jacket, and trunnion hoop were cast by Sir Joseph Whitworth; hoops by Cambria Iron works; and breech mechanism forgings by Midvale Steel. The gun was fired at Sandy Hook in September 1890. On the sixth round, the carriage was damaged, when a flange of the top rail bent.⁶⁹

The 10-inch cast-iron breech-loading, wire-wrapped rifle, the cast-iron body of which had been manufactured at the South Boston Foundry, was intended as a "medium power gun." The wire had been put on by the Watertown Arsenal, and the gun nearly completed there before being shipped to Watervliet.⁷⁰

2. Major Tests and Experiments in Fiscal Year 1890

To determine a pitch for rifling of the 12-inch breech-loading mortar that would permit firing longer shells than those heretofore used with the piece, experimental firings were undertaken.

68. Ibid., pp. 19-21.

69. Ibid., p. 21.

70. Ibid.

The riflings of the muzzle-loading mortar, which had been test fired more than 400 times, were bored out. The bore was thus enlarged to 12.2 inches and 68 rifling grooves cut, each having a pitch increasing from one turn in 40 calibers to one in 25 calibers. The solid breech was bored through and fitted for the breech mechanism of a 12-inch breech-loading mortar.

When test fired the accuracy of the rebored weapon was not inferior to the Krupp 29-centimeter breech-loading mortar. From these tests, it was determined to adopt the riflings system used in the experimental 12.2-inch mortar for the 30 12-inch mortars under contract to Builders Iron Foundry.⁷¹

Tests on the 8-inch breech-loading steel rifle had been continued by the Board. Three hundred rounds had now been fired from the piece. It had been fired ten times during one thirty-minute period, in which pressure gauges were twice removed and replaced by others, causing a delay of five minutes. The breech mechanism in "the main worked satisfactorily." Defects observed in it had been "obviated" in the improved mechanisms for the new 8-, 10-, and 12-inch guns.

In construction this piece differed from that of the 8-inch gun recently fabricated at the Army Gun Factory, in that there were two layers of hoops over the breech, the tube being inserted into the jacket from the front and the breech mechanism being less well perfected.⁷²

The first of the two mortar carriages (the Easton & Anderson) ordered from Europe was received and positioned at the Proving Ground. More than a score of rounds had been fired from it. Its principal feature was that it allowed a recoil to the mortar along slides which sloped downward and to the rear at an angle of 60°. The recoil

71. Ibid., pp. 23-24.

72. Ibid., p. 25.

was checked in part by two courses of Belleville springs placed parallel to the slides, but principally by two hydraulic cylinders. The piece was elevated into firing position, after recoil, by reaction of the Belleville springs.

So far, tests had indicated that the springs were too weak for the "work imposed on them," and stronger ones were being procured. The traversing, elevating, and loading operations were accomplished with "gratifying facility." As yet, the Sir Joseph Whitworth carriage had not been received.⁷³

3. Fire Destroys the Instrument House

Early on the morning of August 14, 1889, there was a severe lightning storm at Sandy Hook. About 6:20 a bolt of lightning struck the Instrument House. One man was in the structure--Pvt. Thomas F. Thorpe, a member of the guard who was dressing in the large second floor room where he slept when off duty. The other watchman, Pvt. John Hefferman, had stepped out to make his 6:00 A.M. round and to get breakfast.

When the bolt struck, there was a blinding flash followed by a loud bang in the next room where the batteries for the electric work were positioned. Private Thorpe rushed into the battery room and found the floor and part of the hall engulfed in flames. Unable to snuff out the fire with a blanket or reach the tank of water, Thorpe made his way downstairs to Capt. James C. Ayers' office, hoping to speak to the Assistant Proof officer on the telephone. Unable to do so, he raced outside and rang the alarm bell.

Captain Ayers heard the bell, and his first thought was that it was reveille. Seeing that it was 6:25, he pulled on his clothes and raced out of the Officers' Quarters, closely followed by Lts. William W. Gibson and Harry Taylor.

73. Ibid., p. 28.

By the time they reached the Instrument House, flames were bursting from the building on all sides. Captain Ayers sought to enter the instrument room but was driven back by the smoke. Most of the enlisted men had gathered by this time, but they were unable to "arrest the conflagration and were unable to enter the building to save any equipment as every room was an inferno." Previous to the arrival of the officers, several of the men had fought their way into the laboratory and had brought out star gauges, fine scales, and a few other articles. They had been driven from the instrument room after saving a barometer and several other items.

By 6:50 the building collapsed. Everything in the Instrument House was destroyed, except for the few items rescued. Among the articles destroyed were the velocity instruments; pressure gauges; the photographic outfit, except for the best camera and lens, which fortunately were at the quarters; a telescopic sight for field guns, a Y-level, etc. All the facility papers, drawings, and records collected since 1874 were burned.

A small old fashioned safe withstood the intense heat. Locked inside were some old vouchers, blank discharges, final statements for enlisted men, and a gold chronometer.⁷⁴

4. Construction of a Narrow Gauge Spur from Wharf to Proof Battery

The sum of \$25,000 allotted in 1889 for improvements to the Proving Ground was disbursed by Colonel Mordecai in Fiscal Year 1890. There was considerable discussion involving expenditure of the \$5,320 earmarked for laying a tramway to the proof battery and targets. It was finally determined to build a narrow gauge track. Arguments favoring the track were found in a study which demonstrated that most of the materials and supplies to be transported would be comparatively light-

74. Ayers to Mordecai, Aug. 15, 1889, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

weight; the increased cost of standard gauge cars; and the space occupied on the dock would be shared with other Departments. The argument which swayed the Ordnance Board was that narrow gauge track, if properly constructed, would support a 12-inch gun.

If a rail connection were made with an outside railroad in the future, it would pass over only a short distance of the route to be constructed and such changes as were necessary could be made then. The track from the wharf to the proof battery was to be built of sixty-pound rails, with the six-foot ties eighteen inches apart. By mid-March the roadbed from the wharf to the proof battery had been prepared, and the laying of the track began.⁷⁵

G. General Benet Reports a Revolution

General Benet, under whose administration a solid foundation for modernizing the nation's weaponry had been laid, retired on January 22, 1891. Forty-one years' service, the last sixteen as Chief of Ordnance, provided him with an unexcelled perspective of the technological revolution which had occurred.

After many years of hope had been deferred, he reminded the officers and men of the Ordnance Corps that they could now congratulate the nation on the establishment of a gun factory at Watervliet, where "even at this early day and before much of the special machinery has yet been procured, samples of 8- and 10-inch" high powered guns have been completed. On saluting the Army and country on the success of this triumph of American scientific and mechanical skill, it was only fair to mention that "great credit is due to those officers of the Ordnance Department, who have labored early and late in its accomplishment."

75. Mordecai to Chief of Ordnance, Mar. 19, 1890, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

In his more than forty years' service, the "entire personnel" of the Department had changed, "and the great lights of the past have in the course of nature given way to their "more youthful and active successors." Smoothbores had "yielded to rifles, and 500 yards and uncertain accuracy to the unerring bull's-eye far beyond the unaided reach of human vision; and the brittleness of cast-iron spheres has been superseded by the marvelous perforating of steel armor by elongated projectiles."

Gun powder, with General Thomas Rodman's improvement in the size, burning, and consequent reduced pressures, as well as the small-grained variety used for demolition, were now yielding to smokeless compounds and to the "destructive power of titanic explosives." Great were the inventions for the destruction of human life and property, which, "supplemented by the new chemical and mechanical processes, governed and guided by electricity, as the motor," marked this era in the military history of the world. Happily for the progress of the human race, Benet observed, the arts of peace have "advanced no less marvelously, and their beneficent effects more than compensate for the evils that wars and rumors of wars can ever inflict on man."⁷⁶

76. Executive Documents, Serial 2836, pp. 37-38.

V. THE PROVING GROUND'S FIRST DECADE AS A SEPARATE FACILITY

A. Proving Ground Gets an Identity

The nation's accelerated rearmament program with its heavy expenditures, in which the Proving Ground had a vital role, led to its establishment as an independent facility. On October 31, 1890, some three months before his retirement, General Benet issued Ordnance Order No. 27, establishing the Sandy Hook Proving Ground as a separate installation. No longer would it be under the control of the President of the Ordnance Board. Capt. Charles Shaler was designated the Proving Ground's first commander. One month later, on November 28, the strength of the Ordnance Detachment was increased from thirty-five to forty-five enlisted men.¹

Captain Shaler was replaced as post commander by Capt. Frank Heath on June 17, 1891. In July 1893 Heath left for Chicago, where he was in charge of the Ordnance exhibit at the World's Columbian Exposition. While he was absent from Sandy Hook, Capt. William Crozier commanded the post. On his return from Chicago on August 23, Heath again took charge.²

1. Returns from U.S. Military Posts, 1800-1916, NA, Microcopy M-617. Charles Shaler of Florida graduated from the U.S. Military Academy as No 15 in the class of 1867. Commissioned a 2d lieutenant in the 5th U.S. Artillery, Shaler transferred to the Ordnance Department on July 5, 1867. He served as assistant ordnance officer at Rock Island, Ill., from September 1867 to July 1868. After a two-year tour of duty at West Point as assistant professor of Chemistry, Mineralogy, and Geology, Shaler returned to Rock Island as assistant ordnance officer. On November 1, 1877, he was assigned to the San Antonio Arsenal. He served as an assistant at the Watervliet Arsenal from July 1887 until October 27, 1890, when he was ordered to Sandy Hook. Cullum, Biographical Register, III, 87.

2. Returns from U.S. Military Posts, 1800-1916, NA, Microcopy M-617. Frank Heath of New York was graduated from the U.S. Military Academy as No. 10 in the Class of 1868. Commissioned a 2d lieutenant, he was assigned to the 3d U.S. Artillery. After serving with the artillery at a number of southern posts, he was ordered to the Military Academy, as Assistant Professor of Mathematics in August 1871. On November 1,

By September 1893 the Ordnance Detachment had been increased from forty-five to sixty-two enlisted men. This had occurred in three increments: on June 27, 1891, from forty-five to fifty-four; on July 3, 1893, to sixty; and on September 16, 1893, to sixty-two.³

B. Six Important Years on the Firing Range

I. Accomplishments in Fiscal Year 1891

a) Gun Deliveries and Tests

By the end of Fiscal Year 1891, the Department had completed two 8-inch, one 10-inch, and one 12-inch breech-loading modern steel-rifled guns. The No. 1 8-inch gun, cast at the West Point Foundry in 1886, had been fired more than 300 times at Sandy Hook, and, except for anticipated bore erosion, was in good condition. The No. 2 8-inch gun, cast in 1890 and the first piece of this caliber manufactured entirely of American steel, had fired more than 100 rounds without injury. The latter piece had been tested with both Brown powder and smokeless powder procured from Germany's Rottweil-Koln works. The German powder, which had a nitro-cotton base, was far superior to the Brown powder of American manufacture.

Tests of the 10-inch breech-loading steel rifle had been delayed by the breaking of the carriage, which had to be sent to the shop for repair, and by failure of the powder mills to produce "a suitable sample of powder." This piece had been fired about fifty times. The proposed charge was 250 pounds of powder for a 575-pound shell. DuPont was under contract to manufacture a Brown powder for these guns. A sample of Chilworth brown powder had been imported from Great Britain for trial in the gun but had proven unsatisfactory. As

2. (Cont.) 1874, he was transferred to the Ordnance Department. After service at Frankford and Rock Island arsenals and the Cheyenne Ordnance Depot, Heath was ordered to the Springfield Armory in November 1883 as assistant ordnance officer. Heath, prior to his assignment to Sandy Hook, was assistant at Watervliet. Cullum, Biographical Register, III, 110-11.

3. "History of the Sandy Hook Proving Ground," Records of the Office, Chief of Ordnance, NA, RG 156.

soon as suitable powder could be obtained, the 10- and 12-inch guns would be placed "under systematic trial for endurance, accuracy, rapidity of fire, etc.," at Sandy Hook.⁴

A 12-inch breech-loading mortar, entirely of steel, had been completed at the Army Gun Factory and shipped to the Proving Ground. It was awaiting testing. This mortar, it was believed, possessed "considerably more power and endurance than the cast-iron mortars, with a greater margin of safety against accident." To offset these advantages, however, its cost was nearly double that of the unit price of the thirty cast-iron steel-hooped mortars under contract to Builders Foundry.⁵

b) Department Awards Additional Contracts for Guns and Mortars

Under provisions of the Armament of Fortifications Act of August 18, 1890, a contract had been placed by the government with the West Point Foundry for furnishing and assembling eleven 8-inch guns from forgings furnished by the Department. In accordance with the Act of February 24, 1891, which appropriated \$800,000 for purchase of forgings for 8-, 10-, and 12-inch guns, the Department had placed a contract with Midvale Steel for twelve sets 8-inch, twelve sets 10-inch, and nine sets 12-inch forgings. With the deliveries to be made under the contract with Bethlehem Iron Company, these sets would raise the number of forgings to be delivered before December 31, 1896, to thirty-six sets 8-inch, thirty-five sets 10-inch, and twenty-four sets 12-inch.

Under the Fortifications Acts of August 18, 1890, and February 24, 1891, for providing the Department with twenty-five 8-inch, fifty 10-inch, and twenty-five 12-inch guns, Bethlehem Iron Company was

4. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 52d Congress, 1891-92 (Washington, 1892), Serial 2928, IX, 8-9, 12.

5. Ibid.

low bidder. The Board of Ordnance and Fortifications judged the price fair to all parties, and a contract for furnishing the 100 guns was awarded to Bethlehem. The first 8- and 10-inch guns under this agreement were to be delivered by the end of 1893. The first 12-inch gun was to be completed by December 31, 1894. Cost of each gun would be about:

8-inch	\$16,576
10-inch	34,473
12-inch	52,365

The price was exclusive of the cost of ten proof rounds.

A contract was also signed at this time with the South Boston Ironworks for manufacture of forty-three additional cast-iron 12-inch mortars, identical to those being fabricated by Builders Iron Foundry.⁶

c) Carriage Contracts

The Department had contracted with Builders Iron Foundry for manufacture of eight cast-iron spring-return carriages of the Raskazoff model for 12-inch mortars, with the option of increasing the number to the extent of the appropriation available. This would enable the Department to procure either some thirty carriages or a number equal to that of the mortars being built by the Providence firm. The first carriage was to be completed by December 31, 1891.

Another type of carriage--the steel Carnet--purchased from Sir Joseph Whitworth & Co., had been received at Sandy Hook and was awaiting tests. Also at the Proving Ground was a 10-inch pneumatic disappearing carriage manufactured by the Pneumatic Gun Carriage and Power Co. of Washington, D.C.⁷

6. Ibid., pp. 9-12.

7. Ibid., p. 13.

Contracts had been made for the manufacture of these types of carriages for tests: one 8-inch and one 12-inch barbette carriage by the Watertown Arsenal, and one 12-inch carriage for a gun lift by Le Creusot. The latter was "substantially a barbette carriage, but with an increased length of recoil to adapt it to the requirements of the gun lift." A 10-inch disappearing carriage, the Gordon type, was built by the Morgan Engineering Works in Alliance, Ohio. One 8-inch and one 10-inch disappearing carriage, Buffington-Crozier type, were built by the Southwark Foundry & Machine Company in Philadelphia. "The principle involved in its construction was first presented by Col. [Adelbert R.] Buffington of the Ordnance Department, and the present design embodied important changes, which were due to Capt. [William] Crozier of the Ordnance Department."⁸

2. Fiscal Year 1892 Testing and Armament Program

a) Tests and Trials at Sandy Hook

In Fiscal Year 1892 experimental firings increased. Weather conditions permitting they took place daily, Sundays excepted. By June 30, 1892, the 10-inch breech-loading rifle had fired 158 rounds, and the 12-inch breech-loading rifle 64. The former had been tested with the pneumatic disappearing carriage, while the latter had recently been mounted on the gun lift carriage manufactured by Le Creusot. By testing the gun and lift together, considerable money would be saved.

The No. 2 8-inch breech-loading rifle had been fired 174 times, but as Gun No. 1 had fired more than 300 rounds, the "strength" of this type of gun was assured. The accuracy of these guns had been demonstrated, when at a range of one mile four out of five projectiles struck within a twenty- by twenty-one-inch area. At 3,000 yards six shots impacted within a one-and-a-half by four-foot target.⁹

8. Ibid.

9. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 52d Congress, 1892-93 (Washington, 1893), Serial 3083, VIII, 14, 19.

(See Appendix A for Tables I-VI providing data on the Sandy Hook tests in Fiscal Year 1892.)

The Board for Testing Rifled Cannon had completed tests of Dr. Woodbridge's 10-inch breech-loading rifle. This piece, constructed as recommended by the Getty Board except for the wire wrapping being carried forward of the trunnions, was begun in 1884. It weighed about twenty-eight tons, with a bore length of twenty-eight calibers. The Woodbridge had fired 161 rounds. With a charge of 160 pounds and a 453-pound projectile, it had yielded a muzzle velocity of 1,840 feet per second with a chamber-pressure of 30,245 pounds.

An evaluation of the tests caused the Board to conclude that the Woodbridge, consisting essentially of a cast-iron body strengthened by steel-wire winding, was inferior in power to standard guns of the same caliber. As it was also subject to deep scourings and guttering, the Board could not recommend it for government service.

Tests had also been continued by the Board on the 12-inch breech-loading, cast-iron rifle sent to the Proving Ground from Watervliet in 1889. It had been fired 228 times, and the "advantage derived from the use of a steel lining in protecting the bore against erosion from powder gases" had been demonstrated.

The Board for Testing Rifled Cannon had finally completed its trials of the 12-inch breech-loading cast-iron mortar, and had "adjudged" it satisfactory for issue to the Army. This piece was similar to the seventy-three mortars under contract, differing from them only with respect to rifling. The rate of fire for this piece, which was designed to fire a maximum charge of 80 pounds of Brown prismatic powder with a 630-pound projectile, was one shot every 11-1/2 minutes with the present imperfect carriage.

Tests were in progress with the 12-inch steel mortar received at the Proving Ground in 1891 from the Army Gun Factory. This piece was designed to fire an 800-pound shell with a maximum charge of

105 pounds. Trials had been delayed when several carriages broke down after a few rounds.

The steel mortar was similar in construction to the 8-inch rifle, the tube being inserted into a jacket from the rear and held against a shoulder by a screw bushing which was threaded on the interior to receive the breech-block. The tube and jacket were hooped throughout by a single layer of hoops.¹⁰

b) Contracts and Deliveries

By December 31, 1892, there had been completed at the Army Gun Factory fifteen 8-inch, eight 10-inch, and three 12-inch breech-loading rifles. These pieces would be ready for issue as soon as they were proof fired and necessary carriages provided. There had been finished by the same date 44 12-inch breech-loading cast-iron mortars.

With funds appropriated by the Fortifications Act, signed into law by President Benjamin Harrison on July 23, 1892, contracts had been let to Bethlehem Iron for forgings for ten 8-inch, twelve 10-inch, and ten 12-inch guns. Bethlehem had also been awarded a contract for manufacturing seven of the new all-steel 12-inch mortars.¹¹

c) Testing, Altering, and Waiting for Carriages

In its Sandy Hook tests, the Easton & Anderson spring-return mortar carriage had developed defects, which though serious, could be corrected. At the same time, its good qualities (simplicity of construction, efficiency, and cheapness) led the Department to reconstruct the cheeks of the carriage, so far as practicable, while retaining the remaining parts, the bed-plates, etc., of the original construction. The rebuilt carriage had been subjected to a severe trial by the Ordnance Board and pronounced satisfactory.

10. Ibid., pp. 15-16.

11. Ibid., pp. 14, 17.

Builders Iron Foundry had completed eight of the Raskazoff-type mortar carriages. Some of these had been manufactured by Morgan Engineering Works of Alliance, Ohio, as a subcontractor. The Belleville springs for these carriages had been fabricated at the Watertown Arsenal.

The Carnet 12-inch mortar carriage purchased from Sir Joseph Whitworth & Co. had been tested. During the trials, it was found necessary to make a change in the gears of the elevating mechanism to obtain increased power. The rate of fire was undesirably slow, because of the difficulty in elevating and depressing the piece. The Ordnance Board concluded that the Carnet was inferior to the "more simple" spring-return carriage.¹²

Work on the Gordon 10-inch disappearing carriage and the 8- and 10-inch Buffington-Crozier disappearing carriages had progressed. Manufacture of 8- and 12-inch barbette carriages at the Watertown Arsenal had been delayed by necessity of first procuring and setting up an air furnace and some additional machinery, and, further, by the failure of some of the first castings.

A contract had been negotiated with Grusonwerk of Magdeburg-Buckau, Germany, for a 12-inch casemate carriage, including manufacturing rights.¹³

3. Fiscal Year 1893 Program

a) Tests and Trials

The number and variety of firings in Fiscal Year 1893 for experimental and testing purposes were greater than during any previous twelve months. Much of the work involved rapid-fire guns

12. Ibid., pp. 17-18. The Carnet carriage was made largely of steel castings, and "arranged for all-round firing and for elevations from the horizontal up to 75°." Its line of fire always coincided with the direction of the recoil.

13. Ibid., pp. 19.

(6-pounder Hotchkisses, 6-pounder Driggs-Schroeders; 6-pounder Seaburys, and 4.7-inch Armstrongs) and field and siege guns.¹⁴

Test firings of seacoast guns were limited by powder shortages. The 12-inch breech-loader had been fired twenty-eight times, the 10-inch breech-loader fifty-two, and the No. 2 8-inch breech-loader fifty-one times in the twelve months since the last annual report.

During the year the Board for Testing Rifled Cannon had completed its trial of the 12-inch breech-loading cast-iron rifle. Two hundred and sixty-three rounds had been fired, with the charge varying from 245 to 275 pounds, depending on the quality of the powder. Weight of the projectile was about 800 pounds, with the maximum chamber pressure limited to about 31,000 pounds per square inch. Muzzle velocities had ranged from 1,725 to 1,750 feet per second. At the conclusion of the test, the bore showed marked erosions from the action of the powder, but not of sufficient character to require the piece to be rejected.

This gun, which had been manufactured under the provisions of the Fortifications Act of March 3, 1883, had demonstrated a tremendous advance in power over the 15-inch Rodman Smoothbore. Indeed, its energy was about equal to that obtained with the "old short Krupp 12-inch steel rifle" in German service before 1880. But, when compared with modern steel rifles of 12-inch caliber, the weapon's performance "fell very far behind." Its weight was fifty-four tons, while that of the new 12-inch rifles was fifty-two tons. The muzzle energy of the cast-iron gun was about 17,000-foot-tons, about equal to that of the new 10-inch steel rifles, as opposed to the 27,000- to 30,000-foot-tons of a 12-inch steel rifle.

14. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 53d Congress, 1893-94 (Washington, 1894), Serial 3205, IX, 381, 383.

The enormous weight of metal in the body of the cast-iron guns had strained to the limit the "resources of the founder's art." Three out of four castings for one of the two 12-inch cast-iron guns had failed during manufacture. Brig. Gen. Daniel W. Flagler, who had replaced General Benet as Chief of Ordnance, took cognizance of the number of high-powered steel rifles coming out of the nation's factories and recommended that the Army not adopt this gun.¹⁵

During the year a 5-inch breech-loading rifle had been received for tests at the Proving Ground from the Brown Segmental Wire Gun Co. of Reading, Pennsylvania. This piece consisted

of a segmental core wound with wire under such tension that the compression between the longitudinal segments or the core induced thereby will be more than sufficient to resist all the ordinary powder pressures.

The trunnions are not attached to the core or body of the gun, but to an outer trunnion jacket, which jacket is attached to the gun proper by means of the breech nut. The breech block engages in a bushing which is screwed into the trunnion jacket. By this means the recoil is transmitted to the trunnions through the bushing and jacket, and the core or body of the gun is thus relieved from the major part of the longitudinal thrust due to powder pressure upon the bottom of the bore.

A thin steel lining tube extended from the bottom of the bore forward to a point about four and one-half calibers in front of the chamber. The object of this arrangement was to provide against the erosive effect of powder gases upon the exposed joints of the segments in that part of the gun, where the pressure was the greatest. The lining tube was removable.

In allotting funds for test of the Brown Segmental Wire Gun, the Board of Ordnance imposed three requirements as to pressures: twenty rounds with a pressure of 40,000 pounds; sixty

15. Ibid., pp. 34-36.

rounds with a pressure of 50,000 pounds; and twenty rounds to be utilized in experimental firings.¹⁶

Trials of the steel breech-loading mortar had been limited by repeated breakdowns of the carriage improvised for the tests. Because of the comparative lightness of the piece, in respect to the weight of its projectile, an unusually heavy strain was impressed upon the carriage in firing. Neither the carriage for the 8-inch gun nor that for the 10-inch gun possessed sufficient resistance. The gravity-return mortar carriage was also unsuitable, because of the great height of the top carriage. No other resources at hand, Captain Heath had the mortar carriage cut down until only a few degrees of elevation could be given the mortar. In this manner a suitable carriage was obtained for butt firings. As yet, only fifty-six rounds had been fired from the piece.¹⁷

b) Contracts and Deliveries

The manufacture of seacoast guns at the Army Gun Factory and by contract had proceeded satisfactorily during the year. By December 31, 1893, there would be completed:

<u>Place of Manufacture</u>	<u>8-inch guns</u>	<u>10-inch guns</u>	<u>12-inch guns</u>
Army Gun Factory	25	20	9
West Point Foundry	8		
Bethlehem Iron Works	1		
Total	<u>34</u>	<u>20</u>	<u>9</u>

By the Act of February 18, 1893, \$600,000 was appropriated for the purchase of additional steel-gun forgings. Proposals were solicited, and contracts awarded by Chief of Ordnance Flagler to Midvale Steel for nine sets of forgings for 8-inch guns, and to Bethlehem Iron Works for seven sets for 10-inch guns and eight sets for 12-inch guns. The tube for one

16. Ibid., pp. 36-39.

17. Ibid., pp. 39-40.

of the sets of the 12-inch forgings was to be of nickel steel and to be forty calibers in length. The abnormally heavy pressures encountered in the test of heavy guns using Brown powder had pointed to the necessity of having very strong walls in the gun to resist such pressures; otherwise, serious deformation or ruptures might result.

At present, Chief of Ordnance Flagler saw no reason for making any reduction in the thickness of the nation's 8-, 10-, and 12-inch rifles over the chamber, notwithstanding that it was "somewhat greater than in some of the more recent types of guns designed abroad for use of modern powders."¹⁸

Seventy-three 12-inch mortars would be completed by December 31, 1893. No more could be placed under contract until Congress made another appropriation for the "manufacture of this most useful and economical arm" of our coast defense.¹⁹

c) Securing and Testing Carriages

The 8-inch barbette carriage manufactured at Watertown Arsenal had been completed and shipped to Sandy Hook, where it had been tested. A number of minor defects developed, and changes indicated were incorporated in seven more carriages being built at Watertown.

There were also being manufactured at Watertown five 10- and four 12-inch barbette carriages, and two 12-inch lift carriages. The lift carriages were similar to the gravity-return, except that the gun-lift carriage had a special automatic arrangement of its hydraulic cylinders to retain the gun in its recoiled position after firing, and that the chassis and upper roller path were of cast-steel and in two pieces.

18. Ibid., pp. 33-34.

19. Ibid., p. 40.

The Gordon experimental 10-inch carriage had been sent to the Proving Ground, where it was undergoing preliminary firing to determine what modifications were necessary before it was turned over to the Ordnance Board. The 8-inch Buffington-Crozier disappearing carriage had been finished and was being set up for tests at Sandy Hook. The Grusonwerk people had completed the casemate carriage and it was en route to the United States.

To provide carriages for the seventy-three mortars that were scheduled to be completed by the end of the year called for good salesmanship on the part of the Department to awaken an interest in the project on the part of responsible manufactures. In addition, there were protracted negotiations with the owners of the patent rights on the spring-return mortar carriage. Contracts for fabrication of the mortar carriages were signed with: Builders Iron Foundry, twenty-eight; Robert Poole & Son Co.; thirty-six, and West Point Foundry, seven. By substitution of coil springs for Belleville springs in the carriages some economies were effected.²⁰

4. Fiscal Year 1894 Program

a) Tests and Trials

In Fiscal Year 1894, as in the previous year, slight progress was reported by Captain Heath in tests of the 10- and 12-inch breech-loading guns, because of the failure of manufactures to produce a suitable quality of Brown powder. Since his last annual report only seven rounds had been fired from the former and nineteen from the latter. It was anticipated, however, that tests would be completed in Fiscal Year 1895, as more uniform results were now being obtained with sample lots of Brown powder provided for the 10-inch rifle.

The No. 2 8-inch rifle had been fired 94 times during the year. This piece, which had now fired 319 rounds, showed "more or

20. Ibid., pp. 41-42.

less erosion of the bore and chamber and the rifling" was so much worn down at the commencement of the forcing cone, where it was of reduced depth, that the projectile was no longer retained in its original loading position. The accuracy of the piece, though still good, was not up to the high standard attained when it was first emplaced at Sandy Hook. Captain Heath proposed to slightly enlarge the rotating bands on the projectiles to stop them at their original loading position and restore, if practicable, the piece's accuracy.²¹

Tests of the Brown 5-inch segmental wire gun had been completed with the firing of 192 rounds. After the final round, which was with a thirty-six-pound powder charge, the recorded pressures were 50,956 and 48,450 pounds per square inch on the two gauges employed, and two large cracks were pinpointed in the lining tube. The upper crack was about one-fourth inch at its widest point. Considerable gas had escaped from the outside under the front edge of the trunnion tube. It was discovered, on removing the jacket, that one of the segments had parted about 34-1/2 inches from the breech. The bore was eroded and scarred, but the segments, with this one exception, were intact.²²

In 1893-94 the Department had tested at Sandy Hook another Woodbridge 10-inch wire-wound gun. This latest piece was classified as a prototype of the Brown segmental gun. Its lining however, extended throughout the length of the bore. The tension of the wire-wrapping had been determined by Dr. Woodbridge. The gun, like its two predecessors, failed. On the twenty-third round, the inner tube ruptured in five places.

21. Executive Documents, Printed by Order of the House of Representatives for the 3d Session of the 53d Congress, 1894-95 (Washington, 1896), Serial 3302, IX, 29.

22. Ibid., pp. 29-30.

The 10-inch Crozier wire-wound rifle had been received at the Proving Ground from Watervliet. It consisted of "a rather heavy central tube of forged steel overlaid with a practically continuous layer of wire from breech to muzzle." A steel jacket, carrying the breech-block and trunnion hoop, was placed over the wire covering with very slight shrinkage, and was connected at its forward end with the tube. By the end of the fiscal year, the Crozier had been fired sixty-eight times with no sign of weakness.

Since 1876 the Department had tested a number of wire-wound guns, including the Crozier which was undergoing trial. All these, except the Crozier, had failed. The Brown, the only one not manufactured by the Department, had demonstrated great endurance. These tests had satisfied the Department as to the advantages possessed by the built-up steel guns vs. those of wire-wound construction.²³

The 12-inch breech-loading steel mortar had now been fired 174 times with varying charges. Results obtained slightly favored the cast-iron mortar which was in production.²⁴

b) Contracts and Deliveries

Chief of Ordnance Flagler reported to Congress that the number of rifles manufactured at the Army Gun Factory during the year was not as great as expected, owing to the limited funds available for production. A number of improvements had been introduced, with a view of obtaining a high degree of accuracy in the work and "more particularly a certain interchangeability of the several parts of the breech mechanism of guns of the same caliber." Special attention had been given to accurate threading of breech-blocks, breech bushings, and their recesses, as well as to the preparation of complete and accurate sets of templets and gauges for the work. While the templets and gauges were

23. Ibid., pp. 30-31.

24. Ibid., pp. 31-34.

being readied, work on breech-blocks, breech bushings, etc., was suspended.

A summary of work underway at the Army Gun Factory showed:

<u>Kind and caliber of gun</u>	<u>Under construction June 30, 1893</u>	<u>Completed June 30, 1894</u>	<u>Under construction June 30, 1894</u>
8-inch B.L. rifle	12	11	6
10-inch B.L. rifle	11	11	11
10-inch B.L. rifle, Crozier	1	1	
12-inch B.L. rifle	6	6	7
12-inch B.L. steel mortar	2	1	6

As all these guns were well advanced toward completion (the remaining work on many of them being only the threading which had been delayed), General Flagler forecast that nearly all would be ready for proof testing by December 31, 1894. There would then have been completed at the Watervliet Gun Factory, since it was put into operation, thirty 8-inch rifles, thirty-five 10-inch rifles, fifteen 12-inch rifles, eight 12-inch steel breech-loading mortars, exclusive of several wire-wound guns, and a large number of field and siege guns, howitzers, and mortars.

The West Point Foundry had discharged its contract for finishing and assembling eleven 8-inch rifles from forgings supplied by the Department. Bethlehem Iron Works had reported satisfactory progress on its 100-gun contract. Ten 8-inch guns were under manufacture "and a number [were] well along toward completion." Several tubes and jackets and hoops for 10-inch guns had been fabricated.²⁵

25. Ibid., pp. 27-29, 31.

c) Testing Carriages

Seven of the new model 8-inch barbette carriages had been completed at the Watertown Arsenal, along with three 12-inch barbette carriages. Two of the 8-inch carriages had been issued--one to West Point and the other to Fort Monroe.

Completion of two 12-inch barbette carriages and four 12-inch gun-lift carriages had been delayed by failure of the steel makers to produce sound castings. But, as many of the parts were now well advanced, Chief of Ordnance Flagler predicted that, if the steel castings scheduled for delivery proved satisfactory, completion of the carriages would be but a matter of a few months' work.²⁶

The Grusonwerk carriage tests had commenced at Sandy Hook, but had to be discontinued when one of the cast-iron parts fractured.²⁷

The Gordon 10-inch disappearing carriage, undergoing tests at the Proving Ground, was massive--the top carriage alone weighing upwards of 70 tons, and its total weight being more than 200 tons. Its principal parts were cast-iron, while the cheeks of the top carriage of the journal cranks were steel.

Preliminary to the tests, fifteen rounds were fired for the purpose of developing the workings of the hydraulic-powered carriage and making adjustments and minor alterations. The carriage was then subjected to trial, in accordance with a carefully matured program. It was found that it took eight men working the pumps 30 seconds to raise the carriage from the firing to the traversing position.

In firing for rapidity, ten rounds were sent to sea, six being continuous, without delay because of shipping. From these,

26. Ibid., p. 34.

27. Ibid., p. 40.

the Ordnance Board determined that the actual time required for ten rounds was 58 minutes, 28 seconds.

All told, thirty-three rounds were fired from the Gordon carriage, and a number of defects or disadvantages in the system developed. On reviewing the reports submitted and considering Capt. William B. Gordon's rebuttal, the Board on Ordnance and Fortifications determined to purchase a modified 10-inch carriage of the Gordon design.²⁸

The Ordnance Board on November 14, 1893, began its test of the Buffington-Crozier 8-inch disappearing carriage at Sandy Hook, and on July 6, 1894, its trial of the 10-inch disappearing carriage. In the Buffington-Crozier system, the gun rested by its trunnions on the upper ends of two cast-steel rotating arms in bearings bushed with bronze. These arms were pivoted, near their mid-points, upon an axle of forged steel, and were connected beneath the gun by a plate transom. The axle rested in bearings on the top carriage, which was formed with two hydraulic cylinders in two pieces of steel bolted together. In each cylinder were two throttling bars of steel, which passed through notches in the piston.

The hydraulic cylinders were connected by a pipe at their forward ends to equalize the pressure in them during recoil. The pistons were fastened by means of nuts to projections on the chassis. The top carriage ran upon rollers of forged steel, which were placed in recesses of the cheek plates of the chassis. The cast-steel cheek plates were bolted at the forward ends to the upper front roller path, which rested upon a live roller ring. The rear of the chassis rested upon the rear traverse wheels. This arrangement provided for traversing the carriage, and was effected by means of gearing worked manually. The counter-weight was suspended from a shaft joining the lower ends of the rotating arms.

28. Ibid., pp. 34-36.

A vertical ratchet was formed on the inner face of each crosshead piece, to be caught by a pawl on the cheek plate to hold up the counterweight. This pawl was mounted upon a short crank, actuated by a long lever at the side of the carriage, which was used for lowering the piece should the recoil not be sufficient. There was a well for reception of the counterweight at the front of the carriage.

Upon firing the piece, the central pivot of the rotating beam moved horizontally to the rear, carrying the top carriage with it; the lower end moved vertically upward, being constrained by the crosshead guides; the gun moved downward and to the rear in the arc of an ellipse. The energy of the recoil was partially absorbed by raising the counterweight and the residue by the resistance of the hydraulic cylinders. After loading, the pawls were tripped, and the greater "moment" of the counterweight raised the piece into battery. The gun was hauled down into loading position by hand through blocks and falls attached to the upper ends of the rotating arms and to lugs on the cheek plates.

In the firing test of the 8-inch Buffington-Crozier carriage, the gun crew got off 10 rounds without mishap, in 12 minutes, 21 seconds. Forty-seven rounds were fired without any breakdown in the trials.

The Ordnance Board was delighted with the carriage's performance, and reported it possessed "in a marked degree the properties which should pertain to a disappearing carriage for high-power guns." Although the carriage was "considered . . . in all respects fit for use in the service," the Board believed, "it might be modified to advantage by adding a more efficient counter-recoil buffer, and by increasing the facilities for hauling down by hand," and diminishing the depth of the well for the counterweight. The 10-inch Buffington-Crozier carriage also passed its tests in a similar manner.²⁹

29. Ibid., pp. 37-40.

Contracts for sixty-four spring-return 12-inch mortar carriages were completed during the year, and a number of these carriages, with their mortars, issued to the Army.

The West Point Foundry had manufactured for the Department an experimental 12-inch spring-return mortar carriage designed by Captain Gordon. This carriage, which was "simple in construction," had been sent to Sandy Hook for tests. The Pneumatic Gun Carriage and Power Co. had also constructed and submitted for trial a 12-inch mortar carriage on the pneumatic system. Preparations were underway at the Proving Ground for mounting this carriage, along with a mortar carriage and platform for a 7-inch breech-loading mortar manufactured at the Watertown Arsenal.³⁰

5. Fiscal Year 1895 Program

a) Tests and Trials of Guns

Despite Captain Heath's confident prediction that the Proving Ground tests with the 8-, 10-, and 12-inch rifles would be completed in Fiscal Year 1895, this was not the case. When Chief of Ordnance Flagler submitted his annual report for the year, he informed Congress that recent improvements made in the manufacture of Brown powder insured, "with fair certainty the attainment of suitable powders and their subsequent reproduction, and it is now expected that the prescribed tests of these type guns will be completed" before December 31, 1895.

As of June 30, the No. 2 8-inch rifle had fired 377 rounds, and would probably admit of fifty more before the tube would have to be resleeved. The 10-inch rifle (its tube of Whitworth steel) had fired 265 rounds, and was much scored and gutted. By increasing the diameter of the rotating bands on the projectiles, the windage had been reduced enough to retain the shot in its original position, and its

30. Ibid., pp. 40-41.

accuracy was unimpaired. This piece had been subjected to some very "heavy wave pressures" during its test, and a number of samples of smokeless powder fired in it.

The 12-inch rifle (its tube of Le Creusot steel) had now fired 159 rounds, and was still in good condition. This piece had also been subjected to very heavy pressures. Its tube still looked good and was perhaps of more uniform quality than the Whitworth tube.³¹

The Crozier 10-inch wire gun had been fired 210 times, and appeared to be in good condition. The bore of this piece had enlarged more than that of the 10-inch hooped gun, but it was much less scored and eroded, notwithstanding that the average pressure had been greater than that to which the hooped gun was subjected.³²

During the year the test of the steel breech-loading mortar was completed by the Board for Testing Rifled Cannon. It had been fired 335 times, of which ten rounds were with shells of 630 pounds, six with a shell of 775 pounds, 280 rounds with a shell of 800 pounds, and 39 rounds with a 1000-pound shell. One hundred and eight rounds had been fired with pressures of about 31,000 pounds per square inch and 20 rounds with pressures of 37,000 pounds per square inch. As respects to endurance, the mortar exhibited little or no erosion and gave every appearance of being able to endure an infinite number of rounds.

Some trouble had been experienced at the beginning of the trial with the gas check, but, after introduction of the new steel split rings, this problem was corrected. There had also been difficulty with some parts of the breech mechanism--the locking bolt for the console

31. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 54th Congress, 1895-96 (Washington, 1896), Serial 3378, XI, 32-33.

32. Ibid., pp. 33-34.

and the rotating-crank locking bolt. These bugs had been remedied in the seven steel mortars since constructed at the Army Gun Factory

The mortar, when it was fired for accuracy, was mounted on the Gordon carriage.³³ See Appendix B for Tables I-IV, providing data on certain categories of tests carried out in Fiscal Year 1895 at the Proving Ground.

b) Gun Production

By June 30, 1895, there had been manufactured at the Watervliet Gun Factory:

8-inch breech-loading rifles	30
10-inch breech-loading rifles	33
12-inch breech-loading rifles	14
12-inch steel breech-loading mortars	8

The West Point Foundry had finished and assembled under contract eleven 8-inch guns. Under its 100-gun contract, Bethlehem Iron Co. had completed ten 8-inch guns, and had ten 10-inch guns nearly ready as well as some forging produced for 12-inch rifles.

An improved gas check, developed by Mr. Gordon, foreman at Sandy Hook, was adopted for all heavy guns, both seacoast and siege. It omitted the front steel cup and the lips of the rear cup, substituting for them split steel rings to which an asbestos pad conformed. These split rings were a marked improvement over the old form of gas check.³⁴

33. Ibid., p. 37.

34. Ibid., p. 33.

c) Determining the Rapidity of Fire from Barbette Carriages

The Ordnance Board sought to ascertain with what rapidity the 8-, 10-, and 12-inch rifles could be fired from barbette carriages at Sandy Hook. Ten rounds were to be fired from each piece.

The breech-block was closed, the gun at its proper elevation for loading; and the shot in the tray. The gun commander then gave the command, "Load!" Loading and firing continued until the tenth round roared out from the muzzle. All delays not chargeable to the carriage itself were deducted from the elapsed time.

The rate of fire for each was:

8-inch rifle, manned by a 12-man detachment,
10 rounds in 17 minutes.

10-inch rifle, served by 14 men, 10 rounds
in 14 minutes, 39 seconds.

12-inch rifle, manned by 17 men,³⁵ 10 rounds
in 28 minutes, 11 seconds.

d) Proofing and Shipping Guns, Mortars, and Mortar Carriages

At Sandy Hook firings for experimental and proofing purposes were conducted daily, weather permitting. More and more time and personnel were involved in the proof of the heavy ordnance becoming available for emplacement in the Endicott batteries, several of which had been completed. During the year, guns, mortars, and carriages were proved, issued, and shipped to:

1) Lt. Col. S. M. Mansfield, Grover's Cliff, Massachusetts, sixteen 12-inch breech-loading mortars, and twelve spring-return carriages for 12-inch mortars.

35. Ibid., p. 40.

2) Lt. Col. W. R. King, David's Island, New York Harbor, sixteen 12-inch breech-loading mortars, and twelve spring-return carriages for same.

3) Col. G. H. Mendell, Fort Winfield Scott, California, twelve 12-inch breech-loading mortars, twelve spring-return carriages for 12-inch mortars, and three 12-inch breech-loading rifles.

4) Lt. Col. W. H. H. Benyaurd, Lime Point, California, one 12-inch breech-loading rifle.

5) Ord.-Sergt. Matthew Duggan, Sandy Hook, New Jersey, sixteen breech-loading mortars, sixteen spring-return carriages for 12-inch mortars, and one 8-inch and two 15-inch pneumatic dynamite breech-loading guns, with their carriages, machinery, and appurtenances.

The mortars and carriages for Grover's Cliff and David's Island were shipped by water, while the California-bound 12-inch mortars, 12-inch rifles, and carriages went across the continent by rail. The 12-inch rifles were placed on cars of 125,000-pound capacity furnished by the Pennsylvania Railroad. In loading, the breech and chase of the gun were placed on heavy timbers properly secured to the car's platform. Slippage in either direction was controlled by timber braces resting against these timbers and the trunnions of the gun.

For the base ring and racer of the mortar carriages special preparations were necessary. These parts were fourteen feet in diameter and weighed about twelve tons. As the diameter was too great for horizontal loading, it was necessary to place them upon the car in a vertical position. To accomplish this, a gondola car was readied by cutting away a portion of the car flooring in the shape of two square holes of suitable width and length of slightly less than the diameter of the parts. A heavy timber framework was then placed upon the floor with a square opening through it to correspond with that in the floor. The various portions of the framework were fastened together by bolts and tie-rods.

It was arranged that each car would carry the components pertaining to one carriage. In loading the base ring and racer, it was hoisted to a height sufficient to clear the car, which was then run under it, and the part lowered into position and secured by wedges to the framework.

The lowest point of the base ring and racer, as loaded, was seven inches above the top of the rail, and with the height thus established at fourteen feet, seven inches above the rail, the car was able to pass through all tunnels and bridges on the route taken from the Highlands to San Francisco. The side frames and remaining parts of the carriage were loaded on a second car.³⁶

e) Another Fatal Accident

On February 19, 1895, a 4.7-inch Hotchkiss rifle, while being test fired, burst, mortally wounding Lt. Fremont Peck. The lieutenant died at 5:15 P.M., and at 10:30 that night the remains were taken to Governor's Island aboard the steamer Ordnance. In more than twenty-one years this was only the second Proving Ground accident to result in a fatality.³⁷

6. Fiscal Year 1896 Program

a) Tests and Trials of Guns

Tests, proofs, and experiments undertaken during the year involved: (a) siege rifles and howitzers; (b) rapid-fire breech-loading rifles; (c) breech-loading rifled mortars; (d) seacoast guns; (e) field guns; and (f) tests in the explosion chamber and sand.³⁸

The experimental firings with the 10- and 12-inch breech-loading rifles, which had been underway for years, were finally

36. Executive Documents, Serial 3378, pp. 171-72.

37. Returns from U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

38. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 50th Congress, 1896-97 (Washington, 1897), Serial 3485, IX, 155-58.

completed. The former had endured 292 rounds without any apparent loss of strength. Of this number 144 had given pressures above 35,000 pounds per square inch, while the maximum pressure obtained was 62,000 pounds per square inch. The erosion of the tube for some distance in front of the projectile was now so great as to destroy its accuracy, and for this reason alone the gun was deemed unserviceable by the Board.

As development of a Brown powder suitable for 12-inch guns was carried out with the second piece, the ballistic requirements (450 pounds Brown powder, initial velocity of 1,975 feet per second, with a pressure of 37,500 pounds per square inch) were not obtained until the test was more than one-half completed. The gun had been fired 227 times, of which 135 rounds had yielded pressures above 35,000 pounds per square inch. The maximum pressure recorded was 73,800 pounds per square inch. As a result of these firings, the only ascertainable injury was due to the erosion of the powder gases.

As this was the first gun of this caliber on which the new breech mechanism had been tested, some trouble had been experienced, which led to certain modifications during the trial. In procuring additional forgings for manufacture of 12-inch guns, the Department had incorporated these changes into the breech mechanisms, with the "expectation of obtaining a more perfectly satisfactory action."³⁹

After having fired 275 rounds, the Crozier 10-inch wire-gun was turned over to the Board for Testing Rifled Cannon. By then the bore was too eroded for additional firing. Members of this Board were, however, on the Ordnance Board, under whose supervision the firings had taken place. The former Board, after evaluating the

39. *Ibid.*, pp. 29-31. Among the modifications effected were: (a) replacing the steel cups in front and rear of the gas-check pad with split rings; (b) replacing the pinions of the rotating gearing with shrouded gears; (c) strengthening and modifying the tray latch-spring bolt; and (d) modifying the translating stud, and adding a bolt for locking the block to the tray when it is opened.

records, concluded that the gun was suitable to be put into government service.⁴⁰

b) Gun and Mortar Production

Chief of Ordnance Flagler informed Congress that by June 30, 1896, there had been manufactured at the Army Gun Factory:

<u>Year</u>	<u>8-inch rifles</u>	<u>10-inch rifles</u>	<u>12-inch rifles</u>	<u>12-inch mortars</u>
1890	1	1	0	0
1891	0	0	1	7
1892	12	0	0	18
1893	0	18	5	48
1894	12	5	3	4
1895	5	8	3	3
1896	<u>10</u>	<u>9</u>	<u>9</u>	<u>0</u>
Total	40	41	21	80

In addition to these, the West Point Foundry Co. had finished and assembled eleven 8-inch rifles. Bethlehem Iron Co., under its 100-gun contract of November 7, 1891, had completed, as of June 30, 1896, ten 8-inch and fifteen 10-inch guns.

Under provisions of the Fortifications Act of June 6, 1896, a contract for purchase of twenty-one additional sets of forgings for 10-inch guns was awarded by the Department to Bethlehem, and one for twenty-one sets of forgings for 12-inch rifles to Midvale Steel.

At its 2d Session, the 54th Congress had also appropriated funds for a 16-inch rifle. Forgings for this piece would be

40. Ibid., p. 30. The Crozier had been designed for a pressure of 42,000 pounds per square inch and a muzzle velocity of 2,100 feet per second, with from 260 to 290 pounds of Brown prismatic powder and a 575-pound projectile. Of the 275 rounds fired, 20 gave pressures below 35,000 pounds per square inch, 14 between 35,000 and 40,000 pounds, 231 between 40,000 and 45,000 pounds, and 10 more than 45,000 pounds.

provided by Bethlehem, while it would be completed and assembled at the Army Gun Factory.⁴¹

During the late summer, the artillery, for the first time, had held practice with the new armament, including 8-, 10-, and 12-inch rifles, mounted on barbette, gun-lift, or disappearing carriages, emplaced in the new Endicott batteries.

Utilizing monies appropriated by the Act of June 6, 1896, the Department had contracted for sixty-six additional 12-inch steel breech-loading mortars. Part of the forgings would be finished and assembled by Builders Iron Foundry and the remainder at the Army Gun Factory. A contract for thirty finished mortars was awarded to Bethlehem.

Upon completion of these, the Department would have 144 12-inch mortars for issue, of which one-half would be steel and the remainder cast-iron, steel hooped. In addition, one cast-iron mortar had been sent to the Benicia Arsenal for proof of mortar powder and one steel mortar to the U. S. Military Academy for instruction of the cadets.⁴²

c) Contract for and Improvements to Carriages

Chief of Ordnance Flagler, in accordance with the Act of June 6, 1896, placed contracts for 10-inch disappearing carriages with:

Bethlehem Iron Co.	12
Southwark Foundry and Machine Co.	10
Niles Tool Works Co.	8

41. Ibid., p. 32. The Endicott Board, in its report, had called for emplacement of forty-four 16-inch guns as part of the nation's coastal defenses. Until 1896 Congress had failed to fund the project. Chief of Ordnance Flagler believed that Congress had heretofore been influenced by those who professed to believe that 12-inch guns were sufficient for "our needs." But, as he had pointed out, several European powers already had guns of 16-inch caliber, or larger, in their navies or coast defense. Executive Documents, Serial 3378, pp. 34-36.

42. Executive Documents, Serial 3485, pp. 32-33.

Orders were also given to Watertown Arsenal for manufacture of five 8-inch, five 10-inch, and four 12-inch disappearing carriages; for several 12-inch barbette carriages; and for alteration of three gun-lift carriages to barbette carriages. Funds appropriated to date, General Flagler informed Congress, were sufficient to provide:

12-inch:	
Disappearing C.P.	1
Disappearing F.P.	14
Barbette	11
Gun-lift	2
Casemate	1
10-inch:	
Disappearing C.P.	1
Disappearing F.P.	64
Barbette	5
8-inch:	
Disappearing F.P.	10
Barbette	8

Several modifications of the Buffington-Crozier disappearing carriage, Model 1894, had been introduced into those now under construction, designated Model 1896. These changes were made with a view to increasing the facility and the rapidity of maneuvering. They included: (a) live chassis rollers for axle rollers; (b) a single turntable for a forward turntable and rear traverse circle; (c) gun iron for cast steel in the chassis rails; and (d) a chain and sprocket retraction gear for the rope and tackle.

At a shot trial of one of the Model 1894 carriages, fitted with live chassis rollers, the saving in counterweight was found to be about 7,000 pounds, and the effort required to haul the piece down by about one-half. It was anticipated that mounting the carriage upon a single turntable would reduce by one-half the time required for traversing, besides affording an increased field of fire.⁴³

43. Ibid., pp. 33-34.

Contracts had been let, under authority of the Act of June 6, 1896, for construction of fifty-seven 12-inch spring-return mortar carriages of the Gordon type by Robert Poole & Son and for ten by Southwark Foundry & Machine Co.⁴⁴

d) Proofing and Shipping Guns, Mortars, and Carriages

There had been tested, proved, and shipped from Sandy Hook for installation in the seacoast fortifications: one 10-inch breech-loading rifle to Fort Hamilton, New York Harbor; one 8-inch disappearing carriage and five 8-inch breech-loading rifles to Fort Wadsworth, New York Harbor; two 10-inch breech-loading rifles to Willetts Point, New York Harbor; two 10-inch breech-loading rifles and one 10-inch disappearing carriage to Fort Winfield Scott, California; and six 12-inch mortars and seven 12-inch spring-return mortar carriages to Sullivan's Island, South Carolina.⁴⁵

e) Tragedy Strikes Again

On September 28, 1896, seven months after the accident that took Lieutenant Peck's life, tragedy struck again. 1st Lt. George Montgomery and a gun crew were manning a Canet rapid-fire gun. A metallic cartridge prematurely exploded, killing Cpl. Robert Doyle and Pvt. 1st Class Frank Conway, and wounding Lieutenant Montgomery, Pvts. 1st Class William McDonald and Patrick Ryan, and Pvt. 2d Class James Coyne. The remains of Doyle and Conway were shipped respectively to Philadelphia and Troy, New York, where they were turned over to relatives for burial.⁴⁶

C. Improving and Expanding the Facilities: 1891-96

I. Fiscal Year 1891 Ushers in a New Era

As an independent and vital cog in the rush to provide the United States with a modern system of coast defenses and weaponry,

44. Ibid., p. 34.

45. Ibid., p. 154.

46. Returns from U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

the Proving Ground's facilities were expanded and improved. In Fiscal Year 1891, the year that it became a separate post, some improvements were made in the physical arrangements of the proof battery and firing facilities. These consisted of several new concrete gun platforms, which would be fitted with heavy cast-iron bed plates, similar in principle to the face plate of a lathe, to permit mounting thereon "a considerable variety of gun carriages." New machinery, costing \$4,000, had been installed in the machine shop.⁴⁷

2. Improvements to the Grounds in Fiscal Year 1892

The twelve months beginning July 1, 1891, saw a number of improvements and additions to the grounds. These reflected the increasing tempo of the modernization program fostered by the need to provide armament for the fortifications called for by the Endicott Board. Ground was broken in 1891 for reinforced concrete batteries of the Endicott system at Boston, New York, Washington, and San Francisco. With construction funds available, the Ordnance Department allotted a considerable sum for expenditure at Sandy Hook.

a) The 80-Ton Gantry Crane

On June 8, 1891, proposals were invited for supplying a gantry crane of 80-ton capacity, mounted on a traveling platform. Both crane and platform were to be operated by hand and to be employed in mounting and dismounting guns. A satisfactory bid was received from Maxwell, Manning & Moore.⁴⁸

The crane, designed and built by Shaw Electric Crane Co. of Muskegon, Michigan, was positioned by Maxwell, Manning & Moore workmen in Fiscal Year 1892. According to Captain Heath, the crane "worked well" and expedited the Proving Ground's mission.⁴⁹

47. Executive Documents, Serial 2928, p. 20.

48. Ibid.

49. Executive Documents, Serial 3083, pp. 8-9. A photograph of the "Gantry Crane: Carrying 12-inch B.L. Rifle and Proof Carriage, Complete, Sandy Hook Proving Ground," and a drawing of the subject crane are found in Serial 3083, Appendix 29, figures 4 and 5.

b) Two-Story Frame Office

To replace the Instrument House, destroyed by the 1889 fire, a two-story frame office building (52' 10" x 44' 6") was erected. On the first floor was a spacious instrument room, rooms for clerks and draftsmen, and offices for the proof and assistant proof officers. The second story had a battery and battery storeroom, photograph room, office for the Ordnance Board, and three sleeping rooms for clerks and draftsmen.

Because of the problem caused by shock waves sent out when the big guns were fired, no plaster was used. All walls and ceiling were constructed with North Carolina yellow pine, tongued, grooved, and beaded. The floors were of the same material. To guard against fire, an automatic-sprinkler system was installed.

The instrument room was equipped with four Boulenge chronographs, as modified by Berger; a drop chronograph; a Seibert velocimeter; a Western Union switchboard; detector, tangent, and universal galvanometers; a mercurial densimeter; weighing scales; star gauge; and a set of gauges for determining the pressure of powder in guns. The four chronographs were connected with the runways at the firing batteries, so that by employing two instruments for each gun, simultaneous velocities could be obtained from two guns of the main proof battery, or from one gun at the main battery and one gun at the siege battery, as desired. For velocity, signal, telephone, anemometer, and other purposes, two wires led into the building. Those from the main proof battery were No. 10 phosphor-bronze wire, strung on poles. The runways of the siege battery were connected with the switchboard by a standard cable laid underground. The building was heated by water, employing indirect radiation on the first floor and direct radiation on the second.⁵⁰ The new office was 200 yards north of the Officer's Quarters and about the same distance west of the right flank of the proof battery.

50. Ibid., pp. 422-23. The office was designed by R.M. Hunt, a New York City architect. Exterior and interior plans of the office building are found in Serial 3083, Appendix 29, Plates I and II.

c) Ordnance Detachment Barracks

The new barracks built for the Ordnance Detachment was a "substantial frame structure, rectangular in shape, measuring 52 x 134 feet, the front being broken by a tower and veranda." It had a mess capacity for fifty and sleeping accommodations for eighty. On the first floor were the kitchen, dining hall, wash and bathrooms, reading room, dispensary, office, and quarters for three married soldiers. The second floor was divided into six squad rooms. Water was supplied by a tank placed in the attic. The tank was filled from a well by a Rider hot-air pump.⁵¹

d) Frame Ammunition Shed

A frame ammunition shed, built at a cost of \$1,000, was erected on the parade of the masonry fort. Here shells were loaded with powder or high explosives.⁵²

e) Platform and Butts for Field Guns

A substantial platform for field guns with two firing butts was built. It was protected by a wooden covering, fifty feet long by twenty feet wide, and with its loading shed and other "appliances" constituted a complete proof battery, at which experiments with field guns could be conducted independently and simultaneously with those at the principal proof battery.⁵³

51. Ibid., pp. 423-24. The barracks were designed by Lt. C.B. Wheeler of the Ordnance Department. Both it and the office were built by a contractor named Larkins. Plans of the barracks are found in Serial 3083, Appendix 29, Plate III. The barracks were about midway between the Officers' Quarters and the wharf.

52. Ibid., p. 422; "History of Sandy Hook Proving Ground," Records of the Office, Chief of Ordnance, NA, RG 156.

53. Executive Documents, Serial 3083, pp. 425-26. The field guns' platform was about midway between the Officers' Quarters and the Proof Battery.

f) Improvements to the Principal Proof Battery

A number of butts were remodeled and enlarged, and new and substantial platforms for several guns and carriages laid. These were arranged so as to be conveniently reached by the gantry crane. A hoisting engine and steam shovel, recently purchased, greatly expedited this work.

The gun platforms of the principal proof battery at this time mounted on position: No. 1 a 10-inch disappearing carriage, Gordon type; No. 2 a 10-inch carriage altered for 8-inch breech-loading rifle and for 12-inch breech-loading mortar; No. 3 vacant; No. 4 8-inch proof carriage; No. 5 10-inch proof carriage; No. 6 12-inch proof carriage; Nos. 7 and 8 faceplates; Nos. 9 and 11 vacant; No. 12 the Easton & Anderson 12-inch mortar carriage; and No. 13 vacant. To the left of the principal battery were the emplacements where Captain Heath proposed to test rapid-fire guns, while in position No. 10, on the parapet of the masonry fort, was mounted the pneumatic depressing carriage for a 10-inch rifle.⁵⁴

3. Ordnance Department Expands Its Railroad

a) War Department Acquires a Railroad

Experimental and test firings, along with other projects assigned to the Proving Ground, had escalated in Fiscal Year 1893. This led the 2d Session, 52d Congress, to appropriate \$26,676 for purchase of the tracks and fixtures belonging to the New Jersey Southern Railroad on the reservation, and for acquisition of a strip of land, about one and one-half miles in length, and the tracks thereon which connected the reservation right-of-way with the operating trackage of the Central Railroad.⁵⁵ On March 24, 1893, the War Department employed this money to purchase about six miles of railroad track, along with the sidings, frogs, and switches, on the Hook from the Central Railroad.⁵⁶

54. Ibid., pp. 8-9, 447.

55. Executive Documents, Serial 3083, pp. 8-9.

56. Executive Documents, Serial 3205, pp. 11, 383.

Following acquisition of the railroad, it was necessary to connect it with the extant tracks near the proof batteries to facilitate its use. It was also necessary to change the gauge of the latter from narrow to standard, alter its location, and change the curves to conform to the newly acquired trackage.

The Ordnance Department's railroad was connected with the new government railroad by a Y near Camp Low. This enabled a car with a gun or other heavy equipment to be received by the Ordnance Department from the Central Railroad at Highland Beach and turned in the direction required for convenient handling at the battery. From the Y the new right-of-way veered east toward the 3,000-yard target, then paralleled the beach to the proof battery, which it entered via the gantry crane runway. Through this arrangement, the crane was positioned above a flat car. It could then hook onto and lift up a gun or other piece of heavy equipment, and within a few minutes deposit it at any point in the battery. A switch enabled the train to continue onto the wharf and to the rear of the battery. Another switch sent the train along the rear of the old fort's scarp and up to and through a large frame shed built in Fiscal Year 1893 for storage of 12-inch mortar carriages. A turntable allowed access to the machine shop, and another at the wharf permitted cars to be spotted directly under a 15-ton crane.⁵⁷

Use of the new rail connection resulted in "a great economy in transportation of heavy weights" to and from the Proving Ground. Cost of transporting a 12-inch gun from the Watervliet Gun Factory was reduced from \$1,600 to \$275, of a 10-inch gun from \$450 to \$150, and that of other shipments in a similar ratio. Guns, carriages, and other heavy items were constantly being received over the government railroad, and the depot quartermaster at New York City told

57. Executive Documents, Serial 3302, pp. 173-74; "History of Sandy Hook Proving Ground," Records of the Office, Chief of Ordnance, NA, RG 156. Lieutenant Wheeler was in charge of this work.

Capt. Everard E. Hatch it would save the United States at least \$25,000 in transportation costs during the first fiscal year of its operation.⁵⁸

b) Captain Hatch Builds a Trestle

To improve service over the railroad, measures would have to be taken for protection of the 1,500 feet of track which passed over the narrow neck connecting Sandy Hook and the mainland. During the winter and early spring of 1894, a series of violent storms sent the surf raging across the neck, tearing up tracks and covering them with sand and debris. Several times after the government railroad was opened for traffic and once as late as May 21, 1894, this section of track was closed. Besides the inconvenience caused, the cost of keeping the right-of-way open was considerable.

Captain Hatch suggested an answer. He urged that either a heavy bulkhead filled with stone and of sufficient height to prevent waves from sweeping over it be constructed along the beach parallel to the tracks, or that the road-bed be raised five or six feet by a trestle, which would allow the sea tide to pass beneath. He favored the latter alternative as it would cost considerably less.⁵⁹

The Quartermaster Department, in Fiscal Year 1895, built a single-track timber-trestle to carry the railroad over the neck. The trestle's road-bed was five feet above the sand, and thus well out of danger of being obstructed even during the worst nor'easter. Built of Southern pine, the trestle rested on white oak piles, driven at least eight feet into the clay, which underlay the sand at a depth of twelve to fifteen feet.

Captain Hatch and his officers were delighted with the trestle, and forecast that henceforth there would be no trouble from

58. Ibid., p. 174.

59. Ibid.

washouts in this area. They were present and took photographs when the first locomotive crossed the trestle pulling cars on which were positioned the first 12-inch rifle received for proof from the Watervliet Arsenal.⁶⁰

c) Captain Heath Buys a Baldwin Locomotive

Utilizing a \$3,500 appropriation, Captain Heath purchased from Baldwin Locomotive Works of Philadelphia, a four-wheel saddle-tank locomotive fitted with steam brakes and headlight. It was of standard gauge and burned Pennsylvania anthracite. The locomotive weighed about 28,000 pounds and had a hauling capacity on the level of 760 tons. After its arrival on the reservation, in Fiscal Year 1894, the locomotive was in constant use.⁶¹

4. New Construction and Facilities: Fiscal Years 1893-94

a) Improvements to the Wharf

By Fiscal Year 1893 the "outer extremity" of the Engineer's Wharf had "so deteriorated by use and long exposure" as to become dangerous. Plans and specifications for rebuilding this ninety-five- by thirty-three-foot section of the wharf were prepared by Lieutenant Wheeler of the Ordnance Department. The work, costing about \$5,500, was contracted to Henry DuBois & Sons of New York City.

The approach to what was now designated the Ordnance Department Wharf was strengthened by DuBois & Sons workmen for a distance of 380 feet to safely transport weights up to and including 12-inch guns. Heretofore, it had been necessary, when landing 10- and 12-inch guns, to beach the barge at low tide, and haul them ashore by means of cradles, rollers, and a capstan. To reinforce the approach, all caps and other timbers showing signs of weakness were replaced. Bents were positioned between the existing piers of the approach, reducing the

60. Executive Documents, Serial 3378, pp. 174-75.

61. Executive Documents, Serial 3302, p. 174.

space between the supports. Now when big guns were brought to Sandy Hook by barge, they were placed on cars spotted on the wharf and hauled directly to the firing battery.⁶²

b) New Carpenter Shop Machinery

During the year the capacity of the carpenter shop was boosted by the purchase and installation of certain sophisticated wood-working machinery: a Berry & Orton band saw; a wood-turning lathe; one mortiser and borer, with five chisels and five bits; a saw table; and one Ajax wood-boring machine.⁶³

c) New Engine and Boiler

An increased demand for power compounded the problem caused by the inefficient and overaged engine and boiler. Utilizing \$2,000 appropriated by the 52d Congress, the Department purchased a twenty-five-horsepower engine and a forty-horsepower boiler. Putnam Machine Co. of Fitchburg, Massachusetts, supplied the engine and Messrs. H. N. Bates & Co. the horizontal tubular boiler.⁶⁴

d) Constructing New Butts and Platforms

To facilitate the greatly increased experimental and test firings, the butts were redesigned. The new butts were built with an opening, ten by seven feet, and were roofed for a distance of six feet back from the main revetment. Into this opening the projectiles were fired, and it was expected that the natural fall of the sand would be sufficient to stop them. Trials, however, demonstrated that with this slope of sand, the projectiles were deflected upwards, and that an undue height of butt would be required to properly stop them. The opening was accordingly revetted with three-inch boards and filled with sand,

62. Executive Documents, Serial 3205, pp. 11, 382-83. Wheeler's plans are found on Plate II.

63. Ibid., p. 382.

64. Ibid. The cylinder of the Putnam automatic steam engine was 9 inches in diameter with a 21-inch stroke.

which caused the projectile to pass much farther into the sand than heretofore. As finally constructed, the butts "answered every purpose, and for the conditions existing at this place can scarcely be improved." Previously, the revetment had been so quickly torn away that the butts had to be "practically" renewed after a few rounds.⁶⁵

Two large butts, capable of stopping projectiles from the heaviest caliber guns, had been built, the gantry runway improved, and the ground in the vicinity cleared. Platforms for 8- and 10-inch Buffington-Crozier disappearing carriages, a 4.7-inch Armstrong rapid-fire gun and carriage, and a platform for Brown's segmental wire gun had been built.⁶⁶

Heavy concrete platforms were built in Fiscal Year 1894 for the Grusonwerk minimum port carriage for 12-inch breech-loading rifles and a second Gordon disappearing carriage for 10-inch breech-loading rifles. Two platform plates were positioned on which could be tested barbette carriages for 8-, 10-, and 12-inch rifles; Buffington-Crozier disappearing carriages for 8- and 10-inch rifles; 4.7-inch Armstrong rapid-fire guns and carriages; and carriages for 12-inch mortars.⁶⁷

e) Building an Explosive Test Chamber

For use in connection with tests of high explosives, when it was desirable to collect fragments resulting from the bursting of shells, a large and very strong chamber was built. It was similar, though adapted to heavier work, to the one in use by the Navy at its Indian Head, Maryland, Proving Ground.

65. Ibid., pp. 381-82. A plan of the subject butt is found in Serial 3206, Plate I.

66. Ibid., p. 381.

67. Executive Documents, Serial 3302, p. 173.

The chamber was of sheets of mild steel, built-up of double plates, each one-inch thick. Interior sheets varied in width from thirty-six to twenty-four inches, and were laid vertically; the outside sheets were twelve inches wide, laid horizontally, with joint crossings at right angles. The steel lining was backed on all sides by twelve-inch yellow pine timbers, secured to the lining by through bolts.

The chamber had a capacity of 1,000 cubic feet, and was vented by an open entrance 10 feet high and 1-1/2 feet wide, and two rectangular vents constructed on the deck of the chamber, each 6 feet long, 10 feet deep, and 12 inches wide. The deck vents were formed of 1/2-inch steel plate, each side composed of a single plate secured to the 12-inch channel upright, and fastened to the deck by heavy 12-inch channel beams bolted securely to the inside linings. The vents were stayed together by wrought-iron stays. A 3-inch wrought-iron pipe passed up through the stays and was secured to the lining at the lower end; through this pipe, the battery wires passed for securing the electric connection by which the charge was fired.

The chamber was entered by a zigzag passageway, lined for 4 feet at the end next to the chamber by a continuation of the interior plating; the remainder being built-up 12-inch yellow pine timbers, laid horizontally, and firmly bolted to the steel lining and secured top and bottom with binding plates and through 1-1/2-inch bolts. The mouths of the deck vents were protected by channel-iron deflecting plates secured to a continuation of the upright by angle irons and bolts, making them easily removable if destroyed. The chamber was buried to a height of 9 feet from its deck, so that the surface of the ground was level with the mouths of the deck vents. The chamber, when in use, was lined with rough 3-inch spruce boards. These acted as buffers for the fragments of the exploded shell, and prevented scoring and indentation of the steel lining which would otherwise occur.⁶⁸

68. Ibid., p. 175.

f) Positioning a Searchlight

A powerful searchlight was positioned at the Proving Ground in Fiscal Year 1894 for testing its practical use as an "auxiliary in seacoast defense." The plant consisted of one searchlight with parabolic sixty-inch glass mirror, equipped with a horizontal and vertical motion. A metal shutter enabled the light to be employed for signaling.

The light was mounted on a tower positioned on the southeast bastion of the old masonry fort. The tower was constructed on the square plan, 25 feet at the base and 12 feet at the top. It was made in four sections or floors, the legs in each section being of yellow pine, 10 x 10s, each timber terminating in a cast iron socket on each floor. The tower was anchored to the fort's scarp by 1-1/2-inch iron bolts. It was provided with a stairway, giving easy access to the top level of the platform, which was built of 3-inch planking, securely fastened to the floor beams and provided with a hatchway. Beneath the floor was a box for the signal shutter and dispensing lens.

A plane-table-house had been built in the first bay, and so located as to clear ties, struts, etc., on three sides, and give the observer a "perfect view" over a considerable range.

A twenty-horsepower steam engine arranged for direct coupling with a dynamo of 160 amperes and 70 volts, the whole being capable of producing an intensity of light equal to 200,000-candlepower, was acquired. The steam engine and dynamo were positioned near the machine shop boiler.⁶⁹

g) Construction of Two Sheds, a Tool House, and Foreman's Quarters

Four frame buildings were erected on the Proving Ground during Fiscal Year 1894. They were: (a) a single-story field gun shed; (b) a single-story breech-block shed; (c) a single-story tool

69. Ibid., pp. 175-76.

house; and (d) a two-story foreman's quarters. The first three of these structures were near the proof battery, while the quarters were about midway between the Officers' Quarters and the Engineer's wharf.⁷⁰

5. New Construction, Maintenance, and Repairs: Fiscal Years 1895-96

a) Improvements to the Machine Shop

With the increased workload, there were "constant" demands for "first-class machine shop work in connection with repairs and alterations of experimental guns and carriages as required during their test." In Fiscal Year 1895 the machine shop was enlarged and improved by removal of the foreman's office to a more convenient location and the addition of a storage room for tools. The shop was ceiled, and the "cumbersome stove" replaced by a steam heating system.

Prompt and economical repairs and alterations were facilitated by the purchase and installation in the new shop space of an engine lathe, twenty-inch swing; a Brickford's No. 2 radical drill; an emery grinder, with countershaft; and a forty-two-horsepower engine.⁷¹

In Fiscal Year 1896 the machine shop was improved by purchase and installation of a Niles planer (thirty-two x thirty-three inches) capable of planing work ten feet in length; a 14-inch stroke Niles slotter, to slot to center of 60 inches; one Brown & Sharp No. 4 universal milling machine, with change gear, index plates, and tables; one Fitchburg engine lathe, sixteen-inch swing over ways, with eight-foot-long bed; and one Pond new pattern forty-two-inch triple-gear engine lathe, with bed twenty-six feet long, to turn seven feet from center.⁷²

70. "History of Sandy Hook Proving Ground," Records of the Office, Chief of Ordnance, NA, RG 156.

71. Executive Documents, Serial 3378, p. 171.

72. Executive Documents, Serial 3485, pp. 16-17, 153.

b) Hoist for Use at the Butts

Arrangements for overhauling the sand butts for recovering fired projectiles were improved. Previously, a Lancaster grapple, suspended from a derrick, operated by a steam hoisting engine, had been employed. The boiler and a portion of the engine had been damaged by fragments of a shell fired from a 12-inch mortar. To escape the expense of purchasing a new boiler, Proving Ground machinists utilized the electric plant which had been erected for use with the 10-inch Gordon disappearing carriage. Its large 10-horsepower motor was substituted for the boiler and connected to the hoisting engine, which was slightly altered for the purpose. This resulted in a light, compact hoisting apparatus which was easily moved to or from the butts as required. It was wired to the machine shop dynamo, the engine of which was supplied with steam direct from the main boiler, thus eliminating hauling of fuel and water to the butts as heretofore required.⁷³

c) Repairs to the Wharf

By Fiscal Year 1896 the immediate approach to the main wharf had become "so deteriorated by use and long exposure as to become . . . unserviceable." This approach, 224 feet long by 30 feet, 6 inches in width, was supported on stone-filled cribs. A study demonstrated to Captain Heath and the Quartermaster General that to rebuild the cribs would be too expensive. It was accordingly determined to remove the cribs and stones until their level was about 6 inches below ebb tide. The approach would then be reconstructed, employing piles instead of cribs.

John N. Kelly of 83 Elizabeth Street, Brooklyn, was awarded the contract for this project with a bid of \$4,370. Despite many unexpected difficulties resulting from large quantities of stone remaining

73. Executive Documents, Serial 3378, pp. 171-72.

on-site, Kelly fulfilled the terms of his contract in a creditable and satisfactory manner.⁷⁴

d) Construction of a Photograph House, Fire Station, and Locomotive Shed

Three one-story frame structures were added to the Proving Ground in 1895. Two of these, each erected at a cost of \$500, were a photograph house and a fire engine station. A locomotive shed cost \$1,000.⁷⁵

6. Two Years on the Government Railroad

In Fiscal Year 1895, there was heavy traffic over the government railroad. During the twelve months there was received at the Proving Ground 6,890,612 pounds of military hardware and supplies, ranging from five 12-inch rifles from Watervliet Arsenal to 299,320 pounds of anthracite coal from Cattaraugus, Pennsylvania. The 1,984,139 pounds of war materiel shipped included everything from twelve 12-inch mortars to San Francisco to 4,919 pounds of bronze fittings for the Rock Island Arsenal.

The number of cars loaded with U. S. property, on which the government paid transportation charges entering and leaving the reservation in Fiscal Year 1895, was 216. There were also seventy-three cars loaded with U. S. property upon which contractors (Morgan Engineering Co., the U. S. Life-Saving Service, Pneumatic Gun Co., Ordnance Department, I. J. Hathaway & Co., I. P. Morris Company, and E. I. DuPont Co.) had paid the transportation charges.⁷⁶

74. Executive Documents, Serial 3485, pp. 153-54.

75. "History of Sandy Hook Proving Ground," Records of the Office, Chief of Ordnance, NA, RG 156.

76. Executive Documents, Serial 3378, pp. 173-75.

In Fiscal Year 1896 the railroad was improved by removal and replacement of old and wornout ties and rails. The roadbed, connecting the proof battery with the line purchased from the Central Railroad, was ballasted, employing stone taken from the old wharf and cribs and eighty carloads of furnace slag. The latter proved to be an excellent ballast on sand.⁷⁷

Traffic over the U. S. Ordnance Railroad was not as heavy as in the previous year. The weight of materials received was 6,594,527 pounds and of those shipped 656,000. The number of cars on which the government paid transportation, entering and leaving the reservation in Fiscal Year 1896, was 77, while the number of cars loaded with United States property upon which contractors paid shipping charges was 168.⁷⁸

D. Major Heath's Final Years at the Proving Ground

1. Guns and Mortars Proved and Shipped in Fiscal Year 1897

In Fiscal Year 1897 large numbers of mortars, guns, and carriages were received at Sandy Hook, and were proved and shipped to various seacoast defenses. Included were:

two 8-inch breech-loading rifles,
twenty-eight 10-inch breech-loading rifles,
six 12-inch breech-loading rifles,
six 12-inch breech-loading mortars,
six 10-inch disappearing carriages,
one 12-inch barbette carriage,
one 12-inch gun-lift carriage, and
six 12-inch breech-loading mortar carriages.⁷⁹

77. Executive Documents, Serial 3485, p. 154.

78. Ibid.

79. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 55th Congress, 1897-98 (Washington, 1897), Serial 3637, IX, 21.

2. The Spanish-American War and Its Repercussions

a) Guns, Mortars, and Carriages Proved and Shipped

During the twelve months ending June 30, 1898, the nation's gun factories increased production. The long-simmering dispute with Spain over Cuba exploded into war in April. With war clouds gathering, top priority was given to arming the Endicott batteries, a number of which had been completed in recent months. Fiscal Year 1898 was accordingly a busy one at the Proving Ground. Received, proved, and forwarded to the seacoast defenses were:

two 8-inch breech-loading rifles,
twenty-eight 10-inch breech-loading rifles,
six 12-inch breech-loading rifles,
six 12-inch breech-loading mortars,
six 10-inch disappearing carriages,
one 12-inch barbette carriage,
one 12-inch gun-lift carriage, and
six 12-inch breech-loading mortar carriages.⁸⁰

b) Proving Ground Machinists go to the Field

In addition to the routine work done in the machine shop, Proving Ground machinists were detailed to various coastal defenses to: adjust the service-telescopic sights for newly positioned guns and carriages; alter throttling bars and counter-recoil buffers; and make the minor adjustments and repairs found necessary to place the heavy ordnance in "perfect working order."

This work took the machinists to Endicott batteries at Fort St. Philip, Louisiana; Fort Pickens, Florida; Fort Pulaski, Georgia; Fort Moultrie, South Carolina; Fort Monroe and Sheridans Point, Virginia; Fort Washington, Maryland; Fort Mott, New Jersey; the works guarding the approaches to New York Harbor; Fort Adams, Rhode Island; and Fort Preble and Long Island Head, Maine.⁸¹

80. Executive Documents, Serial 3637, p. 21.

81. Ibid., pp. 39, 127.

c) Modifying the Dynamite Battery

The three-gun dynamite battery positioned at Sandy Hook in 1891 was overhauled by a team of Proving Ground technicians under Captain Heath's supervision. Four lofty smokestacks, projecting 40 feet above the battery and deemed to be dangerously exposed to fire of rapid-fire guns of the Spanish fleet in case of attack, were removed. Necessary draft for the boilers that furnished power to operate the battery was now provided by two steel-plate steam fans, with bottom horizontal discharge, driven by a 4- by 6-foot vertical steam engine. These blowers were manufactured by B. F. Sturtevant of Boston, Massachusetts. Thirty-two dummy projectiles were purchased and held for use in determining accurate range tables for the battery.⁸²

d) Another Accident

On January 29, 1898, a 5-inch rapid-fire gun burst at noon, wounding an employee of the Postal Telegraph Company.⁸³

e) Ordnance Detachment Goes to War

In the weeks following destruction of the battleship Maine on February 15, 1898, in La Habana harbor, the nation prepared for conflict as the diplomats groped for a solution to the crisis, and the "yellow press" called for war. Captain Heath and his officers, knowing that the Sandy Hook fortifications would play a key role in defense of New York Harbor against an attack by the Spanish fleet, contacted Chief of Ordnance Flagler on March 28. In event of hostilities, Heath and his command desired authority to report to the commanding officer at Fort Hancock "for the purpose of manning and serving one of the batteries at that post."⁸⁴

82. Ibid.

83. Returns from U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

84. Heath to Flagler, Mar. 28, 1898, found in Executive Documents, Serial 3752, p. 130.

General Flagler replied on April 14. He was agreeable to Captain Heath's proposal, provided the services of the detachment were not needed for ordnance purposes.⁸⁵

The United States declared war against Spain on April 25. Two days earlier, on the 23d, Lt. Col. Tully McCrea, the commanding officer at Fort Hancock, contacted Captain Heath. "Owing to the inadequate number of artillerymen at the post to man the guns," he was gratefully accepting Heath's offer. Ten-inch Battery No. 2 was assigned to the Ordnance Detachment. It would be cared for and kept ready for immediate action by Captain Heath and his officers and men.⁸⁶

Although the Ordnance Detachment saw no action, the brief victorious war with its expansion of the Army secured a promotion for Captain Heath. After eighteen years in grade, he was advanced to major on July 7, 1898. The next day the strength of the Ordnance Detachment was increased from sixty-two to seventy-one.⁸⁷

3. Fiscal Year 1899 Program

a) Tests and Proofs

In these twelve months tests of projectiles of various "grades and calibers," for acceptance under contract, were greater than in any previous year. They covered 352 lots of shrapnel for field and siege guns, and 128 lots of steel shot and shell for siege and seacoast cannon.⁸⁸

85. Flagler to Heath, Apr. 14, 1898, found in Executive Documents, Serial 3752, p. 131.

86. McCrea to Heath, Apr. 23, 1898, found in Executive Documents, Serial 3752, p. 131.

87. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

88. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 56th Congress, 1899-1900 (Washington, 1899), Serial 3911, XIV, 229. A breakdown of the lots showed: shrapnel--7 lots 3-inch, 217 lots 3.2-inch, 69 lots 3.6-inch,

During the year there had been proofed and issued to the seacoast fortifications from Sandy Hook: fifty-six 8-, 10-, and 12-inch breech-loading rifles and sixty-six 12-inch breech-loading mortars.⁸⁹

b) Machinists and Laborers Keep Busy

Setting up plates for tests, building and repair of backing, recovering projectiles from sand butts, etc., kept a large force occupied. The machinists again spent much time in travel status, adjusting telescopic sights for guns mounted in fortifications, superintending assembly of disappearing carriages, altering throttling bars and counter-recoil buffers, and making minor adjustments and repairs necessary to place the guns and carriages mounted in the Endicott batteries in serviceable condition.⁹⁰

c) Repairs and Improvements to the Dynamite Battery

The Ordnance Detachment was called upon for assistance in maintenance of the Fort Hancock dynamite battery. Because of the complexity of the machinery, and the numerous pipes, valves, pumps, boilers, etc., continuous service by a skilled mechanic was required to keep the battery in "passable condition." An addition had been made to the plant of a condenser, as the battery commander had

88. (Cont.) 21 lots 5-inch, and 38 lots 7-inch; shell--4 lots 5-inch cannon, 16 lots 5-inch armor piercing, 2 lots 5-inch armor-piercing shot, 24 lots 7-inch howitzer, and 11 lots 7-inch common mortar; armor-piercing shell--4 lots 8-inch, 8 lots 10-inch, and 2 lots 12-inch; armor-piercing shot--9 lots 8-inch, 5 lots 10-inch, and 5 lots 12-inch; 28 lots 12-inch deck-piercing shell; and 9 lots 12-inch torpedo shell.

89. Ibid.

90. Ibid., pp. 41-2, 229-30. This work took them to Fort Monroe and Sheridans and Wards Point, Virginia; Forts Wadsworth, Hamilton, Slocum and Schuyler, and Willetts Point, New York; Forts Hancock and Mott, New Jersey; Fort Adams, Rhode Island; Fort Clark, Massachusetts; Battery Point, Delaware; Fort Caswell, North Carolina; Fort St. Philip, Louisiana; Fort Washington and North and Hawkins Points, Maryland; Fort Pulaski, Georgia; and Forts Sumter and Moultrie, South Carolina.

complained that the passage of steam into the air would pinpoint its location to an attacking naval squadron. This improvement involved utilization in the boilers of pure water resulting from the condensation. The resulting vacuum also increased the power of the plant. The condensing system was furnished by Henry R. Worthington of New York City.

Major Heath complained that maintenance of the dynamite battery was serious and would continue to "involve the employment . . . of a skilled mechanic and engineer."⁹¹

d) Accidents Inflict More Casualties

There were two accidents at the proof battery in 1899. On March 20 a 10-inch breech-loading rifle burst, killing the recording clerk, Henry Murphy, and wounding Pvts. Charles Diemen and James Harrington. Then, on July 13, a 3-inch Hotchkiss shell exploded, wounding Pvts. O'Neill, Czulgus, and Roberson.⁹²

4. Major Heath's Final Year at the Proving Ground

a) New Direction to Proofs and Tests

By the turn of the century, with the development, manufacture, and emplacement of the big seacoast guns (8-, 10-, and 12-inch) and mortars well in hand, additional emphasis was given to the development, manufacture, and proof of rapid-fire guns and carriages.

91. Ibid., p. 231. The condenser had 1,200 square feet of cooling surface and was mounted directly over a combined air and circulating pump of sufficient capacity to maintain a vacuum of not less than 25 inches. The shell, water-box, and bonnets of the condenser were highgrade cast-iron, well ribbed; the tubes were seamless drawn brass, well trimmed inside and out and well secured to insure their being tight under working pressure, provision having been made for expansion and contraction. Circulating and air pump cylinders were brass-lined. The valves of the circulating pump were of best vulcanized rubber, while those of the air pump were especially adapted to withstand the hot water from condensation. There was a hot well and a filter to dispose of grease in the feed water.

92. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

For example, in the year ending June 30, 1900, there were proved and issued from Sandy Hook:

eight 6-pounder rapid-fire guns,
one 15-pounder rapid-fire gun,
nine 10-inch breech-loading rifles,
twenty-two 12-inch breech-loading rifles, and
fifty-one 12-inch breech-loading mortars.

In addition, twelve 6-pounder rapid-fire guns and fifty-six 15-pounder rapid-fire guns had been subjected to proof, but had not been issued. A large number of tests of armor-piercing shot and shell, representing lots submitted by contractors, had been undertaken along with many tests with smokeless powder.⁹³

b) Experiments Become More Diversified

The experimental work of the Ordnance Department, much of which was connected with projects of the Ordnance and Fortifications Board continued to be conducted at Sandy Hook. During the past twelve months many subjects had been tested. Among these were trials of designs for improved carriages and tests of details of proposed changes in field materials. Experiments included trial of a Vickers-Maxim mountain gun, a Vickers-Maxim field gun mounted on Darmencier carriage, pillar mounts for 5- and 6-inch rapid-fire guns, metallic carriages for machine guns with protective shields, and a number of carriages for the 7-inch mortar and howitzer and for 8-inch, 10-inch, and 12-inch guns. Four models of telescopic sights were tested.

93. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 56th Congress, 1900-01 (Washington, 1900), Serial 4097, XXIII, 26-7, 233. Ballistic tests of service steel projectiles received from contractors involved: shrapnel--one lot 6-pounder, three lots 3-inch, and two lots 3.2-inch; shell--one lot 6-pounder armor-piercing, twelve lots 8-inch armor-piercing, twelve lots 6-inch armor-piercing, eight lots 7-inch howitzer, three lots 8-inch armor-piercing, three lots 10-inch armor-piercing, ten lots 12-inch armor-piercing, fourteen lots 12-inch deck-piercing, and four lots 12-inch torpedo; and shot--three lots 6-inch armor-piercing, two lots 8-inch armor-piercing, two lots 10-inch armor-piercing, and four lots 12-inch armor-piercing.

One subject, requiring much experimentation, had been an attachment to the breech-blocks of guns for using "obturating" primers. After a series of trials, a successful device for this purpose was attained. Detonating fuses of many kinds had been tested for use with high explosives of the "insensitive class." New primers, exploded either by serrated wire or by electricity, had been tried with success.

Experiments had continued upon high explosives for filling shells, including wet gun cotton thorite, jovite No. 2, cerberite, and explosives of the lydite and ammonia nitrate classes. The desired explosive was one which was safe in the gun and storage, but which was certain to detonate on impact. Many which fulfilled the first condition were known, and most explosives ignited by the impact of a shell on a steel target, though the energy of the explosion varied. A compound fulfilling both conditions and free from all other objections was still needed.

A number of experimental tests of minor details had been undertaken. These included: dry batteries for electric firing, oils for the recoil of cylinders of gun carriages, colored field glasses to detect the flash of smokeless powder, details of range finders, and tests of minor parts of breech mechanisms.

During the year tests had been completed, or nearly so, on these guns and carriages:

Sims-Dudley 2.5-inch dynamite gun, carriage, and ammunition;
Vickers-Maxim 75 mm mountain gun, carriage, and equipment;
Seabury 4.72-inch rapid-fire gun; 5-inch single-forging gun,
Gordon rapid-fire breech mechanism; 3-inch built-up field gun;
5-inch single-forging field gun; and five patterns of field
carriage with controlled recoil.⁹⁴

94. Ibid., pp. 26-28.

c) Captain MacNutt Relieves Major Heath

On March 26, 1900, after almost nine years as post commander, Major Heath was relieved. His replacement was Capt. Ira MacNutt.⁹⁵

5. Ordnance Department Continues to Improve and Add to the Facilities

a) Living Conditions in November 1897

In mid-November 1897, Col. R. P. Hughes of the Inspector-General's office spent several days at the Hook. At that time the Ordnance Detachment consisted of:

Capt. Frank Heath,
1st Lt. George Montgomery,
1st Lt. Lawson M. Fuller,
1st Lt. Charles C. Jameson,
7 sergeants,
8 corporals,
36 privates 1st class, and
11 privates.

There was also a hospital steward attached to the station. Colonel Hughes was of the opinion that this was an error and that measures should be taken to assign a medical officer to the Proving Ground. To document his position, Colonel Hughes called attention to the serious accidents that had occurred in conjunction with the proof battery. At present there was no place to take a person injured or felled by

95. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617. Ira MacNutt of Pennsylvania was graduated from the U.S. Military Academy as No. 18 in the Class of 1870. Commissioned a 2d lieutenant in the 3d U.S. Artillery, he pulled duty at a succession of southern and western posts until 1876, when he was ordered to West Point as Assistant Instructor in Infantry Tactics. MacNutt transferred to the Ordnance Department on June 13, 1878. He served as assistant ordnance officer at Rock Island Arsenal from December 1878 until December 1880. After duty as Chief Ordnance Officer, Department of the South, and Assistant at Frankford, Watertown, and Watervliet Arsenals, he, in January 1892, became inspector of ordnance at the Bethlehem Iron Co., where he remained until ordered to Sandy Hook in January 1900. Cullum, Biographical Register, III, 150.

sickness except to send him to his bunk. There was currently a man stricken with erysipelas but fortunately the victim occupied quarters outside the barracks. The man was being treated by a civilian physician, who visited the post twice a week. It would, Colonel Hughes wrote, "be a wise precaution if one of our medical officers made a careful examination of the situation and saw to it that all precautions were taken to prevent any further spreading of the disease."⁹⁶

The reservation, Colonel Hughes found, was in charge of the Engineer Department, whose on-site representative was 1st Lt. Robert McGregor. Reporting to McGregor and responsible for police and security were a sergeant, two corporals, and six privates from the 5th U.S. Artillery. Also on post were two artillerists being schooled in care and operation of the 12-inch gun-lift battery.

An overworked ordnance-sergeant and an assistant were in charge of the three-gun dynamite battery, the sixteen-gun mortar battery, and the recently completed 10-inch breech-loading two gun battery.⁹⁷

Although the detachment barracks was only six years old, Colonel Hughes had a harsh opinion of its amenities. He found that at Sandy Hook there were a number of factors that seemed to warrant giving special attention to the physical comforts of the ordnance personnel.

It was agreed that the detachment included the "hardest worked soldiers" in the Army, and that during the winter their environment was harsh, while there were scant opportunities for entertainment and recreation.

96. Hughes to Inspector General, Nov. 19, 1897, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

97. Ibid.

The men were called on to work an eight-hour day, and "when off duty, their only resort in cold weather" was the barracks. Consequently, humanity dictated that the barracks should be made as comfortable and cheerful as a reasonable expenditure of public funds afforded. At present, the squad rooms were heated by coal stoves and lighted by coal oil lamps, with limited facilities for bathing.

Sleeping near a coal-stove, Colonel Hughes allowed, was "not a good preparation for a day's work, reading by a poor light is not an unadulterated pleasure, and a rusty bath-tub is not inviting." The barracks basement, Colonel Hughes added, "is so constricted that a system of steam or hot-water heating could be installed without trouble."⁹⁸

As a result of Colonel Hughes' report, a number of improvements were made to the Proving Ground facilities in the three years beginning July 1, 1897.

b) New Wing for Machine Shop

A wing was added to the machine shop in Fiscal Year 1897. The central portion of the shop's floor was provided with a standard-gauge track connected with the reservation railroad system. Cars loaded with guns, heavy parts of carriages, etc., requiring repair, could now be run directly into the shop. This increased its efficiency, expediting the changes and repairs connected with experimental firings and tests.⁹⁹

c) Electric Lighting Comes to the Proving Ground

An electric plant for illumination of the grounds, lighting the Officers' Quarters and office, and for use in connection with experimental firings and tests was installed. This project was carried out

98. Ibid.

99. Executive Documents, Serial 3637, pp. 21, 203.

under supervision of Lt. George Montgomery, assistant proof officer. To implement it, Lieutenant Montgomery utilized the high-speed engine and dynamo, purchased in May 1895, as a component of the electric hoisting unit. A storage battery, fixtures, and wiring were purchased and installed.

The 40-horsepower engine employed by Lieutenant Montgomery was a high-speed type manufactured by Struthers, Wells & Co., of Warren, Pennsylvania. It was provided with steam from the same boiler that supplied the machine shop engine. The bedplate, to reduce vibration to a minimum, was bolted to a concrete foundation. The Thompson-Houston dynamo was a compound-wound bipolar machine, with a 44-kilowatt capacity. It had a voltage of 220. A black walnut switchboard mounted a switch for closing the charging circuit and a Weston voltmeter and ammeter. The normal output of the dynamo in charging was 25 amperes. Both engine and dynamo were in a small frame building forming an offset to the boiler-house.

The charging mains of weatherproof insulated copper wire carried the charging current overhead 1,200 feet to the storage battery in the cellar of the office. A 175-volt bell was placed in the boiler-house. It provided a means of communication between the battery room and boiler-house, thus saving time lost in sending a messenger to the boiler-house every time it was necessary to stop, start, or alter the charging current.

Preparatory to installing the battery, a concrete floor and larger windows were added to the office cellar. The battery, purchased from the Electric Storage Battery Co. of Philadelphia, consisted of sixty-three capacity cells and nine counter EMF cells to regulate the pressure in the lighting mains.

The battery room was provided with four wooden tables, resting on sixteen-inch concrete pillars. These tables had a thick coating of asphaltum to prevent acid from acting on the wood. Three of the tables were each occupied by twenty-two cells, while the fourth, a smaller one, carried six.

An elaborate marble, black enameled switchboard was positioned with the battery. It was equipped with a Weston Voltmeter, a two-way reading Weston ammeter, a three-point switch, a Lewis cut-out switch, a ten-point regulating switch, and a charging and discharging double-pole knife-edge switch. The charging and lighting currents passed through the overload switch, usually set to open at thirty-five amperes, and the voltmeter and ammeter gave readings for both currents. The Lewis cut-out switch was intended only for charging.

The battery had an eight-hour capacity of 25 amperes. The voltage of the lamps was 110, and they demanded about one-half ampere per lamp of 16-candlepower. It could, therefore, maintain fifty 16-candlepower lights for eight hours.

Besides lighting, the battery was employed in the office for call bells, the annunciator, and the Boulenger chronographs, as well as for firing and testing purposes. This enabled the staff to dispense with the primary batteries, heretofore employed for that purpose.

Maintenance of the battery was trifling compared with a primary one. Twice a week the cells were refilled with water to replace that lost by evaporation, and to maintain a specific gravity of 1,200. The cells seldom demanded more acid.

Wires for lighting the Officers' Quarters passed the 400 feet from the battery room underground in 2-inch pipe. They led directly to a double-pole knife-edge switch, with fuse, in the basement of the quarters which controlled the lights in the building. From this switch, two mains of No. 3 insulated copper wire, in brass-covered conduits, carried the current to a cut-out box on the second floor. Eight lamp circuits left this box and fed the lamps directly. The wiring was No. 12 Grimshaw, white-core insulated copper wire, carried in a concealed single circular loom tube. Cut-outs were double pole, of porcelain, mounted on slate. Chandeliers in the vestibule and halls were controlled by Cutter flash switches. Wiring for the hall lights on the

first and second floors was such as to enable a person in either hall to turn on or off both lights simultaneously.

The cellar of the Officers' Quarters was provided with drop-cord lights, but the rest of the structure was furnished with electroliers and brackets in antique brass, fitted for Edison sockets.

With exception of the hall light, which was a bracket-fixture, and one wall socket light in the cellar, drop lights were exclusively employed in the office. Lamp cords were suspended from rosette cut-outs screwed to the ceiling and attached to Edison sockets.

Two exterior lights, one in front of the office and the other in front of the Officers' Quarters, were supplied from lead-covered insulated wires placed underground. One was controlled from the office and the other from the Officers' Quarters. Sixty-two 110-volt lamps were used in the Officers' Quarters, twenty-two in the office, and two for exterior lighting.¹⁰⁰

d) Proving Ground Gets a Water System

In Fiscal Year 1898 an efficient water system was installed under the supervision of Lt. L. M. Fuller. Seven years before, in 1891, estimates had been secured for installation of a Proving Ground waterworks system. The plant projected would have cost \$10,000. The high cost and lack of available funds caused the project to be postponed until the autumn of 1897. At this time the proposal again surfaced, and the estimate was pared. Chief of Ordnance Flagler, on reviewing the plans, made a \$2,000 allotment for installation of a "plant sufficient for the use of the proving ground," with the realization that it would have to be expanded in the future.

The allotment was to cover only the "bare cost of materials and the superintendence in erecting the tower and tank." All

100. Ibid., pp. 204-27.

work involved in laying pipe, setting hydrants, making connections, etc., would be accomplished by the Ordnance Detachment.

Until March 12, 1898, when the new system was put in operation, the post water supply consisted of tanks positioned in the Brick Officers' Quarters, office, and barracks. The two small tanks of about 350 gallons capacity in the brick house and the two boiler-iron tanks of 2,945-gallon capacity in the office were supplied by a Rider hot-air engine mounted in the basement of the brick house. A large 3,500-gallon cypress tank in the barracks was filled by a hot-air engine. Post fire protection consisted of a number of 3-1/2-inch well points driven in nests of four near the principal buildings. A pipe projected above the ground with connections for a hand fire engine.

The new system included a 12,000-gallon cypress tank, mounted on a galvanized steel structure 45 feet in height about 100 feet south of the Officers' Quarters. Here was a knoll 5 inches higher than the basement of the brick house.

A 3-inch galvanized iron pipe led from the tank past the brick house and master-mechanic's quarters to a Y. Here it branched, one section leading to the barracks and the other by the flagstaff. The latter, at a point near the flagstaff, was reduced to two inches, and continued on to the machine shop. This pipe was the charging and discharging main, and in the machine shop was connected to a Dunn-Laidlaw-Gordon pump, with 6- x 4- x 6-inch cylinders and a capacity of about 3,000 gallons per hour at fifty-pounds pressure.

A three-inch suction pipe led from the pump to the former site of the Sandy Hook Life-Saving Station, a distance of about 1,000 feet. This site was one of the highest on the Hook, and was as far away from any buildings as any that could be selected.

From the discharging main branches led to 2-1/2-inch fire hydrants near the Brick Officers' Quarters, master-mechanic's quarters, barracks, office, and machine shop. These hydrants were

sited to cover other structures, so that fire protection was afforded not only to the Ordnance Department buildings but to several belonging to the Corps of Engineers. Smaller yard hydrants were positioned at various points and were of use in cleaning guns. The mains were connected to pipes which supplied the smaller tanks in the Officers' Quarters, barracks, and office, and by means of float valves kept them full. A float valve in the greenhouse maintained the evaporation tank at a constant level.

A water crane for the reservation locomotive was positioned near the tracks and proved to be a great time saver. Formerly, water for the locomotive was pumped in the roundhouse by steam from the engine.

The nest of water points for supply of the system consisted of four 3-1/2-inch galvanized points at the diagonals of a square, the diagonals being 40 feet in length. These points were sunk about 2 feet below mean low water and joined by means of flange unions and 3-inch galvanized pipe at a cross in the center, which was attached to the main suction pipe. A peculiarity of Sandy Hook was that water taken from near the surface was fresh, while that from a greater depth was brackish.

For fire protection a hose-reel with 400 feet of 2-1/2-inch hose and two nozzles was on hand, as well as a hand fire engine. The latter could be connected to the hydrants and employed in this manner, or the hose could be connected directly to the hydrants. In a trial, a hose so connected forced water onto the roof of the office. The most satisfactory method, however, was to utilize the steam pump, which would force water up to 150 pounds pressure, with from 75 to 100 pounds of steam in the boilers.

The efficacy of the new water system for fire protection was tested on June 28, 1898, when the coal shed adjoining the machine shop caught fire from a kettle of heated jovite. The fire was clearly beyond control by buckets and would have destroyed the shed with its 200 tons of coal and possibly the machine shop.

Within less than ten minutes of the sounding of the alarm, a hose was connected by the post firemen to a hydrant and a stream of water was directed on the fire. The steam pump was also brought into action with a 3/4-inch cleaning hose, and what could have been a disastrous fire was quickly extinguished.¹⁰¹

During all but the warmest weather, about 4,000 gallons of water daily sufficed for the Proving Ground. On hot days 6,000 to 7,000 gallons were consumed. The greater part of this could be pumped before working hours or while steam was being raised. An electric telltale, which rang a bell in the engineroom, indicated when the 12,000-gallon tank was full. Numerous stopcocks, at various points in the mains, allowed the water to be cut off for repairs.¹⁰²

e) Two New Magazines are Erected

Since establishment of the Proving Ground in 1874 powder had been stored in the magazines of the unfinished masonry fort. In Fiscal Year 1899 these magazines had to be abandoned, because they were scheduled for demolition by the Corps of Engineers, who needed the sites for construction of 10- and 12-inch emplacements (Batteries Halleck, Joseph Bloomfield, and Israel Richardson) for the Endicott system defenses. A new magazine was built about 800 yards down the beach in a sheltered position. Its interior dimensions were 60 by 40 feet. The foundations were brick, and the footings course concrete. The superstructure was brick, with hollow walls for ventilation. Floors, windows, and doors were fireproof, while the roof was galvanized corrugated sheet iron, resting on steel trusses.

It was considered necessary, in the interest of safety, to erect a second small building (20 x 40 feet) of corrugated sheet iron for separate storage of high explosives. This structure was

101. Executive Documents, Serial 3752, pp. 128-30.

102. Ibid., p. 130.

positioned in "an unfrequented place about 3,500 yards down the beach" from the proof battery.¹⁰³

f) Relocating the Proof Battery

In Fiscal Year 1900 the Corps of Engineers commenced construction of 10- and 12-inch gun Endicott emplacements at Sandy Hook. As Batteries Joseph Bloomfield and Israel Richardson were to be positioned along what had been the front of the old masonry fort, the proof battery, machine shop, and associated structures would mask their fields of fire. It was, therefore, mandatory for the Ordnance Department to establish a "new firing battery front." This would involve "construction of new or the removal of all the old buildings used in connection with the work of the battery."

A site for the new proof battery was selected about 900 feet southeast and down the beach from the one that had been in use for twenty-six years. The contract for the new battery called for:

(1) One gantry runway, complete, with concrete steps, walks, crossing, a gantry crossing, turntables, etc., to cost \$11,622.60.

(2) Two sand butt frames, having superficial areas of 5,218 and 4,232 square feet and fronts of 560 and 384 square feet, respectively, to cost \$1,832.50.

(3) Four switching tracks, running from the main track in the rear toward and between the traverses, terminating at the gantry runway and having gantry tracks on each side between the traverses, to cost \$4,150.

(4) Seven armor-plated backings for 12-inch shot, 12-inch shell, 10-inch shot, 10-inch shell, 8-inch shot, 8-inch shell, and 12-inch O.T. shell, to cost \$11,000.

103. Executive Documents, Serial 3911, pp. 41-42, 231.

(5) Five concrete traverses at \$8.40 per cubic yard.

By June 30, 1900, this work had been completed, with exception of the concrete platforms for the two 12-inch mortar carriages, the portion of the concrete part of the gantry in rear of these platforms, about one-half the planking of the runway, and the two turntables.

With the gantry runway behind the carriage platforms it would be possible for the Ordnance Detachment to erect carriages at any point without interfering with the firing. Addition of four switch lines, together with the main track crossing, provided fire points at which a car could be unloaded, and a site selected which would not be far from the desired location of any carriage selected. A depressed track had been constructed to the extreme right of the runway for unloading large pieces, such as mortar carriage base rings, for which the gantry crane lacked sufficient lift above the floor of a car spotted on a surface track.

In the middle of the runway was positioned a standard gauge track for use of handcars transporting projectiles or other gear which need not be handled by the gantry. By means of the two turntables placed at the outer switch lines, these cars could be taken to any platform without interfering with the gantry crane. The ground between the platforms and traverses in their rear would be planked level with the tops of the rails so wagons could be driven to any part.

The five concrete traverses were parallel to the gantry runway and eleven feet to its rear. They were twelve feet thick, twelve feet high on the front face, and sloped to nine feet on the rear face. They contained niches for overhead protection. Planking was laid in rear of the traverses for 10 feet out to a boardwalk, which paralleled the traverses and was thirteen feet wide.

The seven armor-plated backings were sunk beneath the level of the gun platforms to permit direct firing at targets for ranges, firing into the sand butts, or firing to sea from any platform.

They were positioned at an average of 138 feet in front of the gun trunnions, and the maximum depression for the guns varied from 2° 20' for the horizontal fire of a 12-inch mortar to 6° 36' for the 12-inch barbette carriage. Screens to be employed in firing for velocities were placed beyond the butts of the armor-plated backings.¹⁰⁴

To complete the project, Captain MacNutt called for: (a) a concrete traverse on two sides of the service magazine; (b) concrete skids for parking new guns and those proved; (c) observation platforms on the traverses and steps leading to platforms; (d) a heavy clay soil covering between the gun platforms and armor-plated backings, and also a clay or cinder covering in the gun park and railroad yard; and (e) electric power for operating crane and gantry and for experimental carriages using electrical motors, including the entire plant, building, wiring, etc.¹⁰⁵

g) Building a New Machine Shop

A new frame machine shop with wings, having a floor space of 10,363 square feet, was built under contract. The main part of the structure housed the machine shop proper, while the wings were occupied by a carpenter shop, forge room, engine and dynamo room, and boiler-room. Between the wings was erected a large coal bin of 300-ton capacity. The latter was easily accessible from the boiler-room and was connected by a siding with a railroad track leading to the wharf.¹⁰⁶

6. Ordnance Department Railroad Proves Itself

In November 1896 a nor'easter hammered the New Jersey coast, carrying away about 3,500 feet of the narrow neck connecting Sandy Hook with the mainland. Fortunately, the piles were driven about

104. Executive Documents, Serial 4097, pp. 26-28.

105. Ibid., p. 232.

106. Ibid., p. 231. The new machine shop was about 100 yards west of the office.

five feet into clay, so the railroad trestle was uninjured. It was necessary, however, to extend the trestlework 1,350 feet to maintain communications. This project was accomplished by the Quartermaster Department.

Traffic over the trestle in Fiscal Year 1897 zoomed to 10,187,451 pounds. Involved were 96 cars on which the government paid transportation, and 449 upon which the contractors paid these charges.¹⁰⁷

Studies had shown, Captain Heath boasted, that a great reduction in cost of transportation had been effected--not only directly but also as a result of the competition with water-borne commerce since purchase and integration of the reservation railroad. Thus, the construction costs of the trestle were more than justified.¹⁰⁸

During Fiscal Year 1898 the Ordnance Railroad was improved by removal and replacement of old and worn-out ties and rails. The Corps of Engineers placed a riprap of heavy stone on the oceanside of the trestlework to shield it from nor'easters.

More than 15,358,000 pounds of freight were received and shipped by rail in the twelve months of Fiscal Year 1898. This represented 694 cars received for the Quartermaster Department, 13 for the Corps of Engineers, 18 for Fort Hancock, 1 for the Life-Saving Service, 3 for Western Union Telegraph, 10 for the Postal Telegraph, and 298 for the Ordnance Department. There had been shipped from the reservation 102 cars for the Ordnance Department, 7 for the Quartermaster Department, and 3 for the Corps of Engineers. Thirteen passenger cars had arrived on Sandy Hook on May 25 with eight companies of the 3d New Jersey Volunteer Infantry. The cars received

107. Executive Documents, Serial 3637, pp. 203, 208.

108. Ibid., p. 208.

on account of the Quartermaster Department were carrying building materials for use in construction of the Fort Hancock structures.¹⁰⁹

In Fiscal Year 1899 no funds were spent on the railroad connecting the Proving Ground with the Central Railroad of New Jersey at Highland Beach, except for routine repairs. With the Spanish-American War ended, traffic over the United States Ordnance Railroad fell to 10,275,000 pounds during the twelve months ending June 30, 1899.¹¹⁰

Fiscal Year 1900 was a record year for the railroad. Six hundred and four cars, loaded with 16,423,000 pounds of materiel and supplies, were received by the Ordnance Department, Corps of Engineers, Life-Saving Service, and Fort Hancock. Shipped from the reservation by the Ordnance Department were 3,079,000 pounds of equipment on seventy-seven cars. The railroad was also used extensively by the contractors building the new Endicott batteries, thus reducing the cost of construction to the United States.

The only money spent on the railroad during the year was for right-of-way maintenance. It would be necessary, however, Captain MacNutt warned, to relay in the near future a considerable part of the trackage, because of the "comparative short life of . . . ties laid in the sand."¹¹¹

109. Executive Documents, Serial 3752, p. 128.

110. Executive Documents, Serial 3911, p. 230.

111. Executive Documents, Serial 4097, pp. 232-33.

VI. THE PROVING GROUND COMES OF AGE

A. Fiscal Year 1901 at the Proving Ground

1. Captain Babbitt Takes Command

Unlike Major Heath, Captain MacNutt's tour of duty as post commander was brief. On December 9, 1900, less than nine months after he took charge of the Proving Ground, he was replaced by Capt. Edwin B. Babbitt.¹

One month before (on November 9), during a storm, the 48-ton two-masted schooner Grover Cleveland, loaded with lumber for the Proving Ground, was wrecked on the north side of the Ordnance Dock. One-third of the lumber was salvaged, while the rest was washed overboard by the huge breakers which doomed the craft.²

The strength of the Ordnance Detachment was increased from seventy-one to eighty-nine enlisted men on August 20, 1901. The new tables of organization called for ten sergeants, fifteen corporals, forty-three privates 1st class, and twenty-two privates 2d class. Eleven months later, on July 26, 1902, the tables of organization were revised, boosting the strength of the detachment to ninety enlisted men. There would be nine sergeants, ten corporals, thirty-four privates 1st class, and thirty-four privates 2d class.³

1. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617. Edwin B. Babbitt of New York was graduated from the U.S. Military Academy as No. 19 in the Class of 1880. Commissioned a 2d lieutenant in the 5th U.S. Artillery, Babbitt served at Forts Wadsworth and Monroe until April 1889, when he was transferred to the Ordnance Department. He was ordered to Springfield Arsenal as an assistant. Babbitt, after a brief tour as ordnance inspector at Standard Steel, was in August 1890 ordered to West Point as assistant instructor of ordnance and gunnery. He served as an assistant at Benicia Arsenal from August 1896 to September 1898, when he was transferred to Sandy Hook. Cullum, Biographical Register, III, 381.

2. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

3. Ibid.

2. Program Focuses on Ammunition

a) Experiments, Tests, and Proofs

In Fiscal Year 1901 the most important tests were those connected with high explosives and detonating fuses. Results were satisfactory. Two high explosives for use in shells, and a reliable detonating fuse were developed at the Proving Ground.⁴

Projectiles tested at Sandy Hook included: canister; shrapnel; star shells; 6-inch, 10-inch, and 12-inch armor piercing shells; 12-inch D.P. shells; 12-inch torpedo shells; and 6-inch armor piercing shells.⁵ More than 5,500 proof rounds had been fired during the twelve months, a 25 percent increase over the previous year. Seventy-one guns of various calibers had been proved, ranging from 15-pounders to 12-inch rifles.⁶ Smokeless powder had been tested for twenty-nine guns of different kinds and calibers, and Brown powder for seven different guns.⁷

4. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 57th Congress, 1901-02 (Washington, 1902), Serial 4285, XVIII, 48.

5. Ibid., pp. 48, 335. Lots tested consisted of: two lots 1.65-inch canister, one lot 3.2-inch canister, fifty-six lots 3-inch canister, four lots 6-inch shrapnel, one lot 3.2-inch star shell, three lots 3.6-inch star shell, eight lots 6-inch armor-piercing shell, eight lots 10-inch armor-piercing shell, ten lots 12-inch armor-piercing shell, eighteen lots 12-inch D.P. shell, four lots 12-inch torpedo shell, and three lots 6-inch armor-piercing shot.

6. Ibid., pp. 44, 335. Guns proved included: one 15-pounder Driggs-Seabury rapid-fire, one 5-inch rapid fire, eight 7-inch howitzers, nineteen 7-inch mortars, one 10-inch rifle, thirteen 12-inch rifles, and twenty-six 12-inch mortars.

7. Ibid., p. 336. Smokeless powder had been tested for: 1.65-inch Hotchkiss mountain guns; 6-pounder Driggs-Seabury rapid-fire gun, No. 1; 15-pounder Driggs-Seabury rapid fire gun; 3-inch Maxim-Nordenfelt mountain gun; 3.2-inch breech-loading rifle, No. 113; 3.2-inch breech-loading rifle, No. 13; 4.7-inch Armstrong guns; 5-inch breech-loading rifle (siege); 5-inch rapid-fire gun, No. 5; 5-inch rapid-fire gun, Model 1897 (service); 6-inch rapid-fire gun, Model 1897; 7-inch howitzer; 7-inch breech-loading mortar, No. 1; 8-inch breech-loading rifles; 10-inch breech-loading rifles; 10-inch Brown segmental gun; and 12-inch breech-loading mortars.

b) Machinists' Workload Increases

The machine shop had been employed in repair and alterations necessary at the Proving Ground and also in repair work for the artillery district under charge of Inspector of Seacoast Armament Captain MacNutt. In addition five machinists had been detailed to various Endicott fortifications around the nation. Great difficulty had been experienced in recruiting skilled men for this work. To keep a sufficient number of trained machinists on the payroll, Captain Babbitt proposed to increase the capacity of the post, giving employment to about three times the present strength. During the year ending July 30, 1901, the machinists had banded 250 8-inch and 67 10-inch Parrott projectiles for target practice.⁸

3. Construction, Repair, and Maintenance

a) Completing the New Proof Battery

During the twelve months ending June 30, 1901, the projects underway at the end of Fiscal Year 1900 and those proposed by Captain MacNutt were completed under the supervision of Captain Babbitt. Those associated with the new proof battery included: completion of the two 12-inch mortar emplacements, extension of the gantry runway, installation of two turntables, and covering with planking the ground around the traverses.

7. (Cont.) Fixed ammunition loaded with smokeless powder had been tested in the 6-pounder Driggs-Seabury rapid-fire gun, No. 1; 6-pounder Driggs-Seabury rapid-fire gun (service); 15-pounder Driggs-Seabury rapid-fire gun; and 3.2-inch breech-loading rifle (converted No. 225).

Hexagonal powder had been tested in the 3.2-inch breech-loading rifle, No. 1 W.A. (converted to Model 1897); 5-inch breech-loading siege rifle; and 8-inch breech-loading rifles.

Brown prismatic powder had been tested in 8-inch, 10-inch, and 12-inch breech-loading rifles.

Saluting powder had been tested in a 5-inch breech-loading rifle.

8. Ibid., p. 336.

Concrete traverses were constructed on two sides of the service magazine. On the left flank of the main battery, a eighty-six- by sixty-seven-foot platform for field and siege guns was established, and permanent emplacements for 5-inch siege guns and 7-inch siege howitzers and mortars established. Clay, rock, and loam platforms were positioned for tests of field guns and carriages.⁹

b) Gun Park

In the rear of the battery, a gun park was established. It included concrete skids topped by iron rails and had space for sixteen 12-inch rifles, twenty-four 10-inch rifles, thirty 8-inch rifles, and ten 12-inch mortars. Space was available for additional skids for 12-inch mortars and rapid-fire guns.

Three thousand five hundred yards of cinders, covering 18,000 square yards of the gun park, were spread. This was a wise move, as it proved to be a great protection to valuable materiel by preventing sand from drifting during storms.¹⁰

c) Construction of Three Sheds and a New Use for the Old Tool House

On the west side of the gun park, two "light" frame sheds were erected for storage of breech mechanisms, tools, and heavy tackle. A scale shed was built a little south of these, and a "heavy" pressure house immediately in rear of the centre traverse. The old tool shed was relocated from the old battery site and positioned beside the new sheds. It was rehabilitated and painted and used for storage of field carriages awaiting competitive tests.¹¹

9. Ibid., p. 337.

10. Ibid.

11. Ibid.

d) Relocating Necessary Instruments and Wiring

In connection with these tests, a humidity chamber was erected near the boiler-house, and a building containing a vibrating table was put up 400 feet in rear of the battery. The former was partially surrounded by concrete and sand traverses, and it could also be employed for a hydraulic press for loading armor-piercing shot and shell with high explosives. The velocity instruments were connected with the new battery by eight No. 10 insulated copper wires, and one large No. 6 return wire. These wires were overhead.¹²

e) Extending Essential Services to the New Proof Battery

A board road, 13 feet wide and 1,400 feet long, was laid from the office to the new battery. A walkway was built from the battery to the detachment barracks.

The water system was extended to the new front. This involved laying about 1,000 feet of pipe and putting in fire and other hydrants. A lead cable, containing twenty-one wires, connected the office with the service magazine and pressure house. This cable served the telephone and signal systems.¹³

f) Old Proof Battery is All but Abandoned

Several million pounds of equipment were moved from the old to the new battery without interrupting the work schedule. The eighty-ton gantry crane took four days to relocate. A team under Lt. Kenneth Morton, accomplished this by laying a track of seventeen-foot gauge to take the crane, while the gantry car was placed on two iron cars (a temporary track having been laid into the gantry way) and moved down by rail.

12. Ibid.

13. Ibid.

By June 30, 1901, all that remained at the old proof battery were the 10-inch Howell disappearing carriage (scheduled to be dismantled); the 10-inch pneumatic disappearing carriage, awaiting trials by the Board of Ordnance and Fortifications; one 4.7-inch gun and mount (to be removed); and one 12-inch mortar mounted on an old 12-inch rifle barbette carriage. The latter was used for horizontal fire, while changes were being made in the horizontal-fire carriage at the new front.¹⁴

g) Improvements to Officers' Quarters, Barracks, and Office

A hot-water heating system was installed for heating the officers' quarters. Heretofore there had been no means for heating the third floor occupied by the junior officers and the servants' wing. The plumbing, reported defective by the sanitary inspectors, was being rebuilt. Whenever funds became available, the ceilings of the officers' quarters, which had been damaged by firing, would be replaced with metal.

A steam-heating plant was installed in the barracks at a cost of \$2,500. It replaced some twenty stoves. As the barracks were frame, Captain Babbitt was amazed that they had not been destroyed by fire. The soldiers found the steam-heat a great improvement over the stoves, and they reported the barracks more comfortable during the winter of 1900-01 than in the previous winters.

Taking cognizance of the fumes, which he found objectionable, Captain Babbitt had the storage battery removed from the cellar of the office and set up in a separate building.¹⁵

14. Ibid., pp. 337-38.

15. Ibid.

h) Work Begins on a Sewer System

A sewer system, extending from the storehouse to the inner bay, was under construction. It consisted of 1,700 feet of eight-inch heavy iron pipe, with four-inch branches, from the storehouse, office, machine shop, and mechanics' quarters. The need for the sewer had become apparent, as all water for both Fort Hancock and the Proving Ground was obtained from wells and surface drainage was a source of contamination.¹⁶

4. Improvements to and Expansion of the Transportation System

a) New Trackage and Equipment

Much work had been called for in Fiscal Year 1901 to keep up the roadbed. About 700 yards of new track had been laid during construction of a siding and elimination of a dangerous curve in front of the new proof battery.

A new 70,000-pound locomotive was purchased as a replacement for the old worn-out Baldwin. The new engine was manufactured by Pittsburgh Oil and Locomotive Works. On delivery it was inspected by one of the Central Railroad's master mechanics and pronounced one of the best constructed he had seen. It had a capacity of 800 tons on the level and brought in the heaviest trains at fifteen miles per hour.

Heretofore, those of the civilian labor force employed at the Proving Ground, who lacked suitable means of commuting to homes on the Jersey shore south of the reservation, were quartered during the week in small rooms over the storehouse and in the west end of the ammunition shed. The latter was dangerous in case of fire, and the former made a fire likely.

16. Ibid., p. 338.

To rectify this situation, the Ordnance Department purchased two passenger cars on May 1, 1901. These were placed in daily service between the post and Highland Beach. The train left Sandy Hook at 7:10 A.M. and 5:10 P.M., and Highland Beach at 7:30 A.M. and 5:30 P.M. It carried civilian employees of the Proving Ground to their homes at the highlands of Navesink and the soldiers pulling guard duty at the north end of the government trestle. On an average day, the trains transported 180 passengers.¹⁷

b) Movement of Equipment, Material, Stores, etc., to and from Sandy Hook

During the year there had been received by rail at Sandy Hook 13,539,000 pounds of equipment, materials, stores, etc. The lion's share of these had been consigned to the Ordnance Department (6,073,000 pounds), the Quartermaster Department (4,689,000 pounds), the contractors (1,277,000 pounds), and Fort Hancock (779,000 pounds). Shipped from the reservation were 2,470,000 pounds of equipment and supplies--1,755,000 belonging to the Ordnance Department.

There had been landed at the wharf during this period 2,193,000 pounds of equipment and materials for the Ordnance Department. Some 1,732,000 pounds of gear had been loaded aboard vessels for shipment by water.¹⁸

B. Proving Ground Becomes a Permanent Installation

1. General Crozier Announces a New Status for the Proving Ground

On December 11, 1901, Chief of Ordnance William Crozier notified Captain Babbitt that the Department, after more than a quarter of a century, had decided to consider the Proving Ground a permanent

17. Executive Documents, Serial 4285, pp. 338-39.

18. Ibid., pp. 389-90.

installation. Hereinafter, all buildings and improvements would be designed with this in view.¹⁹

Captain Babbitt would prepare a plan showing "the line of demarcation of the territory which it is desirable to reserve for Proving Ground uses." On doing so, Babbitt was to indicate in a general way the location of buildings needed for further development.

It was planned, General Crozier continued, to "establish a course of instruction in the design and construction of ordnance at the Proving Ground which will contemplate the stationing at that post of about eight assistant officers, four more than the present number." The instructors were to be detailed from among those officers assigned to the Proving Ground. In preparation of the master plan to guide future development at Sandy Hook, Captain Babbitt was to keep this school in mind and to submit estimates so that the Department could start programming funds.²⁰

2. Babbitt's Master Plan for Expanding the Facilities

On reviewing the history of the reservation, Captain Babbitt found that, until 1898 and the establishment and garrisoning of Fort Hancock, the area had been under "practical control of the Commanding Officer of the Proving Ground, except for such limited supervision" as the District Engineer provided. Upon arrival of the garrison, conditions governing administration of the reservation had changed. The large number of people traveling to and from Fort Hancock, the increased visitation to the Proving Ground, and more civilian employees on the reservation made it desirable that there be definite spheres of jurisdiction to insure that there were no evasions of police and sanitary regulations.

19. Crozier had been appointed Chief of Ordnance on November 22, 1901, to replace General Buffington, who had retired on May 22, 1901. Buffington had succeeded General Flagler in April 1899.

20. Crozier to Babbitt, Dec. 11, 1901, NA, RG, 156, Ltrs. Sent, Chief of Ordnance.

With this in view, Captain Babbitt called for division of the reservation into two sectors. One of these would be under control of the Proving Ground and the other the responsibility of the Fort Hancock commander. The Ordnance Department's land was divided into two areas. The first (Area A) in rear of Battery Halleck and north of Fort Hancock included the officers' quarters and mess, the enlisted men's barracks, the office, shops, storehouses, and car-sheds. The second (Area B) extended from in front of Battery Potter and along the beach to the southern limit of the reservation. Included within this acreage were the proof battery, proof-range, and the principal and high magazines. The latter were a safe distance west of the proof-range.

In addition to the buildings currently in Area A, it was proposed to construct:

(a) Storehouse.--A fireproof 100- x 40-foot brick structure with necessary landing stages and platforms for delivery of heavy materials to and from railroad cars. This structure, to cost about \$8,000, was to replace the wooden Ordnance Storehouse, which would be demolished to make room for the Battery Halleck parade. Already, the storehouse was being battered by blasts from the guns of Battery Halleck.

(b) Engine House.--A fireproof brick structure, measuring forty by fifty feet costing about \$4,000, was needed to shelter the Department's two locomotives.

(c) Carriage Storehouse.--A one-story fireproof brick building, 240 x 40 feet, to cost \$17,500, was necessary for "proper preservation of the costly material constantly on hand for test, and for safe storage after test." These items were now stored in the Mortar Shed, a temporary structure, erected as an expedient at a time when sufficient funds were not available.

(d) Proving Ground Office.--The assignment to the post of two artillery officers had caused the office to become overcrowded. With the increase in personnel contemplated, it was essential that the office be

enlarged. Such an undertaking would permit rearrangement of the instrument and drafting rooms and the equipping of a drafting room for use of officers attending the proposed school. The cost of this project was placed at \$10,000.

(e) Officers' Quarters and Mess.--An addition to this brick building was contemplated. Its cost should be increased from the \$8,000 previously asked for to \$11,000. Captain Babbitt had found that the expense of construction at Sandy Hook was from 40 to 50 percent in excess of the architect's estimates.

(f) Enlisted Men's Barracks.--Better accommodations for the Ordnance Detachment had become imperative. The frame barracks, constructed when the detachment numbered 45, were overcrowded. Construction of a new barracks would not result in abandonment and demolition of the 1892 structure, as it would be employed as quarters for those civilian employees whose duties required them to be on call twenty-four hours a day. Two sites were proposed for the new barracks, which was to cost an estimated \$40,000. The preferred location was on the grounds presently occupied by the Engineer dwellings, with the secondary site the one now occupied by the frame post exchange. The exchange could be relocated on the Fort Hancock reservation, just south of the proposed Proving Ground boundary.

(g) Ordnance Officers' Quarters.--Three quarters for married Ordnance Department officers, to cost about \$15,000 each, could be constructed on the bay waterfront on land occupied by the Engineer Department's laborers' quarters. These Engineer buildings would, with approval of the Chief Engineer, be relocated to sites better situated in respect to the quarters of the Assistant Engineer in charge of the Sandy Hook defenses.

(h) Additional Tracks.--Captain Babbitt called for spurs leading from the main line and passing to the rear of Battery Halleck and on to the rapid-fire batteries, peace magazine, and dynamite battery on the north shore of the Hook. Similar spurs should be constructed to Fort

Hancock, Batteries Potter, Granger, and Reynolds, and the torpedo cable tanks. With this arrangement of tracks, it would be possible to deliver directly and promptly to any of the batteries or the peace magazine all ammunition and equipment received on the reservation by either rail or water. Cost of these spurs, most of which would be constructed on sections of the reservation not proposed for inclusion within the Proving Ground, was placed at \$20,000.

In Area B, Captain Babbitt proposed to erect:

(i) Ammunition Storehouse.--A fireproof brick structure, 100 x 40 feet, to cost \$8,000. The present ammunition shed was located among a group of buildings near the office and shops, where it was a serious hazard. Babbitt proposed to segregate the new storehouse down the beach near the powder magazine. The spur to the latter was being extended to serve the former, and the two structures to be a sufficient distance apart to forestall an explosion by one detonating the other.

(j) Small Shed for Storage of Detonators and Other Primers.--This structure was to be constructed near the high explosive magazine but far enough away to provide a safety factor.

(k) Chemical Laboratory.--This building, for which Congress had already made an appropriation, would be erected on the high ground, a short distance from the railroad right-of-way near Camp Low. This would place the laboratory about 3,000 yards from the proof battery and well to the west of the line of range, so the delicate instruments would not be injured by the firing. The building would be accessible by rail, and, after extension of the Fort Hancock road system, by wagon. On the adjacent grounds there was sufficient space for proposed quarters for a resident chemist and, if deemed necessary, an experimental powder plant.

(l) Improvements to the Range Target Butts, Bombproofs, etc.--This need, Captain Babbitt reported, had been manifested in recent tests of ammunition for field guns, where much delay and inconvenience had resulted from the inability to pinpoint shots missing the targets.

Except for rough wooden targets, the range was "practically without a proper equipment for target work." It should be cleared, graded where necessary, permanent foundations for targets erected, and bombproofs constructed that would afford shelter to personnel while permitting them to observe the firing. In addition, the telephone communication system had to be improved. Heretofore, because of lack of funds, it had been policy to "install crude and temporary arrangements for range work." These had never been entirely satisfactory and had been changed from time to time in the interest of expediency.

Captain Babbitt was unable to submit an accurate estimate of the cost of this latter project. He urged Chief of Ordnance Crozier to ask Congress for \$15,000 with a view to beginning work thereon as soon as possible. He did not believe that the total cost of the range improvements would exceed \$30,000.

The western boundary of the proposed proof-range would be parallel to and several hundred feet west of the Ordnance Railroad with an enclave to include the Chemical Laboratory. As the area east of the railroad was essential to the target range, jurisdiction must rest with the Ordnance Department, because, as Captain Babbitt warned, "divided jurisdiction" would result in accidents.

At present, Captain Babbitt informed the Department, the Proving Ground was equipped with a "new and modern firing battery with emplacements therein for all service guns, with special emplacements for new types, with gun parks, target butts for tests of armor-piercing projectiles, and 80-ton gantry crane, with necessary railroad tracks, etc., for serving the same." In addition, there were machine, carpenter, paint, and blacksmith shops; boiler- and engine-rooms; engines and generators for electric lights and power; ten miles of well ballasted railroad track; two locomotives, four passenger coaches, three freight cars, and four gun cars. There was a modern water and two independent sewer systems. The aggregate cost of these improvements, Babbitt placed at \$250,000, while the estimated cost of the recommended additions was \$184,000.

To operate the Proving Ground there were now on post 9 officers (6 Ordnance and 3 Artillery), 89 enlisted men, and a force of civilians varying from 150 to 250.²¹

3. Ordnance Board Makes Its Recommendations

Chief of Ordnance Crozier referred Captain Babbitt's report to the Ordnance Board for study and comment. The Board agreed that the existing conditions at Sandy Hook could be considered permanent in view of the extensive rearrangement of the proof battery in progress to accommodate construction of Batteries Joseph Bloomfield and Israel Richardson. Developments at the Hook since 1897, they concurred, had resulted in "two distinct military commands" being established on the reservation. There was Fort Hancock (which included the seacoast batteries and the garrison) and the Proving Ground with the structures, land, and personnel necessary to its operation. It was important that these conditions be recognized in providing for the police and discipline of the reservation, with each commanding officer exercising "full supervision within the limits of his" responsibility.

This was especially true because the Corps of Engineers was about to relinquish supervision over the reservation. The Board agreed with Captain Babbitt that a "proper control" could best be secured by a division of the area between the two commands. The Board urged that these sections of the reservation be assigned to the Proving Ground: (a) the proof battery, including existing buildings and roads leading thereto; and (b) the railroad to Highland Beach and the eastern shore of the Hook, down which the firing took place. Fort Hancock was to include the remainder of the reservation, except the wharf. The wharf, as long as it was used by the various services, should be under joint-control, with the expense of maintenance allotted by the War Department amongst them. Free and unimpeded use of the wharf and railroad by the Ordnance Department was deemed essential by the Board to "avoid delays

21. Babbitt to Crozier, undated, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

in the large shipments of ordnance materials made to and from all parts of the country." Under no circumstances would this lead to exclusion of the other services from access to their respective establishments. It would be understood by all parties that all freight forwarded to Highland Beach would be delivered by the Ordnance Department locomotives.

Camp Low and the western shore of the Horse Shoe, which were most subject to trespass, would be under control of Fort Hancock. Guards from the fort should be posted at the Camp Low wharf and at the north end of the railroad trestle. Their duty would be to exclude unauthorized persons from the reservation.

The Board recommended that the reservation be divided as suggested, and the boundary marked by stakes. A wire fence should be erected along the west boundary of the firing range "to limit access to the dangerous portion of the proof range." This task would be simplified, because this portion of the line passed through a "wild region where no cross roads" were found or needed.²²

4. Demarkation Board Recommends Against Independent Status for the Proving Ground

To resolve the problem, Secretary of War Elihu Root on March 11, 1902, issued orders constituting a Demarkation Board to establish "lines of demarkation between the territory under the administration of the Commanding Officer of Fort Hancock," and the officer in charge of the Proving Ground. Members of the Board were: Lt. Col. James B. Burbank, Artillery Corps; Maj. William L. Marshall, Corps of Engineers; Maj. Samuel R. Jones, Quartermaster Corps; and Capt. Edwin B. Babbitt, Ordnance Department. The Board was "to recommend such rules for use of each territory as is necessary for the common service of the two establishments and for transit across territory

22. Board to Crozier, Jan. 19, 1902, NA, RG 156, Ltrs. Recd., Chief of Ordnance. Members of the Board were Maj. John G. Butler and Frank Heath.

which it may [be] necessary to traverse . . . to reach the portions of the reservation under the control of the several officers."²³

The Board held one meeting on-site and several at the Army Building in New York City. Although the reservation occupied the narrow six-mile-long Sandy Hook peninsula, the various activities, Colonel Burbank and Major Marshall pointed out, were concentrated at the north end and within an area about one mile in length by five-eighths of a mile in width from oceanside to bayshore. The coast defense batteries began at the extreme point of the Hook and extended in an arc to the bay on the south end of this area.

Within this semi-circle were the artillery officers' quarters, barracks, and hospital; post and Proving Ground storehouses, workshops, etc.; barracks of the Ordnance Detachment and the Engineer workmen and employees. The Proving Ground firing front was outside this area and extended along the ocean front, and by location and natural barriers was isolated from the reservation's other activities.

Captain Babbitt briefed the Board on plans his Department had for division of the reservation. The other officers were surprised to learn that the Ordnance people's proposal called for them in one area to have exclusive jurisdiction over a zone from 300 feet to 350 yards in width commencing on the bayside and extending across the Hook to the ocean beach. This zone severed one-half of the line of defense from the "garrison proper" and divided that under "the jurisdiction of the post commander into two distinct parts."

Within the area claimed by the Ordnance people, Colonel Burbank and Major Marshall were distressed to discover, were the only available wharf upon which freight and passengers were landed; the switching center for all spurs leading to the emplacements and

23. Special Order No. 59, Mar. 11, 1902, Headquarters of the Army, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

storehouses; the macadamized road connecting the Fort Hancock barracks and quarters with the dock, along which was the only area for expansion of the post (its extension to the south precluded by the terrain); both chapels; the general store; the post exchange; the U.S. post office; and the fire-commander's tower for the entire line of defense. The various roads, linking the Fort Hancock barracks and quarters with the emplacements, also crossed this zone, as well as water mains, electric conduits, and telephone and telegraph lines. In addition, the scheme of defense for Sandy Hook had not been completed. More batteries were to be built, and as yet only three of eight proposed range-finder towers had been erected, while neither the "large peace magazine" nor the new torpedo sheds had been located.

Moreover, they continued, the Ordnance Detachment was dependent on the artillery for commissary supplies, bakery products, medical services, and beds in the post hospital for its sick and injured. All sentries at the dock and at the trestle guardhouse were detailed from the garrison by Colonel Burbank. Such guard duties were attributes of jurisdiction and could only be exercised by troops posted to Fort Hancock.

The majority of the Board, after listening to the arguments, took the position that no evidence had been presented by Captain Babbitt to demonstrate that the "special work" of the Proving Ground had been either curtailed, interfered with, or obstructed in the slightest measure by existing conditions. Moreover, they saw no reason why, if additional structures were needed by the Ordnance Department, they could not be erected.

The Demarkation Board, in view of this and necessary "inter-dependent" relations which must exist, recommended against establishment of the Proving Ground as an independent post. It should be understood, the Board's majority wrote, that from the nature of the situation that each branch of the service at Sandy Hook, in the exercise of its professional activities, was independent in the control of its

personnel, equipment, and mission. Police and maintenance of buildings and grounds in their respective installations would be the responsibility of that department.²⁴

5. Captain Babbitt Refutes the Board's Reasoning

Captain Babbitt leaked a copy of the report to Chief of Ordnance Crozier. Replying on July 21, 1902, General Crozier announced that he disagreed with the recommendations. But, as both the Secretary of War and the Adjutant General were planning to be away from Washington for the next several weeks, it would be impossible to obtain another study until after their return. Meanwhile, Captain Babbitt was to make arrangements to precede "with our building program under the appropriations which have been granted." General Crozier questioned whether they could secure a "better report from the Board." By attacking the report, he believed, they might drive the Board into "a position which would be less vulnerable than . . . the one which they have taken."²⁵

To provide General Crozier with data to refute the Board's recommendations, Captain Babbitt prepared a memorandum. His comments included:

(a) The Switching Center for Spurs Leading to Emplacements and Storehouses.--All tracks in the area belonged to the Proving Ground, except the one leading to Fort Hancock, and had been built and were maintained by the Ordnance Department. If the Proving Ground were abandoned, the entire railroad system would not be necessary, as the amount of traffic destined for Fort Hancock would not justify its maintenance.

24. Report of Board, July 11, 1902, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

25. Crozier to Babbitt, July 21, 1902, NA, RG 156, Ltrs. Sent, Chief of Engineer.

(b) Expansion of Fort Hancock.--The argument that the post could not be extended to the south was invalid, because the post had already constructed a pumping station on a small lagoon in that direction. While expansion of the post southward would place the troops farther from the big guns they manned, they would be no farther than at many posts.

When making an earlier study, General Gillespie of the Engineers had stated that land on the southern portion of the reservation was necessary for the expansion of Fort Hancock.²⁶

(c) General Store.--There was no reason why this structure should be controlled by Fort Hancock rather than the Proving Ground. It was connected with the Proving Ground sewer, and the policing of the adjacent grounds was already the responsibility of the Ordnance Detachment.

(d) Two Chapels.--One of these was in a building on the Proving Ground and had been made available for religious services. The other was a structure belonging to the Corps of Engineers and was scheduled to be demolished as soon as the current construction program was completed.

(e) Post Office.--This structure belonged to the Corps of Engineers. There was no reason why this activity should be controlled by either Fort Hancock or the Ordnance Department, except that the Proving Ground's volume of official mail was larger.

(f) Post Exchange.--This was in an old building belonging to the Corps of Engineers. It, however, received its water from the Proving Ground's system and was connected with its sewer.

26. George L. Gillespie had been appointed Chief Engineer on May 3, 1901.

(g) Roads Linking Barracks and Quarters with Emplacements.--There was at present only one road in this category. There was also a little-used trail by way of the canteen in rear of the brick officers' quarters.

If that portion of the reservation used by the Proving Ground were unoccupied, it could be expected to be allowed to grow up into a "Wild jungle," as was the case with Batteries Potter and Halleck and the mortar battery. The Fort Hancock troops, as in the past, could be expected to confine themselves to one or two lines of communication. All that the artillerists required was a right-of-way from the post to the batteries.

Water mains and electrical conduits ran parallel to the roadways. Telephone and telegraph lines were public utilities and were maintained by their respective companies.

(h) Scheme of Defense Not Yet Completed.--It was safe to assume that the Corps of Engineers had "some idea" of the additional defenses projected for Sandy Hook.

(i) Commissary Supplies.--The Commissary General, desirous of effecting economies, had not established an independent facility at Sandy Hook. Before occupation of Fort Hancock by the artillerists, the Ordnance Detachment had obtained its commissary supplies from Fort Columbus.

(j) Medical Attendance and Hospitalization.--Colonel Burbank's predecessors had justified the presence of two surgeons at Fort Hancock by its proximity to the Proving Ground. There was no reason, Captain Babbitt pointed out, why one of the surgeons should not be assigned to the Proving Ground. As a matter of convenience, it would be better for the surgeon to notify the commanding officer of the Proving Ground directly of unsanitary conditions or situations requiring his attention. The commanding officer at Fort Hancock, it was believed, would be glad to be relieved of having such reports pass through his office, especially as he was unfamiliar with the Proving Ground. Before Fort Hancock had

been established, there had been a dispensary at the Proving Ground. During the months the artillerists were encamped on the reservation, before the hospital was completed, the dispensary had attended to the needs of both commands. Upon opening of the hospital, the post surgeon had requested the Proving Ground commander to allow him to transfer from the dispensary to the new facility all equipment and stores. The recent addition to the hospital had in part been justified by its proximity to the Proving Ground and the necessity for providing beds for both posts.

(k) Sentries for Wharf and Outpost Duty at South End of Reservation.--Before establishment of Fort Hancock, the Ordnance Detachment had maintained a guard at the wharf and had general charge of the reservation. To keep order among enlisted men coming from and going on liberty to New York City by boat, soldiers from Fort Hancock had assumed responsibility for the wharf guard. Even so, a sergeant from the Ordnance Detachment met all incoming boats and looked after the men and material belonging to the Proving Ground.

Captain Babbitt challenged the Board's statement that the artillerists were the only troops at Sandy Hook acting in an "actual military capacity." The Proving Ground maintained an armed guard at the proof battery as well as around the office and shops. Soldiers from the Ordnance Detachment provided gun crews for proof work, and in Fiscal Year 1902 had fired more than 10,000 rounds. This was more projectiles than were fired by the entire artillery corps during the same twelve months.²⁷

6. Generals Crozier and Chaffee Establish the Boundary

Chief of Ordnance Crozier succeeded in prevailing on the War Department to accept his views, rather than the recommendations of the Demarkation Board. On December 10, 1902, orders were issued by

27. Babbitt to Crozier, July 25, 1902, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

the Adjutant General, appointing General Crozier and Maj. Gen. Adna R. Chaffee, commanding Department of the East, as a Board to establish on the Sandy Hook Reservation lines of demarkation between the areas administered by the commanding officers of the Proving Ground and Fort Hancock. The Board would also recommend rules for the use of such territory as was necessary for "the common service of the two establishments and for transit across territory which it may be necessary to traverse . . . to reach the portions of the reservation under the control of the several officers."²⁸

On January 17, 1903, Generals Chaffee and Crozier met at Sandy Hook. After reconnoitering the area, they recommended that the line of demarkation separating the two facilities be established as follows:

To begin at the south boundary of the reservation twenty feet west of the center of the railroad track at a point marked A; then proceed north parallel to the railroad at a similar distance from the mid-point of the right-of-way to a point marked B on the attached map; then to continue northwest at a bearing of 15° west to a point north of Battery Potter; then to proceed "tangent to the southern extremity" of the Ordnance barracks to a point sixty feet west of the western face of the barracks; then continue north 10° west to point F; then 4° south to the junction of the bay shore at "G" with the southern edge of the structure constituting the approach to the wharf; the line would recommence at point H, the bay shore, twenty feet north of the railroad spur leading to the wharf; then northeast parallel to and twenty feet north of the middle line of the railroad and switches to a point south of the southwest corner of Battery Halleck; then north 47° east to a site marked "L" on the accompanying map; then parallel to the interior crest of the eastern front of Battery Halleck to a point opposite the midpoint of the battery's interior crest of the east front; and then in a direction perpendicular to the interior crest of the battery's east front to the ocean beach at N. The portion of the reservation to be administered by Fort Hancock was to the south and west of the line A-G and to the north of the line H-N.

28. Ennis to Chaffee, Dec. 10, 1902, NA, RG 156, Ltrs. Recd., Chief of Ordnance. Lt. William Ennis was Assistant Adjutant General.

Points A-N were to be located by the commanding officers of the Proving Ground and Fort Hancock, as "accurately as may be done in accordance with the positions indicated on the attached map." These points were to be identified by appropriate bench marks. The reservation boundary from points E to G and the shore of Sandy Hook Bay was to be guarded, policed, and controlled by the commanding officer of Fort Hancock. He was to maintain it as open space and it was to be for use and passage of both commands. The wharf and its approaches were to be guarded, policed, and maintained by Proving Ground personnel. They were to be kept unobstructed by buildings, and to be used by both commands. Railroads, roads, trails, electrical conduits, water mains, sewers, etc., were to cross the territory of either command as necessities required. These connections and communications were to be maintained without hindrance.²⁹

In March 1903 Secretary of War Root approved the recommendations as submitted by Generals Chaffee and Crozier, and the Proving Ground became a permanent installation with delineated boundaries.

C. Colonel Smith Commands Sandy Hook: 1902-07

1. Colonel Smith's Years as Post Commander

Captain Babbitt, who had worked to have the Proving Ground established as a permanent facility with definite boundaries, was not there to see his dreams realized. On November 1, 1902, he was relieved as post commander by Lt. Col. Charles S. Smith. The new commanding officer of the Proving Ground was a senior officer in the Ordnance Department and held three other jobs. He was also president of the Ordnance Board, president of the Board for Testing Rifled Cannon, and armament officer of the Sandy Hook Armament District.³⁰

29. Chaffee and Crozier to Adjutant General, undated, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

30. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617. Charles S. Smith of Illinois graduated from the U.S. Military Academy as No. 14 in the Class of 1866. Commissioned a 2d lieutenant in the 4th

Smith commanded the Proving Ground as a colonel until October 9, 1907, when he was promoted to brigadier general. His promotion to general was made in recognition of his forty-five years of faithful and distinguished service. Smith continued in command until December 26, when he was retired because of age. Nine days later, on January 4, 1908, Colonel Rogers Birnie assumed command of the Proving Ground. Like his predecessor, Birnie held a number of other positions. He was president of the Ordnance Board, president of the Board for Testing Rifled Cannon, president of the Joint Army and Navy Board on Gun Forgings, and armament officer of the Sandy Hook Armament District.³¹

On April 25, 1904, the authorized strength of the Ordnance Detachment was reduced from ninety-six to ninety-two enlisted men. The new tables of organization called for nine sergeants, fourteen corporals, thirty-four privates 1st class, and thirty-five privates 2d class.³²

30. (Cont.) U.S. Artillery, Smith served in a succession of Atlantic and Pacific coast posts. On November 1, 1874, he was transferred to the Ordnance Department, and was detailed to the Fort Monroe Arsenal as assistant ordnance officer. From November 1876 to December 1881, he was attached to the New York Ordnance Agency. He was principal assistant to the Chief of Ordnance from June 1891 to November 1, 1902, when he was ordered to Sandy Hook. Cullum, Biographical Register, III, 68.

31. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617. Rogers Birnie of Maryland graduated No. 1 in the Class of 1872 from the U.S. Military Academy. Commissioned a 2d lieutenant in the 13th U.S. Infantry, he served on the frontier at Fort Douglas, Utah Territory, from September 1872 to July 1874. He was on Engineer duty on Lt. Wheeler's Geographical Explorations West of the 100th Meridian to March 1879. Lieutenant Birnie was transferred to the Ordnance Department on June 13, 1878. After a brief tour in the Chief of Ordnance's office, he was ordered to the Springfield Armory. He was posted at the Cold Springs, New York, Foundry from November 1880 until July 1886, when he returned to Washington as assistant to the Chief of Ordnance. In July 1898 Colonel Birnie was ordered into the field as Chief Ordnance Officer, 7th Army Corps.

32. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

The following week the 1st Class of Cadets from the U.S. Military Academy spent the day at the Proving Ground.³³

2. Work Load Increases and the Emphasis Shifts

a) Experiments, Tests, and Proofs--Fiscal Year 1902

In Fiscal Year 1902 the improved and additional facilities provided by the new proof battery made possible a greatly increased workload. Among the projects undertaken were exhaustive competitive tests involving new materials and the Gathmann 18-inch gun and projectiles. The former had been conducted by the Ordnance Board and the latter by a joint board of Army and Navy officers. Despite the precarious character of the tests, there were no accidents.

A large force had been employed handling heavy armor and in readying timber backing and sand butts. Ballistic tests had been made of service steel projectiles received from contractors. Proof work had increased. During the previous twelve months 135 guns had been proved, ranging in size from 6-pounder rapid-fire guns to 12-inch breech-loading rifles. There had been issued from the Proving Ground for emplacement in the nation's coastal fortifications:

fifteen 6-pounder rapid-fire guns,
eleven 5-inch rapid-fire guns,
six 6-inch breech-loading rifles,
twenty-four 6-inch rapid-fire guns,
one 10-inch breech-loading rifle,
three 12-inch breech-loading rifles, and
thirty-two 12-inch breech-loading mortars.

During the same period there had been shipped fifteen parapet carriages for 6-pounder rapid-fire guns, one 5-inch barbette carriage, Model 1896, and one 10-inch disappearing carriage, L.F., Model 1896. Many of the gun carriages were now being issued from

33. Ibid.

the place of manufacture directly to the fortifications and were proved on site rather than at Sandy Hook.³⁴

b) Experiments, Tests, and Proofs--Fiscal Year 1903

Many lots of projectiles were subjected to ballistic tests at the Proving Ground during Fiscal Year 1903. Included were 3-inch Driggs-Seabury shrapnel, 6-inch Frankford Arsenal shrapnel, 6-pounder Driggs-Seabury armor-piercing shell, 6-pounder American Ordnance Company armor-piercing shell, 6-inch armor-piercing shot, 10-inch armor-piercing shell, 12-inch D.P. shell, and 12-inch torpedo shell.

Guns proved and transported were:

nine 1-pounder subcaliber tubes,
ten 6-pounder Driggs-Seabury rapid-fire guns,
two 15-pounder Driggs-Seabury rapid-fire guns,
eleven 5-inch siege guns,
fifteen 5-inch rapid-fire guns,
one 6-inch breech-loading rifle,
twenty-three 7-inch breech-loading howitzers,
one 8-inch breech-loading rifle, and
twenty-seven 12-inch breech-loading mortars.

A large quantity of gun powder for all caliber of guns was tested, involving a "great deal of careful firing and a large quantity of fixed ammunitions." More than 6,900 rounds were fired from the proof battery. In a number of cases each round represented two, three, or four objects undergoing tests, requiring separate reports for each. The ninety-nine guns proved were also star-gauged. To meet the increased workload, it had been necessary to hire more mechanics.³⁵

34. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 57th Congress, 1902-03 (Washington, 1902), Serial 4448, X, 51-53.

35. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 58th Congress, 1903-04 (Washington, 1903), Serial 4641, XV, 49-50; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

c) Experiments, Tests, and Proofs--Fiscal Year 1904

During the year there were received and tested for ballistics nineteen lots of projectiles, eight lots of shrapnel, forty-four guns, eighty-nine lots of powder, and seven lots of fixed ammunition. Firings during the twelve months involved an expenditure of 154,660 pounds of powder and 7,665 rounds.³⁶

d) Experiments, Tests, and Proofs--Fiscal Year 1905

As usual firings for experimental and proof purposes were conducted daily, weather permitting. Subjected to ballistic tests were these materials: twenty-eight lots of projectiles, ten lots of shrapnel, ninety-seven guns, eighty lots of powder, and one lot of fixed ammunition.

Firing during the twelve months had involved expenditure of 92,727 pounds of powder, 3,399 rounds of fixed ammunition, and 19,523 pounds of high explosives. A total of 6,329 rounds were fired, and 18 fragmentation tests made.³⁷

On December 1, 1904, Cpl. George Angler had his right hand mangled by explosion of a friction primer for a 12-inch rifle. This was the first accident suffered by Proving Ground personnel in the line of duty since establishment of the new proof battery three years before.³⁸

36. Executive Documents, Printed by Order of the House of Representatives for the 3d Session of the 58th Congress, 1904-05 (Washington 1904), Serial 4790, XI, 14.

37. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 59th Congress, 1905-06 (Washington, 1905), Serial 4950, p. 49.

38. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

e) Experiments, Tests, and Proofs--Fiscal Year 1906

In the year ending June 30, 1906, these materials were subjected to ballistic tests: 222 lots of projectiles, 142 lots of powder, 2 lots of shrapnel, 2 lots of fixed ammunition, and 3 guns.

Firings involved expenditure of 87,601 pounds of powder, 750 pounds of high explosives, and 7,365 rounds of fixed ammunition. A total of 13,183 rounds had been fired, while 39 fragmentation tests had been made.³⁹

f) Experiments, Tests, and Proofs--Fiscal Year 1907

Firings for experimental and proof purposes were conducted daily, weather permitting. There were subjected to ballistic tests: forty-nine lots of projectiles, twenty-four lots of shrapnel, two guns, two shields, sixty-three lots of powder, and thirty-nine lots of fuses.

These firings involved expenditure of 88,542 pounds of powder, 2,135 pounds of high explosives, 5,996 projectiles, and 158 rounds of fixed ammunition. More than 6,360 rounds were fired, while 134 fragmentation and miscellaneous tests were conducted. These tests and experiments necessitated preparation of 320 reports and plotting of 160 targets.⁴⁰

g) Experiments, Tests, and Proofs--Fiscal Year 1908

Ballistic tests for service were made on twenty-eight lots of shot and shell, fifty lots of shrapnel, two guns, sixty-eight lots of powder, and fifty lots of fuses. Included was an expenditure of

39. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 59th Congress, 1906-07 (Washington, 1906), Serial 5110, VII, 49-50.

40. Executive Documents, Printed by Order of the House of Representatives for the 1st Session of the 60th Congress, 1907-08 (Washington, 1907), Serial 5275, VI, 50.

73,945 pounds of powder, 431 projectiles, and 167 rounds of fixed ammunition. A total of 3,755 rounds were fired, in addition to 469 explosive tests. Paperwork for these tests and experiments found the staff preparing 395 reports and firing records and plotting 105 targets. This was in addition to plotting velocity and pressure curves for rounds fired with various charges of powder.⁴¹

3. Department Spends Heavily for Capital Improvements

In the seven years, beginning July 1, 1902, a number of the permanent improvements called for in Captain Babbitt's report to Chief of Ordnance Crozier in January 1902, were constructed.

a) Improvements to the Machine Shop

In Fiscal Year 1902 the machine shop's floor space was increased by construction of a wing parallel to the shop and connected thereto by a passageway that also admitted cars bringing in materials.

Repair projects for the Sandy Hook Artillery District continued to occupy much of the machine shop's force. Besides this work, the mechanics had devised and manufactured safety-firing attachments for 4.7- and 6-inch Armstrong rapid-fire guns; electric-firing attachments for service guns, both seacoast and rapid-fire; and safety-lanyard attachments for seacoast guns on disappearing carriages. They had also rebanded 8- and 10-inch Parrott shells for target practice. Floor space had been added to the smith shop for a small brass furnace, and for preparing molds for pouring castings up to 250 pounds in weight.⁴²

41. Executive Documents, Printed by Order of the House of Representatives for the 2d Session of the 60th Congress, 1908-09 (Washington, 1908), Serial 5425, VI, 50.

42. Executive Documents, Serial 4449, pp. 51-2; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

b) November 28, 1905, Fire

On November 28, 1905, for the second time in sixteen years, a disastrous fire struck the Proving Ground. Destroyed were the machine, carpenter, paint, and plumbing shops, together with the power plant. As soon as practicable after the fire, temporary shops were fitted up in vacant buildings, where such tools and machinery as had been saved from the flames were installed. Power for operating the shops and the electric lighting system was obtained during the emergency by utilizing the generators and steam engine and the electrical laboratory.

Before the end of Fiscal Year 1906 the task of preparing plans and specifications for erection of machine, smith, carpenter, plumbing, and paint shops, including a power plant, authorized by the Sundry Civil Act of June 30, 1906, was underway.⁴³

c) Construction of a New Machine Shop, Carpenter, Plumbing and Paint Shop, and Power House

Construction commenced on the three brick buildings that were to house the machine and smith shop, carpenter, plumbing and paint shop, and power house in Fiscal Year 1907. By June 30 the foundations had been completed and the walls raised to about one-fourth their planned height. Contracts also had been negotiated for purchase of machinery and tools to equip the shops.

The shops, which had been temporarily located in vacant buildings since the fire, continued to provide space for machinists engaged in experimental work. The Proving Ground's staff still devoted much time to servicing and repairing armament emplaced in the Endicott Batteries of the Sandy Hook District.⁴⁴

43. Executive Documents, Serial 5110, p. 4950; Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

44. Executive Documents, Serial 5275, pp. 58-60.

The new fireproof, brick shops were completed and accepted by Colonel Birnie on March 24, 1908. Since then they had been operated in an efficient and satisfactory manner. The single-story machine shop consisted of a main building, 170 by 40 feet, two wings, a washroom, and boiler annex. The carpenter, plumbing, and paint shops, with office, toolroom, and toilet, were housed in a building 157 by 34 feet. The power house, divided into engine-room, boiler-room, and coalhouse, was located in a building 125 by 40 to 26 feet. This complex of structures had cost the taxpayers \$107,600.

The shops were equipped with modern machinery, with each machine driven by an individual motor. The largest lathe in the machine shop could handle a 6-inch gun. The power house contained duplicate generator sets for power and one generator for electric lighting. It was kept in continuous operation to furnish power and light for the Proving Ground activities.⁴⁵

d) Improvements to the Range and Proof Battery

At the proof battery in Fiscal Year 1902 there had been built one concrete emplacement for testing experimental carriages and a set of skids for parking 5- and 6-inch rapid-fire guns.

The gantry crane had been electrified by installation on the crane and its car of six 7-1/2-horsepower motors and one 1-1/2-horsepower motor, together with necessary controllers, switches, etc. A special trolley system had been added that would neither interfere with the movements of the crane nor obstruct the work of the battery. In the power house there were installed to furnish motive power for the crane two 35-horsepower direct-control high-speed engines and two polyphase 25 kilowatt direct-current generators, one 50-horsepower horizontal boiler, and a switchboard with necessary ammeters and voltmeters for the two generators.

45. Executive Documents, Serial 5425, pp. 51-52.

This equipment greatly expedited proofing of the big guns. It was now possible to remove a 12-inch rifle, weighing fifty-two tons, from its proof carriage and place it on a car in twenty-seven minutes. This operation had formerly required four hours.⁴⁶

In Fiscal Year 1903 Colonel Smith and his staff "perfected plans" for establishing permanent velocity screens, grading the ranges, and constructing suitable bombproofs on the ranges. The latter were necessary for proper observation of fire, especially shrapnel and high explosive shell, fired from newly-developed field and rapid-fire guns.⁴⁷

A proposal was prepared and approved in Fiscal Year 1904 for relocating the armor-plated backings and for facilitating the handling of velocity screens. It was essential to provide means for taking velocities when firing at plates. To accomplish this satisfactorily, the backings had to be farther from the emplacements. Colonel Smith's plan called for several railroad tracks, parallel to the line of emplacements. Small cars would propel the velocity screens along the tracks to the desired position. The armor-plated backings would be beyond the screens, and "the runs" which carried the chronograph wires would be buried "to prevent their being cut by fragments of plate or shell."⁴⁸

Having received the necessary allotment, Colonel Smith in Fiscal Year 1905 had his men build three light railroad tracks, parallel to the proof battery, on which cars ran carrying velocity frames. These cars were accurately positioned by "monuments" in the line of the gun used. This arrangement fixed the distance between the screens and from the muzzle of the gun to the first screen. Six chronographs,

46. Executive Documents, Serial 4449, pp. 52-53.

47. Executive Documents, Serial 4641, pp. 51-52.

48. Executive Documents, Serial 4790, pp. 15-16.

instead of four, were mounted in the instrument room, in groups of three, so that two sets of velocities were recorded simultaneously. Management of the switchboards was also improved, and the wiring to the front placed in underground conduits.⁴⁹

The proof battery was enlarged by addition of several emplacements between those already constructed "to accommodate the number of carriages which the increased amount of firing required."⁵⁰

Four bombproofs to provide protection for observers at the targets and facilities for observing the bursting of shrapnel and high explosive shells were built. These stations were of concrete, 8 feet x 10 feet x 7 feet, 6 inches and protected by walls 18 inches thick, with 8 feet of sand on the sides toward the line of fire and proof battery. Observation slots--3/16 of an inch wide, the edges reinforced by angle iron--allowed the observers a full view of all ground surrounding the target and the intervening space.

A contract for construction of an observation range and plotting tower was awarded. This structure consisted of a steel framework, resting on a concrete base and supporting an instrument room. A Swasey depression position finder and plotting board would be installed in the room.⁵¹

In Fiscal Year 1907 ballistic tests of shrapnel and fuses were expedited by a field gun platform constructed at the proof battery. Two velocity screens were erected of sufficient height to permit the taking of velocities at the highest required elevation. The butts for armor-plate tests were relocated to a line parallel to and about 140 feet in front of the guns of the proof battery.

49. Executive Documents, Serial 4950, pp. 59-52.

50. Ibid.

51. Ibid.

To secure more accurate range data, observations were now being taken by three draftsmen stationed in the observation towers. This reduced the extreme variations in ranges to a negligible quantity.⁵²

e) Completion of the Sewer System

The sewer system, on which construction had commenced in Fiscal Year 1901, was completed in the autumn of 1901 and all occupied buildings belonging to the Proving Ground connected with it.⁵³

f) Providing Additional Fire Protection

In Fiscal Year 1904 twelve 3-inch well points were drilled to provide an increased water supply for fire protection and emergency use. They were on a sandy knoll fronting the office in the angle between the roads leading from the proof battery to the office and the road from the brick Officers' Quarters to the office. The new well points were connected by a 5-inch main to the old 5-inch main leading from the well-point group at the explosion chamber to the engine room pump.⁵⁴

The monies appropriated by the Sundry Civil Act, approved by President Theodore Roosevelt on March 4, 1907, for improving facilities for fire protection at the Proving Ground, were allotted for installing a seawater pipeline in connection with the fire alarm system. The pipeline as installed was operated by a 1,000-gallon per minute Worthington pump positioned in the boiler room with steam connection for immediate use when needed. The suction line was 12-inch cast iron flanged pipe, 1,550 feet in length to the water. The intake was

52. Executive Documents, Serial 5275, pp. 58-61.

53. Executive Documents, Serial 4449, pp. 51-53; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

54. Executive Documents, Serial 4950, pp. 51-52.

positioned about 150 feet from shore under the wharf and was protected from injury by ice and debris by a wooden crib supported on pilings.

Three force lines of 6-inch cast-iron, bell and spigot pipe were connected with the pump. Twelve hydrants were distributed to reach the Proving Ground buildings with 250 feet of hose or less. The aggregate length of the 6-inch distributing line was about 2,870 feet, through which water was forced under a pressure of 200 pounds.

There was 1,000 feet of hose, divided evenly to each of the post's four hand-carts. The hose had been tested with 300 pounds pressure. There were two hose-cart houses, one near the office and the other adjacent to the stables. The old hydrants on the fresh waterline, which yielded a pressure of 20 to 30 pounds, were still in position. This system provided additional fire protection for the area.

The fire alarm system included seven alarm boxes near the principal buildings and at the proof battery and dock. They were connected in parallel lines to an open circuit containing a battery and gong. The latter was in the boiler room, and any signal made by it was duplicated on the steam whistle by the fireman. The throwing of the lever on any alarm caused the number of the box to be struck on the gong three times.⁵⁵

g) Addition to the Office

In Fiscal Year 1903 an addition to the office and school, costing \$10,000, was erected. This frame ell nearly doubled the floor space. To expedite testing and experimental activities, an inter-communications system of telephones linking the office, proof battery, storehouse, and shops was installed.⁵⁶

55. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

56. Executive Documents, Serial 4641, pp. 49-52.

h) Construction of a Refrigerating and Heating Plant

A refrigerating and heating plant, costing about \$6,000, was erected in Fiscal Year 1903. This facility would be employed in connection with the Chemical Laboratory for which ground was broken on June 1, 1903, to conduct important investigations of the action of smokeless powder under field conditions.⁵⁷

i) One and One-half Story Brick Chemical Laboratory

In Fiscal Year 1904 the handsome one-and-one-half story brick Chemical Laboratory was completed at a cost of \$23,500.⁵⁸

Following the January 25, 1908, transfer of the equipment of the Chemical Laboratory to Picatinny Arsenal, the electrical laboratory machinery was transferred to the brick structure, and the frame building heretofore employed as an electrical laboratory dismantled and removed. One portion of the frame structure was converted into a garage, and the residue altered and refitted for use as a post exchange for the Ordnance Detachment.⁵⁹

j) Construction of Brick Storehouse and Magazine

Construction was commenced in Fiscal Year 1904 on a brick storehouse and magazine for fixed ammunition. The former was sited to provide for both railroad and cart transportation, while the latter would provide storage for fixed ammunition with a separate room for fuses and primers.⁶⁰ These structures were completed and accepted by Colonel Smith in Fiscal Year 1905.⁶¹

57. Ibid.

58. Executive Documents, Serial 4790, pp. 14-16. A photograph and a floor plan of the Chemical Laboratory are found on Plates 14 and 15, Appendix IV, Serial 4790.

59. Executive Documents, Serial 5425, pp. 51-52.

60. Executive Documents, Serial 4790, pp. 15-16.

61. Executive Documents, Serial 4950, pp. 49-52.

k) Addition to Officers' Quarters

An addition to the brick Officers' Quarters for accommodation of officers on temporary duty at the Proving Ground was built in Fiscal Year 1905. Funds for the project, \$16,600, had been authorized by the Fortifications Act of 1902.⁶²

l) Frame Shed for Storage of Armor-Piercing Projectiles

A shed was erected for storage of armor-piercing projectiles in Fiscal Year 1904.⁶³

m) Construction of a Roundhouse and Engineer's Quarters

In Fiscal Year 1905 a brick locomotive roundhouse, capable of housing three locomotives and a railroad crane, was erected. Built at the same time was a two-story frame structure to serve as quarters for the locomotive engineer.⁶⁴

n) Expanding the Road Network

A gravel road, about 600 feet in length, was opened between Batteries Potter and Israel Richardson as part of the Fort Hancock wagon road system.⁶⁵

o) Mapping the Proving Ground

To facilitate preparation of a more accurate map of the Proving Ground, a team in Fiscal Year 1905 surveyed the northern reaches of Sandy Hook.

Utilizing data compiled by the 1905 survey, maps of the Proving Ground were prepared with revisions to these dates: A

62. Ibid., pp. 50-52.

63. Executive Documents, Serial 4790, pp. 15-16.

64. Executive Documents, Serial 4950, pp. 50-51.

65. Executive Documents, Serial 5425, pp. 51-52.

general map of the reservation, April 4, 1904, scale 1 inch = 900 feet; a detailed map of buildings, roads, and walks, January 23, 1908; and a detailed map of electrical light and power lines, April 4, 1908. The last three were at a scale of 1 inch to 100 feet.⁶⁶

4. Improving Communications--Ashore and Afloat

a) Expanding and Improving the Right-of-Way

About 3,000 feet of new track were laid in Fiscal Year 1902. Besides reinforcing the old roadbed, these rails were used to change the right-of-way and spurs to avoid the new emplacements (Batteries Israel Richardson and Joseph Bloomfield) being added to Battery Halleck and to provide a better approach to the wharf. About 8,000 new ties were positioned, and culverts were renewed and repaired.⁶⁷

In Fiscal Year 1903 about 400 feet of sidings were added to the railroad system at Highland Beach, and connections were made with the old trestle at a point about 650 feet from its southern end. As soon as the Corps of Engineers had built a seawall to protect the neck, the section of the old trestle, which was to be converted into a freight siding, would be filled in with sand and ballast and a graded track made. This could not be done, however, until the seawall had been constructed, because at flood tide the neck was under water.⁶⁸

Under authority found in the Fortifications Act of March 1905, about 1.6 miles of track were constructed by relaying the rails and ties from a point near the proof battery to the Y in Fiscal Year

66. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance; Executive Documents, Serial 5425, pp. 52-53.

67. Executive Documents, Serial 4449, pp. 52-53.

68. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance; Executive Documents, Serial 4790, pp. 14-15.

1906. This provided a straight 5-mile right-of-way, a safe distance west of the firing range from the proof battery to the trestle.⁶⁹

Despite the construction, the railroad was kept open, and traffic soared during the subject year. Freight handled reached 37,429,000 pounds in 1,088 cars. Passengers transported numbered 144,900.⁷⁰

Several sidings were extended in Fiscal Year 1908 to connect with the new shops and to accommodate a change in the line of target butts at the proof battery. Water for the locomotives was now drawn from the Fort Hancock mains whose source was deep wells. There had been a continuing problem with the boilers as long as the water came from surface wells.⁷¹

b) New Trestle

In accordance with the recommendations of a Board convened at Sandy Hook in November 1903, an allotment of \$75,000 was made by the Quartermaster General for construction of a new trestle over the narrow neck connecting the reservation with the mainland. The project was advertised and a contract awarded, having a completion date of November 15, 1904.⁷² The 4,460-foot trestle, with an 850-foot approach at the Sandy Hook end, were completed in Fiscal Year 1905.⁷³

69. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

70. Executive Documents, Serial 5110, pp. 48-49.

71. Executive Documents, Serial 5424, pp. 50-51.

72. Executive Documents, Serial 4790, pp. 14-15.

73. Executive Documents, Serial 4950, pp. 49-50.

c) New Railroad Equipment

In Fiscal Year 1903 a locomotive crane of 80,000 pounds capacity was purchased from the Bay City, Michigan, Industrial Works, for \$11,500.⁷⁴

In 1905 a Fairbanks railway scales was installed north of the machine shop near the new brick storehouse. A small house was erected over the side arm to protect the scales and its operator in inclement weather.⁷⁵

d) Old "Ordnance" is Replaced

A new steamer Ordnance, built at a cost of about \$75,000, was received from the contractor. She replaced the vessel of the same name. The new Ordnance made her maiden run from Sandy Hook to New York City on March 24, 1905.⁷⁶

e) Movement of Materiel and Passengers Soars

The passenger train service inaugurated in May 1901 was an instant success. Three coaches belonging to the Ordnance Department and one to the Corps of Engineers soon made up the train. In addition to the employees of these departments, enlisted men and civilian employees of Fort Hancock were carried. Passes issued by the post commander were honored on both the railroad and the steamer Ordnance. During the twelve months ending June 30, 1902, between 50,000 and 60,000 passengers were transported.⁷⁷

The railroad in Fiscal Year 1907 was maintained in first-class condition. Once again, it proved its value for convenience and economy in the transportation of men and materiel. Seven hundred and one cars, carrying 26,049,600 pounds of freight, had been either received

74. Executive Documents, Serial 4641, pp. 49-50.

75. Executive Documents, Serial 4950, pp. 45-50.

76. Ibid.; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

77. Executive Documents, Serial 4449, pp. 52-53.

or sent from Sandy Hook. Passenger traffic stood at 140,000 for the twelve months.⁷⁸

U.S.S. Ordnance had operated between Pier 12 on the East River at the foot of Wall Street in New York City and Sandy Hook daily except for Sundays and holidays. Passengers numbered 22,033, and freight carried amounted to 1,102,500 pounds. The steamer had logged 10,698 miles during the year.⁷⁹

As in previous years the reservation railroad was maintained and operated by the Ordnance Department in Fiscal Year 1908. It had continued to provide "efficient and economical service" for the Proving Ground and Fort Hancock. Freight shipped over the road during the twelve months was 43,121,385 pounds. Passengers numbered 140,000.

Cost of maintenance and operation of the railroad was \$1,728 per mile per annum. When prorated, this made the cost of transportation per passenger mile, including both maintenance and operation, \$.014, and the cost per ton of freight, \$.029.

During the year U.S.S. Ordnance had transported fewer passengers and less cargo than in Fiscal Year 1907--18,762 passengers and 877,700 pounds of freight.⁸⁰

5. Ordnance School Comes to the Proving Ground

In the spring of 1903 the school for instruction of student Ordnance officers, proposed by General Crozier in 1901, was established at the Proving Ground. This school was the result of a report submitted by Capt. B.W. Drum. Hereinafter, young officers, on being assigned to the Ordnance Department, would be ordered to Sandy Hook. There they

78. Executive Documents, Serial 5275, pp. 58-59.

79. Ibid.

80. Executive Documents, Serial 5424, pp. 50-51.

would engage in the practical work of conducting tests and experiments necessary in the introduction of new artillery materiel into the service, and also for the acceptance of certain standard manufactured materials. In addition, they would participate in a course of practical and theoretical work and study under guidance.

In their college courses these officers had studied mechanics, chemistry, and other sciences relating to the engineering work which was part of the duties of the Ordnance Department. But they still had to undergo the training required to make them mechanical engineers in the special branches which were concerned with the design and manufacture of ordnance materiel of all kinds. They were to spend one year at Sandy Hook, during which study and instruction occupied only part of their time. The remainder of their attention would be devoted to proof work, which was useful and necessary, as distinguished from that which was for their own edification.⁸¹

To provide temporary facilities for the school pending construction of the Chemical Laboratory, electrical apparatus was purchased and positioned in a room in the office temporarily arranged for that purpose. The switchboard and machines were located to facilitate making complete tests of all machines, both as generators and as motors. A course of study featuring such tests and other "practical work" was prepared by the instructor in charge.

Colonel Smith, who had replaced Captain Babbitt as post commander in November 1902, hoped that Congress would soon appropriate funds for a "suitable physical laboratory and museum." Items there could be used for the instruction of the young officers, and "the various designs of ordnance construction may be arranged and utilized in the study of the development of the various features."

81. Ibid., pp. 52-53.

A practical course in machine work was also established. A master-mechanic was transferred from the Frankford Arsenal and detailed as "assistant to the student officers in their study and practice of machine work."⁸²

It was impossible to specify regular hours for instruction of the student officers in "the school of application, owing to the requirements of other duties" at the Proving Ground. Progress of the officers, however, was satisfactory as it "related to their interest and zeal."

Instruction for the officers in machine shop practices had been prescribed, and each was expected to complete the work allotted during the year. Each student averaged about 3-1/2 hours' study and 1/2 hours' practical work weekly in the electricity department. No curriculum had yet been prescribed for the Chemical Laboratory. During Fiscal Year 1904 the chemical apparatus and the standard tests of powders and explosives were explained and illustrated. The student officers also visited the plant of International Smokeless Powder and Chemical Co., at Parlin, New Jersey.⁸³

The class in Fiscal Year 1905 numbered six officers. The course of study included "practical instruction" in chemistry of powders and explosives, applied electricity, and metal-working machines.⁸⁴

The class in Fiscal Year 1906 included from four to six officers. Each officer made at least one complete chemical analysis of samples of black and smokeless powder; conducted tests prescribed for

82. Executive Documents, Serial 4641, pp. 40-51; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

83. Executive Documents, Serial 4790, pp. 14-15.

84. Executive Documents, Serial 4950, p. 52.

acceptance of nitrocellulose and nitroglycerin powders; manufactured in small quantities nitrocellulose and other nitro compounds; and determined the composition of the gas produced following the explosion of nitrocellulose.

Once again, through the courtesy of H.F. Brown of International Smokeless Powder and Chemical Co., the officers had an opportunity to witness the manufacture of smokeless powder on a large scale.

The program for practical instruction in machine shop work consisted of graded exercises at the lathe, universal milling machine, and planner and sharpener. The student officers learned foundry and blacksmith work and how to polish and electroplate metals. This course was terminated by the disastrous fire which destroyed the machine shop on November 28, 1905.

Following the fire, the electrical laboratory, which had been used for instruction, was employed to supply light and power to the Proving Ground and was unavailable as a classroom. Night lectures were instituted, and the greater part of the work, both practical and theoretical, was done in the evening because the officers were occupied with proof work during the day.⁸⁵

In Fiscal Year 1907 the class was increased to nine student officers. Several new courses were added to the curriculum. They were ordnance engineering and differential equations. The former consisted of thirty-one problems applying to service materials, with the principal calculations involved in designing guns, coast and mobile gun carriages, projectiles, and fuses. Experience gained in solving these problems, Colonel Smith reported, enabled the officers who "completed the course to undertake their use with confidence."⁸⁶

85. Executive Documents, Serial 5110, pp. 49-50.

86. Executive Documents, Serial 5275, p. 61.

VII. THE PROVING GROUND'S FINAL YEARS AT SANDY HOOK

A. Colonel Birnie's Years as Commander

1. Colonel Babbitt Replaces Colonel Birnie

Colonel Birnie commanded the Proving Ground for four years and nine months. He was reassigned as Acting Chief of Ordnance on September 21, 1912, and Maj. Jay Hoffer, as senior officer present, took charge of the facility until October 4 when Col. Edwin B. Babbitt reported and commanded the Proving Ground for the second time. Babbitt would wear two hats, as he was also president of the Board for Testing Rifled Cannon.¹

2. Programs for Fiscal Years 1909-12

a) Tests, Proofs, and Experiments in Fiscal Year 1909

Ballistic tests of materiel for service in Fiscal Year 1909 included 103 lots of shot and shell, 49 lots of shrapnel, 70 lots of fuses, 9 lots of tracer shells, 104 lots of powder, and proof of 27 guns.

The number of rounds fired during the twelve months were 7,177 from guns of various calibers. This involved expenditure of 93,000 pounds of powder. In addition, there were fired 15,500 pounds from caliber .30 machine guns and 57 explosive tests. As was to be expected, the amount of paperwork generated had increased proportionately. Five hundred and twenty-eight reports and firing records were prepared and submitted. One hundred and five targets had been plotted, along with many charge-velocities and charge-pressure-curves for powder records.

Maintenance projects associated with the Sandy Hook Armament District had escalated since January 1, 1909. Since that date nineteen companies of Coast Artillery from Forts Hamilton, Wadsworth, Totten, and Schuyler, and the 1st Class, Corps of Cadets, U.S. Military Academy, had been sent to Fort Hancock for annual target practice on

1. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

the big guns. These troops were in addition to the six-company Fort Hancock garrison.²

b) Tests, Proofs, and Experiments in Fiscal Year 1910

During this year ballistic tests of materiel included fifty-nine lots of shot and shell, ten lots of shrapnel, fifty-two lots of fuses, thirty-two lots of tracers, 42 lots of powder, and proof of twenty-seven guns. The principal new or experimental materiel under test included guns, carriages, powders, projectiles, fuses, primers, gunshields, grenades, range-finders, and an electric firing apparatus for coastal defense cannon.

The number of rounds fired from guns of various calibers was 4,073. These firings necessitated preparation of 370 reports and firing records, plotting of forty-four targets, and calculation of charge-velocity and charge-pressure-curves for powder records.³

On February 14 and 15, 1910, Chief of Ordnance Crozier was at Sandy Hook and watched the test of projectiles from a 12-inch gun fired against a concrete target.⁴

c) Tests, Proofs, and Experiments in Fiscal Year 1911

Ballistic tests of materiel for service included twelve lots of shot and shell, seven lots of shrapnel, forty-eight lots of fuses, eight lots of night tracers, one lot of day tracers, forty-nine lots of powder, and proof of five guns. The principal new or experimental materiel under test included guns, carriages, powders, projectiles, fuses,

2. Executive Documents, Printed by the House of Representatives for the 2d Session of the 61st Congress, 1909-10 (Washington, 1910), Serial 5721, XVIII, 20, 43.

3. Executive Documents, Printed by the House of Representatives for the 1st Session of the 62d Congress, 1910-11 (Washington, 1911), Serial 5955, I, 609-10.

4. Returns from U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

primers, gunshields, grenades, range-finders, and electric and pneumatic firing devices for seacoast cannon.

The number of rounds fired from various caliber guns during the year was 5,605. These firings necessitated preparation of 367 reports and firing records, the plotting of twenty-four targets, and preparation of powder records of charge-velocity and charge-pressure-curves.⁵

New gun lever arms of greater strength were received for the 14-inch carriage. They were tested and proved satisfactory.

The 14-inch gun, Model 1907, wire-wrapped, was fired fifty-nine times with powder pressures of as high as 44,300 pounds per square inch.

"A very complete series of firings" with 14-inch armor-piercing shot, sand-filled, and armor-piercing shell, loaded with explosive "D" and fused, was made against large concrete targets. Later, the same targets were attacked with Navy 12-inch armor-piercing shell filled with explosive "D" and fused.⁶

Work for the Sandy Hook Armament District dropped off during the year. It now consisted of assembling brakes and buffers for all 10-inch shot trucks; new lighting conduits on 12-inch disappearing carriages; releveling base rings and regraduling azimuth circles of three 8-inch disappearing carriges, Model 1894; overhauling recoil, countercoil, and tripping systems on two 6-inch carriages, Model 1903; altering a counter-recoil buffer on one 12-inch disappearing carriage, Model 1896;

5. Executive Documents, Printed by the House of Representatives for the 1st Session of the 62d Congress, 1911-12 (Washington, 1912), Serial 6197, I, 698.

6. "History of the Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

and assisting the Coast Artillerists in construction of a marine railway at Fort Hancock.

To facilitate the work of the machinists, their portable tool outfit was modified and increased. It now included: a 10-kilowatt gasoline generator set, a portable motor driven air compressor, motor driven drill, air driven drill, and air-riveting and chipping hammers.⁷

d) Tests, Proofs, and Experiments in Fiscal Year 1912

During these twelve months ballistic tests of service and experimental materiel included twenty-seven lots of shot and shell, twenty-four lots of shrapnel, seven lots of shrapnel cases, forty-eight lots of fuses (combination and detonating), fifteen lots of shell tracers, sixty-two lots of powder, and eight lots of fixed ammunition.

Twenty armor plates were tested for acceptance and twenty guns proved. The principal experimental materiel under test were the 14-inch disappearing carriage, Model 1907; the 12-inch mortar carriage, Model 1908; turret and barbette armor-plate for two 14-inch gun turrets to be erected on El Fraile Island (Fort Drum), Manila Bay, Philippine Islands; the pilot 3-inch mountain gun and carriage; a 4.7-inch and 6-inch howitzer and carriage of latest design; and various designs of high explosive shrapnel.⁸

During the year work done by the Proving Ground mechanics for the Sandy Hook Armament District consisted principally of current repairs. In addition, two mortar carriages were dismantled to correct "hard traversing"; the pintle surface of one 12-inch disappearing carriage, Model 1901, was turned off; the range drums of four

7. Ibid.

8. Executive Documents, Printed by the House of Representatives for the 3d Session of the 62d Congress, 1912-13 (Washington, 1913), Serial 6370, XII, 920.

15-pounder barbette carriages, Model 1898, were regraduated; broken clips were replaced on one 12-inch disappearing carriage, Model 1896; and broken crosshead teeth replaced on a 6-inch disappearing carriage, Model 1903.⁹

3. New Construction and Improvements to the Buildings and Grounds

a) New Two-story Brick Barracks

In July 1902 Captain Babbitt had called the Department's attention to the need for a new and larger barracks. The present crowded frame structure, he reported, was built for a detachment of sixty-two, about two-thirds the strength of the one currently posted at Sandy Hook. If a new barracks were programmed, the old structure could be used as quarters for the few mechanics, engineers, and firemen that remained on the reservation overnight.¹⁰

Plans and specifications for construction of a barracks, authorized by the 1902 Fortifications Act, were prepared and bids called for in Fiscal Year 1905. The proposals received were far in excess of the funds appropriated. Congress was asked for more money for the barracks, and the plans were modified to reduce the cost.¹¹

Construction of the barracks finally began in July 1908. Daniel J. Ryan of Brooklyn was the contractor, while Maj. T.C. Dickson of the Ordnance Department supervised the \$52,000 project from preparation of plans to completion. In April 1909 the building was accepted, and the Ordnance Detachment moved in.

The two-story barracks was brick, with a basement, and afforded comfortable quarters for 100 men. There were five squad

9. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

10. Executive Documents, Serial 4285, pp. 337-38.

11. Executive Documents, Serial 4950, pp. 50-51.

rooms and a mess hall, each 50 by 29 feet, extending in three wings from a 40- by 50-foot central structure. The building was about 150 feet long by 90 feet in depth. Its walls were finished inside with faced brick of natural color. There were two lavatories on each story, convenient to access from the squad rooms.

Grading around the barracks was done by the Ordnance Department, as well as positioning electrical conduit and the 5-inch steam heating lines from the power house to the building. These lines, which also connected with the new post exchange, were respectively 650 and 825 feet in length.¹²

Grading, landscaping, and top soiling of the grounds adjacent to the Ordnance barracks were completed in Fiscal Year 1910. The interior brick walls of the barracks were completed in Fiscal Year 1910, and painted a light color, which in the opinion of Colonel Birnie added materially to its appearance and comfort of its occupants.¹³

b) Rehabilitating the Frame Barracks

The frame barracks, occupied by the Ordnance Detachment for 16 years, was rehabilitated at a cost of \$3,100. Among the improvements was steam heating, the building having been connected with the central power plant. The old barracks now housed the Proving Ground post office and served as quarters for married enlisted men and laborers. Three rooms were assigned to the Corps of Engineers. The old frame barracks, erected in the 1860s and belonging to the Corps, was turned over to the Ordnance Department and razed. The grounds were then landscaped.¹⁴

12. Executive Documents, Serial 5721, pp. 41-42; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

13. Ibid.

14. Ibid.

c) Ordnance Detachment Garden

A garden for the Ordnance Detachment was laid out near the new barracks. Profits from the post exchange were used to purchase top soil. In 1910 "fair progress" was made by the soldiers in growing vegetables to supplement their rations.¹⁵

d) Improvements to the Proof Battery and Range

In Fiscal Year 1909 12-inch gun-lift carriage, No. 2, Model 1891, was installed for proof work. It replaced 12-inch barbette carriage, No. 9, Model 1891, which was shipped across the continent to Fort Warden, Washington.

The sand butts were removed from near the guns to a line beyond the velocity screens, about 500 feet away, and the intermediate ground graded. The plank flooring and platforming in and about the gantry crane runway, an area about 400 feet long by 60 feet wide, were removed and replaced by a concrete surface.

Construction was commenced on an emplacement for a 14-inch gun and carriage on the right flank of the proof battery. Foundations for this emplacement extended to a depth of ten feet below the level of the standing water in the same, and these added to the difficulty. The emplacement, when finished, would contain about 600 cubic yards of concrete. The depth from the level of the platform to the foundation was 21.25 feet and the surface of the platform was 48 feet wide by 60 feet long.¹⁶

The concrete emplacement for the 14-inch gun and carriage was completed in August 1909. The carriage was received from the Watertown Arsenal in late December. It was positioned in January

15. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

16. Executive Documents, Serial 5721, pp. 40-41; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

1910, and on February 4, for the first time, a giant 14-inch breech-loading rifle fired from the proof battery. The lever arms were defective and the carriage was temporarily dismantled, while new ones were fabricated at the arsenal. So that time would not be wasted, the 14-inch gun was remounted upon the altered 12-inch gun-lift barbette carriage. Firings were resumed to determine a suitable powder for the gun and for ballistic tests for 14-inch armor-piercing shot and shell.

Two new concrete bombproofs for observation of fire on the range were constructed, one near the 1,000-yard and the other near the 2,500-yard target. In addition, the range was cleared of underbrush as far as the 3,000-yard target, beyond which the ground was open. This greatly facilitated observation of fire for hits on land.¹⁷

The telephone line connecting the proof battery with the range towers and targets was overhauled in Fiscal Year 1909, and new telephones installed.¹⁸

In Fiscal Year 1912 the saltwater main was extended for fire-fighting purposes to the vicinity of the proof battery.¹⁹

e) Extending Steam Heat to Most Areas of the Buildings

A 3-inch steam pipeline, approximately 1,500 feet in length, was laid in 1909 from the power house into several buildings associated with the proof battery. Steam heat replaced coal stoves heretofore used in these structures. This steam line also heated the powder temperature plant, and, together with the motor installed to operate the pump for refrigeration in the building, enabled Colonel Birnie to remove the boiler. This resulted in increased efficiency and enabled

17. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

18. Executive Documents, Serial 5721, pp. 41-42.

19. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

the post to dispense with the service of one engineer, a saving for the government of \$120 in wages per month.²⁰

A steam line in 1910 was laid from the power plant to the brick Officers' Quarters. A hot water heater was installed in this building (the oldest extant structure on the Proving Ground) for its radiating system, replacing the two coal furnaces previously in use. One of the furnaces was retained for emergencies.

With this improvement, steam heat from a central power house had been introduced into nearly all the Proving Ground buildings. This led to economy in labor and cost of fuel. Colonel Birnie ordered records kept of coal consumption, mean out-of-door's temperatures, and connected radiation surfaces in the buildings heated by steam. The results showed that consumption of coal averaged 2,683 pounds per square foot of radiating surface per week. This he considered to be "a very creditable result."²¹

A saving in the cost of fuel of between 20 and 25 percent, without any increase in the cost of labor, was effected in Fiscal Year 1911 by substitution of buckwheat No. 2 for pea coal. Colonel Birnie forecast a further reduction in fuel costs would be realized by recording the coal and water consumption "so as to check the efficiency of individual employees."²²

f) Construction of Another Coal Bin

The expansion of the steam heating system called for increased fuel storage facilities. Thus, another coal bin was built in Fiscal Year 1910.²³

20. Executive Documents, Serial 5721, pp. 41-42.

21. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

22. Ibid.; Executive Documents, Serial 6197, p. 699.

23. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

g) New Post Exchange

One wing of the old electrical laboratory was moved to a new site near the brick barracks. There it was rehabilitated with an allotment from the Quartermaster Department for use as a post exchange. It opened for business in April 1909.²⁴

The post exchange was enlarged in Fiscal Year 1912 at a cost of \$1,725 to provide a recreation room for the Ordnance Detachment. Purchased and placed in the room were a pool table and a piano.²⁵

h) Improvements to Shops

A rubber tire plant, using materials provided by the Watertown Arsenal, was added to the machine shop. Men employed in it had the task of retiring truck wheels received from the Sandy Hook and Central Armament Districts.²⁶ In Fiscal Year 1910 the tire plant retired 408 wheels and casters.²⁷

Projects undertaken for the Sandy Hook Armament District increased sharply during Fiscal Year 1910. Included were alterations and additions to materiel. The monetary value of this armament work for the district and Proving Ground during the year was about \$20,000 as against \$8,000 during the previous year. Cost of work done for the Central District during the same period was \$4,000, as opposed to a negligible sum in Fiscal Year 1909. This called for a corresponding increase in the machine shop workforce to an average of thirty men per day.

24. Executive Documents, Serial 5721, pp. 41-42.

25. Executive Documents, Serial 6378, pp. 920-21.

26. Executive Documents, Serial 5721, pp. 41-42.

27. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

The equipment had been upgraded, particularly the "outfit of small machine and hand tools."²⁸

In Fiscal Year 1911 an oil burning fuel plant and oil storage tank were installed in the blacksmith shop. This plant provided ample heat for annealing metals. A 2,500-pound steam-drop-hammer was installed to expedite rebanding projectiles. Two rivet-dock thread cutter attachments; an air hammer attachment; and an attachment for finishing bands, separate holders, and steady rests, etc., were purchased for the toolroom lathes.²⁹

The following year this equipment was purchased and installed: a Vehling CO₂ Recorder; a Schaeffer & Budenberg Recording Draft Gauge; a Throttling Calorimeter; a Recording Thermometer; and a Vulcan Soot Blower. The portable tool outfit was enlarged by acquisition of an electric drill and electric clipping hammer.³⁰

In Fiscal Year 1912 the dressing room and toilet facilities at the machine shop were rehabilitated. The machinists and laborers were delighted with these improvements.³¹

i) Improvements to the Water and Sewer Systems

About 475 feet of 8-inch sewer pipe, which had become choked and obstructed by long usage, was removed in Fiscal Year 1910 and replaced by new pipe. The expansion of the Fort Hancock water system enabled the Proving Ground maintenance force to position a hydrant near the wharf for fire protection. At the same time they laid a

28. Ibid.

29. Executive Documents, Serial 6197, p. 699; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

30. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

31. Ibid.

branch line from the Fort Hancock line to the outer extremity of the wharf to enable Ordnance and other vessels to take on water as needed.³²

j) Washroom and Lunchroom

Utilizing \$4,000 appropriated by the Sundry Civil Act of March 4, 1911, construction was commenced on a single-story washroom-lunchroom for personnel employed at the Service Magazine and Refrigeration Plant. The building was 42 by 26 feet, with an annex 16 by 7 feet. Its foundations and foot walls were concrete, the walls of repressed red brick, floors of cement, and roof with steel trusses and purlins, wood rafters and sheathing boards, covered with asbestos shingles.³³

k) Underground Electrical Transmission System

An underground electrical transmission system, provided for by an appropriation of \$5,500 in the Sundry Civil Act of June 25, 1910, was completed during the summer of 1912.³⁴

l) Repairs to the Wharf

Repairs, costing \$4,490, were made by contractor George Humphreys of Brooklyn to sections Nos. 1 and 2 of the wharf in Fiscal Year 1912.³⁵

m) Fire Destroys the Refrigerating Plant

On Sunday night, February 11, 1912, fire destroyed the Refrigerating and Powder Plant. Colonel Birnie believed the fire was

32. Executive Documents, Serial 5955, p. 609.

33. Executive Documents, Serial 6197, p. 699; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

34. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

35. Ibid.

caused by ignition of a few grains of black powder coincidentally left in what were thought to be empty cartridge-bags stored near a steam pipe.³⁶

4. Protecting the Site

The Sundry Civil Act, signed into law by President Roosevelt on March 4, 1909, allotted \$30,000 "for protecting the east shore line of the Sandy Hook Proving Ground." On May 7 the Department signed a contract with Jesse A. Howland of Seabright, New Jersey. The contractor was to build eighteen jetties to protect the beach for 1,700 yards, extending southward from a point 200 yards north of the 1,000-yard target.

The Howland jetties consisted of two rows of chestnut pilings, with vertical sheathing boards and stringers of creosoted pine, strongly bolted and spiked together. Each jetty made a sand-tight wall, perpendicular to the shore, extending seaward for distances varying from 150 to 300 feet. The top line was graded downward from about 1 foot above the height of the shore bluff at the inner edge to a level about 1 foot below flood tide at the outer end.³⁷

The jetties were completed by September 1909. They held up during the ensuing winter's storms. There was difficulty at only one place, where it was necessary to build an inshore addition. Colonel Birnie, however, cautioned the Department that it would be necessary to extend the jetty system northward another 1,100 yards to shield the shore, where it flanked the proof battery and short-range firing space.³⁸

In Fiscal Year 1911, eleven jetties, similar to those completed in September 1909, were built to protect another 3,000 feet of

36. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

37. Executive Documents, Serial 5721, p. 43.

38. Executive Documents, Serial 5955, p. 609.

shore line. Jetties now shielded the beach from the vicinity of the 2,500-yard target northward to a point opposite the high explosive loading shed and overlapped the existing stone revetment on the north shore of the Hook. Construction of these latter jetties had been funded by a \$20,000 appropriation in the Sundry Civil Act of March 4, 1911.³⁹

5. Transportation of Supplies and Personnel

In Fiscal Year 1909 freight traffic over the Ordnance Railroad dropped from 43,121,000 to 36,239,000 pounds, transported in 1,051 cars. The number of passengers (140,000) remained about the same.

The experiment with artesian water from Fort Hancock had failed, as it caused the locomotive boilers to scale as badly as the surface water. Colonel Birnie accordingly contracted with the Tintern Manor Water Company of Long Branch, New Jersey, to provide water for the reservation locomotives. This was done by a connection with one of the company's mains near Highland Beach Station.

Beginning January 22, 1909, Ordnance made additional daily trips on Tuesdays, Thursdays, and Saturdays between New York City and Sandy Hook for the convenience of the Fort Hancock garrison. This additional service had boosted annual operating costs of maintenance and operation, including drydocking and painting, to about \$17,000. The Quartermaster Department, having requested the increased service, paid one-third of the running expenses.

Ordnance had carried 40,658 passengers and 1,564,000 pounds of freight during the year and had logged 12,618 nautical miles. A marked reduction in coal consumed per mile steamed had been effected. Colonel Birnie attributed this to the installation of additional circulation

39. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

pages in the feed-water drum, more frequent cleaning of water tubes, and regulation of the steam jet for draft.⁴⁰

Creosoted hardwood ties, cut and treated on the Picatinny Arsenal Reservation, were employed in Fiscal Year 1912 to maintain the railroad right-of-way. The previous year freight shipped over the railroad fell to 28,500,000 pounds in 560 cars. Passengers carried had dropped to about 126,000. During the same twelve months Ordnance had transported 29,000 passengers, 1,803,000 pounds of freight, and traveled 15,408 nautical miles.⁴¹

During the year a fifteen-ton Orten & Steinbronner steam locomotive crane, costing \$6,275, was purchased by the Proving Ground.⁴²

6. School of Ordnance Application Comes of Age

The student class in Fiscal Year 1910 consisted of eight officers. Detailed as instructors were Maj. Tracy C. Dickson, assisted by Capt. Wilford J. Hawkins and Birchie D. Mahaffey. Major Dickson was relieved from duty at the Proving Ground late in the year and ordered to Panama.

The improvement in the school's curriculum under Major Dickson's supervision was noticeable. He had extensively revised the course of study. Nineteen hundred and ten, Colonel Birnie reported, had been the most successful one in the history of the School of Application, because it was the first time since 1903 that a "satisfactory number of trained officers have been available for duty as instructors."⁴³

40. Executive Documents, Serial 5721, pp. 4142.

41. Executive Documents, Serial 6197, p. 699; Executive Documents, Serial 6378, p. 920.

42. "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

43. Executive Documents, Serial 5955, p. 610.

In addition to the two lectures given each week by the instructor in the various courses, the class had benefitted from a series of seminars given by invited experts: Capt. David S. Seagrave of the Ordnance Department; Messrs. Ward, Rypinski, Clark, and Nesbitt of Westinghouse Electric; and Messrs. Chatain, Seede, Haraden, and Kimball of the General Electric Company. These outstanding engineers had voluntarily donated their time and talents to enrich the program.

Experience had demonstrated that student officers were unable to complete the course of study in one year, while required to subordinate their studies to proof and administrative work. It was apparent to Colonel Birnie that the attempt to perform both classes of work detracted from efficiency in each. It had, therefore, been determined that beginning with the Class of 1910-11 these duties would be separated. The class of nine student officers was divided into two sections. Capt. Joseph H. Pelot, and Lts. H.K. Rutherford, J.H. Burns, and C.C. Shepherd were assigned to the 1st section and performed proof work and covered parts of the course in chemistry of powder and explosives and differential equations. The second section--Lts. R.W. Case, C.S. Donavin, W.E. Dunn, R.B. Cummins, and J.L. Walsh--took the regular course of study and were occasionally assigned proof orders. This program envisioned that the class would spend two years at the Proving Ground instead of one as heretofore.

Instructors were: Maj. Jay E. Hoffer, assisted by Capts. L.B. Moody and R.H. Somers. As in Fiscal Year 1910, a number of outside lecturers participated in the program. From the service came Maj. W.H. Ischappal and Odus C. Horney, and from industry came Messrs. A.H. Clarke, Everett Coplay, W.C. Ward, Arthur H. Abell, Charles G. Owens, and J.K. Coutant of Westinghouse Electric, and Messrs. H.V. Allen, M.W. Franklin, E.A. Harris, H.G. Harvey, and S.M. Castle of General Electric.

The field trip program was expanded. There were trips to Picatinny Arsenal, New Jersey; Westinghouse Electric & Manufacturing Company's Instrument and Small Motor Work in Newark and Lamp Works in

Watessing, New Jersey; General Electric Company's Lamp Works, Harrison, New Jersey; and Midvale Steel Company and the Frankford Arsenal, Philadelphia, Pennsylvania. Officers taking the course in electricity visited the works of General Electric in Schenectady, New York.⁴⁴

The School of Ordnance Application, in Fiscal Year 1912, consisted of two sections. Lts. Lawrence W. McIntosh and Charles A. Eaton were in the 1st Section and performed only proof and administrative work; the 2d Section consisting of Capts. Joseph H. Pelot and Earl McFarland, and Lts. Harry K. Rutherford, James H. Burns, Greedy C. Shepherd, Raphael R. Nix, Roger S. Parrott, and John J. Thomas participated in the regular course of instruction and proof orders covering the general classes of ordnance materiel tested.

There were field trips to Picatinny Arsenal, Dover, New Jersey; Horton Ice Cream Company, New York City (to inspect an unusually complete and modern gas producing plant); Frankford Arsenal and Midvale Steel Company, both in Philadelphia; Westinghouse Electric & Manufacturing Company's lamp works at Watessing, New Jersey; and the General Electric plant in Schenectady, New York. These visits to establishments, where ordnance materiel was manufactured, were deemed to be of great value for the education of the student officers.

During the year the course of study in chemistry of explosives and powder was revised, and that in ordnance engineering reorganized to present the problems involved in more "logical sequence." This second year's experience with the class divided into sections had satisfied the staff of the wisdom in adopting this arrangement. In the future, two proof officers would be taken from those who had completed

44. Executive Documents, Serial 6197, p. 699; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

the first year's course, instead of assigning them to proof work during their first year at the school as had been the practice.⁴⁵

B. Administering the Post: 1913-19

1. Commanders Come and Go

a) Colonel Dickson as Commanding Officer

Colonel Babbitt commanded the Proving Ground on this, his second, tour of duty for nineteen months. On April 15, 1914, he was assigned to Washington as Assistant to the Chief of Ordnance, and Lt. Col. Tracy C. Dickson assumed charge of the facility. Colonel Dickson, while commander of the Proving Ground, also served as armament officer of the Sandy Hook Armament District and as a member of the Ordnance and Engineer Boards.⁴⁶

b) VIP's and the Post

On October 5, 1915, fourteen months after the outbreak of World War I, the Adjutant General authorized an increase in the strength of the Ordnance Detachment from 92 to 112 enlisted men--12 sergeants, 17 corporals, 42 privates 1st class, and 41 privates 2d class.⁴⁷

A large number of ranking officials and officers inspected the Proving Ground during these years. Secretary of War Lindley M. Garrison was at the post on May 24, 1913. On April 20, 1914, the 1st Class of U.S. Military Academy cadets spent the day at the Proving Ground as a part of their course in Ordnance and Gunnery. Four days later, on the 24th, Secretary of War Garrison returned to Sandy Hook, accompanied by Brig. Gen. Hugh L. Scott. The following

45. Executive Documents, Serial 6378, pp. 920-21; "History of Sandy Hook Proving Ground," NA, RG 156, Records of the Office, Chief of Ordnance.

46. Executive Documents, Printed by the House of Representatives of the 3d Session of the 63d Congress, 1913-14 (Washington, 1914), Serial 6798, I, 482.

47. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

year, with much of the world at war, Assistant Secretary of War Henry S. Breckinridge, accompanied by Brig. Gens. Albert L. Mills and Erasmus W. Weaver, toured Sandy Hook on April 20. Maj. Gen. Leonard Wood, Commander of the Department of the East, spent April 22 at the Proving Ground. Chief of Ordnance Crozier was on post most of the week.⁴⁸

By 1916 the nation was preparing for war, and the Proving Ground, as one would suspect, continued to be a focus of attention. On June 10, Newton D. Baker, who had replaced Garrison as Secretary of War, along with Chief of Staff Hugh L. Scott and General Crozier, spent the day at Sandy Hook.⁴⁹

c) Colonel Ruggles Spends Twenty-Seven Months as Post Commander

On August 16, 1915, Colonel Dickson was ordered to Watertown Arsenal, and Maj. J.W. Hawkins, as senior officer present, assumed command of the Proving Ground. Hawkins was relieved by Maj. W.I. Westervelt on October 16. Before the end of the year, on December 11, 1915, Lt. Col. C.L.H. Ruggles reported for duty and replaced Major Westervelt as post commander. Ruggles, like Colonels Birnie and Smith, was also president of the Ordnance Board, a member of the Board for Testing Rifled Cannon, and Armament Officer for the Sandy Hook Armament District.⁵⁰ Colonel Ruggles commanded the Proving Ground for twenty-seven months. On March 4, 1918, he was reassigned to Washington as Chief of Supply, Ordnance Department. His replacement was Col. William A. Phillips. In addition to being Armament Officer for the Sandy Hook Armament District, Colonel Phillips also commanded the newly established Aberdeen Proving Ground.⁵¹

48. Ibid.

49. Ibid.

50. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

51. Executive Documents, Printed by the House of Representatives for the 3d Session of the 65th Congress, 1918-19 (Washington, 1919), Serial 7479, 1, 1,056. Colonel Phillips had entered on duty at the post on April 12, 1917.

d) Final Months See a Succession of Commanding Officers

Colonel Phillips commanded the Sandy Hook and Aberdeen Proving Grounds until February 13, 1919, when he was relieved of responsibility for the former. His replacement, as officer in charge of Sandy Hook, was Lt. Col. James Kirk. Four months later, on June 16, Kirk was transferred to Washington. With Sandy Hook being rapidly phased out by transfer of personnel and equipment to Aberdeen, Kirk was succeeded as post commander by Capt. Theodore H. Beard.⁵²

C. Work Load Shifts and Increases

1. Tests, Proofs, and Experiments in Fiscal Year 1913

Ballistic tests of service and experimental artillery materiel included, as heretofore, ammunition, armor-plate, and guns. The principal new experimental materiel under test consisted of a 6-inch disappearing carriage, Model 1905 M2; 14-inch disappearing carriage, Model 1907; record and counter-record system of 14-inch turret mount; 12-inch mortar carriages, Models of 1896 M₃ and 1908; 12-inch mortars, Models 1908 and 1912; 14-inch guns, Models of 1907, 1907M, and 1909; 6-pounder balloon gun, carriage, and sight; 3- and 3.8-inch howitzers and carriages; 2.95-inch Deport field gun; 2.56- and 2.95-inch Deport mountain guns; and 1-pounder subcaliber tubes for 3-inch field guns and 4.7-inch howitzers.

The number of rounds fired from various caliber guns during the year was 3,487. Twenty-two fragmentation tests of projectiles had been made. These firings necessitated preparation of 368 reports and firing records, the plotting of fourteen targets, and a large number of charge-velocity and charge-pressure curves for powder records.⁵³

52. Sandy Hook Proving Ground, Annual Report for Fiscal Year 1919, NA, RG 156, Decimal File 319.1/2.

53. Executive Documents, Printed for the House of Representatives for the 2d Session of the 63d Congress, 1913-14 (Washington, 1914), Serial 6608, 1, 726.

2. Tests, Proofs, and Experiments in Fiscal Year 1914

During these twelve months the principal materiel tested included 14-inch guns, Models 1907 M1, 1909, and 1910; 14-inch disappearing carriage, Model 1907 M1; 12-inch mortars, Models of 1908 and 1912; 12-inch mortar carriages, Models M1 and 1908; counter-record system of 14-inch turret mount; 3-inch mountain howitzer and carriage, Model 1911; 3.8-inch howitzer and carriage, Model 1908; 4.7-inch howitzers and carriages, Model 1908; 6-inch howitzers and carriages, Model 1908; 1-pounder subcaliber tubes for 3-inch field guns and 4.7-inch howitzers; and 9.2-inch 50-caliber gun and mount for Bethlehem Steel Co.

Fifty-two lots of projectiles received from various contractors, 3 lots of experimental projectiles, 5 lots of night tracers, 38 lots of shrapnel cases, 116 lots of fuses, 8 armor-plates, 113 lots of powder, and 3 lots of rifle grenades had been tested. In addition, forty-five guns and 29 carriages were proof fired.

During the year 6,256 rounds had been fired from guns of various caliber. One hundred and fifty-eight fragmentation tests of projectiles were made. These firings necessitated preparation of 734 reports and firing records and plotting of 75 targets, along with computation of eleven range tables.

At the proof battery, the number of rounds fired was 74 percent greater than the average for the four previous years. This increase in quantity of work compelled Colonel Dickson to hire additional employees to perform work previously accomplished by the Ordnance Detachment, which had been called upon for more manpower for firing details.⁵⁴

3. Tests, Proofs, and Experiments in Fiscal Year 1915

As befitted 1914, the year in which the "Great War" erupted, the amount of proof work completed at Sandy Hook "greatly

54. Executive Documents, Serial 6798, pp. 482-83.

exceeded that of previous years." Included were 43 tests against armor-plate; 171 tests of fuses; testing and retesting of 74 lots of powder; and proof firing forty guns of various caliber. This program entailed preparation and completion of 133 tests and the firing of 8,474 rounds.⁵⁵

4. Tests, Proofs, and Experiments in Fiscal Year 1916

Colonel Ruggles reported that during these twelve months the amount of proof work completed "was greater than that of preceding years." This work included 33 tests against armor-plates; 154 tests of fuses; testing and retesting of 133 lots of powder; and proof firing thirty-nine cannon of various caliber. This comprehensive program necessitated preparation and completion of "113 programs of tests and the firing of 6,955 rounds from cannon."⁵⁶

The satisfactory results obtained at the Proving Ground with the single-section core-igniter charge in large caliber guns had led to the use of that form of charge in lieu of the standard multiple-section charge during the Coast Artillery's annual target practice. This had resulted in marked improvement in the uniformity of pressures and velocities wherever single-section charges were employed.⁵⁷

Maintenance of the seacoast armament had proceeded satisfactorily during the year. There had been serious difficulties with the 14-inch disappearing carriages in that several elevating screws had broken. The "pilot carriage at Sandy Hook had been fired 189 times" before this defect had surfaced, but several carriages emplaced in the Panama Canal Zone fortifications broke these screws on being proof fired.

55. Executive Documents, Printed for the House of Representatives for the 1st Session of the 64th Congress, 1915-16 (Washington, 1916), Serial 6967, 1, 709.

56. Executive Documents, Printed for the House of Representatives for the 2d Session of the 64th Congress, 1916-17 (Washington, 1917), Serial 7140, 1, 837.

57. Ibid., p. 824.

The Ordnance Department was investigating the problem and was satisfied that it could be corrected, although the best method of accomplishing this required "some experimentation and consequent time."⁵⁸

The issuance of seacoast guns and carriages to the Canal Zone fortifications had been completed so far as provided by available appropriations, except that the 16-inch disappearing carriage was still undergoing testing at Sandy Hook. These tests had been nearly completed for the carriage as built, without developing any difficulties of consequence. The carriages, as designed, permitted a maximum elevation to fifteen degrees, while necessary parts for increasing this to twenty degrees were being manufactured, and would be ready for assembly to the carriage in the near future. These changes would be made at Sandy Hook, and a few rounds would be fired for test of the new mechanism.

As Chief of Ordnance Crozier had informed Congress, the design and production of the 16-inch disappearing carriage, which was the first of its kind ever made, and "which successfully controls the forces resulting from a muzzle energy of 188,894,720 foot-pounds, constituted a very considerable engineering success." The production of this carriage had not been undertaken at the time the 16-inch gun was tested, because "for a long time there was doubt as to whether it could be emplaced in the seacoast fortifications, and if so, at what point."⁵⁹

On January 4 the premature explosion of a 4.7-inch shell, undergoing a fragmentation test in the "new explosion chamber," wounded three men--Lts. Follett Bradley and Russell Maxwell, and Pvt. George Reiter.⁶⁰

58. Ibid., p. 832.

59. Ibid., p. 831.

60. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

5. Tests, Proofs, and Experiments in Fiscal Year 1917

On April 6, 1917, the United States declared war on the Kaiser's Germany and plunged into the Great War that was to make the world safe for democracy. As to be expected during these months, the quantity of proof work completed was greater than in any preceding year. Included were 51 tests of armor-plate; 294 tests of fuses; testing and retesting of 277 lots of powder; and proof firing fourteen cannon of various caliber. This involved preparation and completion of 85 test programs and firing of 26,716 artillery rounds.⁶¹

6. Tests, Proofs, and Experiments in Fiscal Year 1918

As one would expect, the volume of work during these months was far "in excess of that for any preceding years." Included were tests of armor-plate, fuses, lots of powder and other ordnance materiel, as well as the proof firing of guns of various caliber.⁶²

7. Tests, Proofs, and Experiments in Fiscal Year 1919

Although Sandy Hook was being phased out as the Army's proving ground, its final year as an active Ordnance Department installation saw no slowdown in the workload. During these twelve months 660 work orders were issued, involving \$250,000. Included were tests of guns, carriages, and ammunition; maintenance of seacoast armament in the Sandy Hook Armament District; shop expense orders; and special orders issued under allotments for alterations to guns, carriages, etc.⁶³

There were 610 arsenal or outside orders, costing the taxpayer \$500,000. These orders covered maintenance of the post

61. Executive Documents, Printed for the House of Representatives for the 2d Session of the 65th Congress, 1917-18 (Washington, 1918), Serial 7341, I, 816.

62. Executive Documents, Serial 7479, p. 1050.

63. Sandy Hook Proving Ground, Annual Report for Fiscal Year 1919, NA, RG 156, Decimal File 319.1/2. There were in the Sandy Hook Armament District in Fiscal Year 1919: 204 seacoast guns, 74 mobile guns, 4 railway guns, 4 railway mounts, and 4 railway cars.

(repairs and improvements to buildings); maintenance of the steamer Ordnance (not including salaries of the crew, fuel, or cost of repairs when the vessel was in drydock); maintenance of the railroad (not including salaries of locomotive crews and track gangs); receiving and issuing general supplies; wagon transportation; heating and lighting; operation of the Ordnance School of Application; preservation of ordnance and ordnance stores; special orders issued under allotments for repair and improvements to buildings and other public works; construction of temporary buildings; and a huge item for funding transfer to the Aberdeen Proving Ground of employees and materiel.⁶⁴

There had been 1,150 tests and experiments involving materiel valued at \$99,950,060. In arriving at this figure the value of the lot represented was that listed in the annual compilation for powders, projectiles, and fuses. In the acceptance test of 12-inch deck piercing shell, the value of the lot represented was listed in the annual compilation. This method was also followed in all retests and experimental tests, which habitually necessitated nearly the same quantity of work as the original test.

In all experimental work conducted under work orders from the Ordnance Board and special boards, values were assigned as appeared appropriate to the test. In the test of the shortened elevating arm for a disappearing carriage, the value of the carriage was included, and in the test to determine effect of moisture on smokeless powder, the value of the lot of powder (50,000 pounds) was the figure employed.⁶⁵

Because the Sandy Hook facility was being phased out and because of the end of World War I, there was less activity at the proof battery than in Fiscal Year 1918. To show this in graphic fashion, Captain Beard prepared a table, listing the more important classes of tests made in Fiscal Year 1919, as well as during the eight preceding fiscal years:

64. Ibid.

65. Ibid.

Fiscal year of	1911	1912	1913	1914	1915	1916	1917	1918	1919
(a) Total number of rounds fired from field and seacoast cannon								#	
							13,201	42,534	10,277
(b) Total number of rounds fired from .30 cal. rifle and machine gun								#	
							13,400	149	
(c) Total number of fragmentations and explosions							115	163	76
Total number of rounds fired from cannon including fragmentations and tests	*	*	*	*	*		+	+	
	3,261	3,493	3,414	3,631	6,388	6,955	26,716	42,846	10,353
Total rounds fired in connection with other tests								#	
								28,329	483
Number of programs and addenda thereto completed for the Ordnance Board								#	Sandy Hook Programs
	105	89	93	117	133	113	85	64	40
Number of tests against armor plates	22	33	22	38	48	33	51	168	127
Number of fuse tests	49	47	40	116	171	154	294	#610	
Number of guns proof fired	5	20	29	74	40	59	14	#26	71
Number of carriages tested									68
Number of lots of powder tested and retested						∅		#	
	79	64	66	111	74	133	277	411	663 ⁶⁶

66. *In the Annual Report for 1918 the total number of rounds reported as fired during the years 1911 to 1915 included those fired from small-arms.

∅Includes 13 lots of saluting powder.

+Total of (a), (b), and (c).

#Data not complete.

For the year ending June 30, 1919, the rounds fired were from Seacoast guns only, 4.72 inches in caliber to 14-inch inclusive.⁶⁷

D. Maintenance and Protection of the Facilities

1. Construction of New Refrigeration and Powder-Heating Plant

Congress included an appropriation of \$6,000 in the Sundry Civil Bill, approved by President William Howard Taft, on August 24, 1911, for reconstruction of the fire-gutted refrigeration and powder-heating plant. The new facility, which was built on the site of the old, was completed by June 30, 1912.⁶⁸

2. Repairing the Wharf

In Fiscal Year 1912 a "portion of the wharf" was "thoroughly overhauled and repaired." Utilizing an appropriation of \$8,500 found in the Sundry Civil Act, approved by President Woodrow Wilson, June 23, 1913, a contract was signed to have the "central triangular section of the wharf rebuilt." When this work was accomplished, the adjacent sections, except the decking, were put in good condition.⁶⁹

3. Improving the Water Approaches to the Wharf

A contractor, in Fiscal Year 1912, removed about 14,000 cubic yards of silt and sand from the approaches to the wharf. When he had finished dredging, there was a depth of fifteen feet at low tide alongside the dock.⁷⁰

4. Repairing the Railroad Trestle

Beach erosion and heavy seas in the winter of 1913-14 again threatened the trestle carrying the Ordnance Department Railroad

67. Ibid.

68. Executive Documents, Serial 6608, p. 727.

69. Ibid.; Executive Documents, Serial 6798, p. 482.

70. Executive Documents, Serial 6608, p. 727.

across the neck south of Spermaceti Cove. Employing contingency funds, emergency repairs were made to the trestle. It was estimated that at least \$25,000 were needed in the near future to maintain uninterrupted railroad transportation to the Hook.⁷¹

An appropriation of \$25,000 was included in the Sundry Civil Act, approved by President Wilson on March 3, 1915, for "filling a portion of the trestle and providing concrete culverts."⁷² To keep the trains rolling, while the trestle was being reconstructed, about 1,600 feet of track were laid to relocate the main line west of the proof range.⁷³ The "permanent filling" of a portion of the railroad trestle was done by contract in the summer of 1916.⁷⁴

5. New Brick Storehouse

A storehouse, costing \$24,000, was erected in Fiscal Year 1915. In July and August 1915 the new structure was connected with the post electrical and steam heating systems, and storage bins were installed.⁷⁵

6. Fire Damages Building No. 33

On the morning of October 13, 1914, fire broke out in a frame storehouse, building No. 33. The blaze was extinguished before it made much headway, but not before it had damaged the ceiling and sheathing, along with some household goods stored within.⁷⁶

71. Executive Documents, Serial 6768, p. 482.

72. Executive Documents, Serial 6967, p. 709.

73. Ibid.

74. Executive Documents, Serial 7140, p. 827.

75. Executive Documents, Serial 6967, p. 710.

76. Returns for U.S. Military Posts, 1800-1916, NA, Microcopy M-617.

7. Fire Damages the Wharf

At 11 P.M., on October 10, 1916, a fire erupted at the wharf. Before it was extinguished, about twenty-five feet of flooring and stringers on the end near the shore were damaged.⁷⁷

8. Artesian Well and Filtering Plant

An artesian well, for which a special allotment was made in Fiscal Year 1916, was completed on August 16, 1916. It was soon discovered that without a filtering plant, the water was not potable. Chief of Ordnance Crozier accordingly made a \$2,000 allotment for construction of a filtering plant. Although the plant was built in Fiscal Year 1917, the contract was in litigation until May 1919, when it was settled with the government paying 75 percent of the contract price.⁷⁸

9. Construction of Additional Seawall

A \$50,000 allotment was utilized in the winter and spring of 1919 for construction of a "temporary seawall as an emergency protection" for the railroad between Sandy Hook and Highland Beach. The 1,000-foot wall was built of "derrick rock," varying in weight from 150 to 10,000 pounds. It served its purpose and no washouts were reported for several months.⁷⁹

E. Riding the Railroad and "Ordnance"

During Fiscal Year 1919, the last year in which the Ordnance Department operated the railroad, it transported 351,146 passengers and 200,348,761 pounds of freight. This involved the movement of 3,294 cars.

From July 1, 1918, until May 21, 1919, the steamer Ordnance logged 11,714 miles in moving 32,670 passengers and 2,071,751 pounds

77. Ibid.

78. Sandy Hook Proving Ground, Annual Report for Fiscal Year 1919, NA, RG 156, Decimal File 319.1/2.

79. Ibid.

of freight. She was laid-up for general overhaul from July 25 to September 14. This was her first "complete over-hauling" since she was launched thirteen years before. The steamer was again drydocked on May 21, 1919, for semi-annual repairs and painting.⁸⁰

F. School of Application's Final Years at Sandy Hook

The Ordnance School of Application in Fiscal Year 1913 was headed by Major Hoffer, assisted by Capt. H.K. Rutherford and Lt. J.J. Thomas. There were nine student officers, divided into two classes.

In addition to lectures given by the school staff, Major Hoffer continued the policy of exposing the class to outside authorities. There were during the year one or more lectures by Lt. Col. Odus C. Horney of the Ordnance Department; Dr. M.W. Franklin, and Messrs. H.M. Hobert, J.A. Haraden, M.D. Troy, W.P. White, and G.H. Stickney of General Electric Co.; Messrs. W.C. Ward, H.P. Fisher, A.E. Allen, and D.A. Bowen of Westinghouse Electric & Manufacturing Co.; and T.E. Brown of the Watertown Arsenal. These men, well-known technicians in their fields, enriched the course.

Major Hoffer continued the field trips. During the year there were visits by the class to Picatinny Arsenal; Goldschmidt Thermit Co., Jersey City; the Otto Gas Engine Co's. plant at Charles Mundt & Son, New York City; and Pennsylvania's Frankford Arsenal and Midvale Steel.⁸¹

On December 20, 1914, Maj. W.J. Hawkins replaced Major Hoffer as officer in charge of the school. Assistant instructors were Capt. Glen F. Jenks and 1st Lt. Franz A. Doniat. In addition to the lectures on methods of manufacture of smokeless powder at Picatinny Arsenal by Capt. J.H. Burns, the class heard talks by Mr. W.R. Haynie of Carels

80. Sandy Hook Proving Ground, Annual Report for Fiscal Year 1919, NA, RG 156, Decimal File 319.1/2.

81. Executive Documents, Serial 6608, p. 727.

Freres Diesel engines; Dr. W.H. Tolman, director of the American Museum of Safety; Mr. M.R. Hutchison, chief engineer of Thomas A. Edison Co.; and Messrs. J.A. Shorey, J.B. Shelby, J.M. Hough, P.A. Dyer, and A.L. Powell of General Electric.

There were field trips for the student officers and instructors to Picatinny Arsenal; Brooklyn Rapid Transit Power Co's plant; a gas producing plant in Jersey City; Bethlehem Steel Co.; E.W. Bliss Manufacturing Co., Brooklyn; J.H. Williams & Co., Brooklyn; General Electric Lamp Works, Harrison, New Jersey; and Westinghouse Electric & Manufacturing Co., Newark.⁸²

Major Hawkins was succeeded as head of the school by Capt. M.L. Britt on March 4, 1915. During Fiscal Year 1915 the student officers toured twelve area plants engaged in the manufacture of smokeless powder, electrical materials, gas and diesel engines, steel, and generation of power. Guest lecturers included Lt. Col. W.H. Tschapput of the Ordnance Department; Maj. Alston Hamilton of the Coast Artillery Corps; Dr. W.H. Tolman, director of the American Museum of Safety; Mr. Charles P. Frey of Western Electrical Instrument Co.; Messrs. J.H. Shorey, R.F. Barton, O.F. Allen, D.P. Burleigh, and C. Fair of General Electric Co.; and Messrs. C.E. Allen, Quinton Adams, W.C. Wood, and a Mr. Paine of Westinghouse Electric.⁸³

Captain Britt was relieved by Major Westervelt as officer in charge of the School of Application on August 30, 1915. During the fiscal year eight line officers, detailed for temporary duty with the Ordnance Department, were ordered to Sandy Hook for a year's course in theoretical engineering work of ordnance construction. Their second year's course would be "entirely practical."

82. Executive Documents, Serial 6798, p. 483.

83. Executive Documents, Serial 6967, p. 710.

At the Proving Ground, the line officers took a number of classes with the School of Application. During the year the student officers visited seventeen plants and "saw much of interest in the manufacture of smokeless powder, electrical materials, gas engines, steel and steel products, ammunition for all calibers of guns up to 16-inch, and in the generation of power." These trips, Colonel Ruggles reported, "especially those to plants making projectiles and fuzes in vast quantities for use abroad, were of much value to the student officers."⁸⁴

The school in Fiscal Year 1919 was transferred from Sandy Hook to Aberdeen.

G. Proving Ground Finds a New Home

1. Colonel Ruggles Justifies the Need for a Proving Ground

On February 2, 1917, one day after Germany announced she was resuming unrestricted submarine warfare, Colonel Ruggles wrote Chief of Ordnance Crozier that the need of a larger area for a Proving Ground was becoming daily more acute. It would become more so when the "projected large caliber mobile artillery, firing high capacity shell and the 16-inch gun and 16-inch mortar arrive." Although it had been suggested as an alternative, the Bethlehem Steel Company's proving ground at May's Landing, New Jersey, was not a satisfactory answer.

Colonel Ruggles believed that the only solution was for the Ordnance Department to purchase and develop a new site, preparatory to abandoning Sandy Hook. Expansion of Fort Hancock, he explained, was gradually encroaching on the beach range. A searchlight had been erected by the Coast Artillery on the Proving Ground, about 2,600 yards down the beach from the proof battery. Recently, a fragment from a 6-inch high explosive shell, which burst on impact 1,800 yards down range, had ripped into the proof battery. There is nothing, Colonel Ruggles warned, to prevent a similar fragment from being hurled into Fort Hancock or Highland Beach. Firing to sea, he continued, was

84. Executive Documents, Serial 7140, pp. 805-06, 837.

frequently interfered with by shipping, and often had to be suspended because of fog or haze.⁸⁵

Within another week, Colonel Ruggles wrote a second letter to the Chief of Ordnance on this subject. He cited six reasons why the Proving Ground should be relocated. They were: (a) danger to personnel and property at Fort Hancock and on the Shrewsbury River; (b) limitations on tests imposed by a restricted beach range; (c) impossibility of using planes of fire segmented by 180°; (d) interference with fire to the seaward by fog, haze, and shipping; (e) unavailability for use in event of war with a major naval power; and (f) expense of prosecuting work during inclement weather because of interruptions to outside work necessitated by the severe winters.

An extensive search for a better location for the Proving Ground had been made by his staff, utilizing Coast Survey charts. As a result of this project, it had been concluded by Colonel Ruggles that on the shores of Chesapeake Bay were several sites greatly superior to Sandy Hook as a proving ground.⁸⁶ The site best answering the needs for a new proving ground, the Ordnance Department concluded, was Maryland's Kent Island.

2. Department Selects a New Site

On August 3, 1917, four months after the United States had declared war on Germany, Chief of Ordnance Crozier informed the Adjutant General that the Ordnance Department had determined that Sandy Hook was inadequate to meet the Army's present demands for the test and proof of ordnance and ordnance materiel. There was an imperative need for the prompt acquisition and equipment of a proving ground to meet current and future requirements thrust upon the service by the greatly increased range and power of mobile artillery.

85. Ruggles to Crozier, Feb. 2, 1917, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

86. Ibid., Feb. 7, 1917, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

After an exhaustive reconnaissance of the country east of the Mississippi, the Department had settled on Kent Island as the only one meeting all its requirements. The Deficiency Estimates now before Congress included \$3,000,000 for increasing the facilities for proof and testing of ordnance materiel, including necessary buildings, equipment, and land.⁸⁷

The Army's proposal to establish its enlarged proving ground for testing and proofing heavy artillery on Kent Island stirred up a hornet's nest. There were irate letters to Congress, public meetings, and petitions trumpeting local opposition.

Responding to this storm, General Crozier on August 7 explained to U.S. Representative Jesse D. Price of Maryland why the Ordnance Department had to have new and expanded facilities. At Sandy Hook, he wrote, the greatest range at which guns could be fired across land was 6,700 yards. This was considerably less than the maximum range of a 3-inch fixed gun and "entirely inadequate for the proper test of guns and ammunition of larger caliber." It was impossible at Sandy Hook, he explained, to fire 6-inch explosive shells, or those from larger pieces, at any distance on the beach range without endangering lives and property.⁸⁸

Confronted by this opposition, the Ordnance Department looked at other nearby Maryland sites. Russell Jones of Harford County called attention to a site on Bush River.⁸⁹ In mid-September the Department determined that a 25,000-acre area on Harford County's Gunpowder River would answer its needs.

87. Crozier to Adjutant General, Aug. 3, 1917, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

88. Crozier to Jones, Aug. 7, 1917, NA, RG 156, Ltrs. Sent, Chief of Ordnance.

89. Jones to Crozier, July 20, 1917, NA, RG 156, Ltrs. Recd., Chief of Ordnance.

3. Establishment of the Aberdeen Proving Ground

On October 6, 1917, legislation was enacted by the 1st Session of the 65th Congress appropriating \$15,480,000 for establishment of a new proving ground on Cheseapeake Bay, near Aberdeen, Maryland. Of this sum, approximately \$3,600,000 was expended for land acquisition.

Aberdeen Proving Ground was formally established on March 4, 1918, with Colonel Ruggles reassigned from Sandy Hook as its commanding officer. As facilities were developed at Aberdeen, those at Sandy Hook were phased out. By the end of Fiscal Year 1918, sufficient personnel had been assigned to Aberdeen to permit the testing and proofing of ammunition and other ordnance materiel.⁹⁰

90. Executive Documents, Serial 7479, p. 1050.

APPENDIXES

Appendix A

Table 1.--Showing firings made with seacoast guns at Sandy Hook Proving Ground, during Fiscal Year 1892

Object of Firing	Breech-loading rifled mortars					Breech-loading rifles					Muzzle-loading rifles			
	Cast-iron, Steel-hopped					Steel			Cast-Iron					
	Steel W.A., 12-inch, No. 1	S.B.I.W., 12-inch, No. 1	B.I.F., 12-inch, No. 1	B.I.F., 12-inch, No. 2	B.I.F., 12-inch, No. 3	W.A., 12-inch, No. 1	W.A., 10-inch, No. 1	W.A., 8-inch, No. 1	W.A., 8-inch, No. 4	Steel tube, S.B.I.W., 12-inch	Wire-wound, W.A., 10-inch No. 1	Chambered, W.P.F., 10-inch, No. 2	Canet S.B.I.W., 8-inch, No. 1	Ames wrought-iron, 7-inch, No. 2
Accuracy								3		13	24			
Endurance											72			
Exhibition by Secretary of War				1		1	1							
Experiments with high explosives												10		9
Experiments with deck-plate targets				7										
Proof of powder	5			20	18	32	32	16			17			6
Range				3							8			
Rapidity										8	10			
Smoothness in flight of projectile							2							
Test of banding of projectiles								15						
Berdan fuse													4	
Merrian fuse				4	2									
Canet cartridge			7											
Easton & Anderson carriage		33												
Free record carriage								4						
Pneumatic disappearing carriage							32							
11-1/2-inch armor plate							3							
French smokeless powder							4							
German smokeless powder							1	14						
Schaphaus-Houghton smokeless powder								3						
Gun	17		7	5	6	5			7					
Frankford Arsenal sight								32						
Siebert Velocimeter								7						
Determine drift of projectile								17						
Verify pressures						1								
Total rounds	22	33	14	40	26	41	90	84	7	21	131	10	10	9



Table II.--Showing firings made with siege and field guns, howitzers and mortars, Sandy Hook Proving Ground, during Fiscal Year 1892.

Object of Firing	Breech-loading rifles and howitzers (steel)										
	W.A., 1891, 3.2-inch, No. 1	W.A., 3.2-inch, No. 18	W.A., 3.2-inch, No. 26	W.A., 3.2-inch, No. 32	W.A., 3.2-inch, No. 1	Hotchkiss mountain 3.2-inch, No. 168	Driggs-Schroeder 6-pdr., No. 1	Watertown Arsenal 5-inch, siege, No. 1	Watertown Arsenal, 7-inch, howitzer, No. 1	B.L. mortar, steel, W.A. 3.6-inch, No. 1	M.L. rifle, wrought iron P.I. Co 3-inch, No. 1
Accuracy			10		56	86					
Coefficiency of reduction in ballistic formula					20						
Endurance					258	320					
Exhibition for Chief of Ordnance	2	4								1	
Proof of powder	32	49	30	241	32	7					159
Range					6						
Rapidity				30	20						
Test of:											
Armstrong fuse					6						
Frankford Arsenal combination fuse		12	54	8							
Frankford Arsenal fuse with lead time train		29									
McIntyre fuse		1									
Merriam fuse			60						2		
Axial vent		10									
Bode quadrant			82								
Equipment for mortar									79		
Electric-welled shrapnel		49	131	18							
Hotchkiss shrapnel			118								
Gerdow breech mechanism	85										
Seabury breech-mechanism							17				
Gravity chronograph			2								
French smokeless powder		23	2								
Schaphaus-Houghton smokeless powder		2									
Frankford Arsenal shrapnel		6	14								
Powder put in water-proof cases		12	24								
Projectiles				37		11					
Rafferty's friction recoil brake			2								
Sawyer's canister			4								
Time of flight of shell					1						
To determine											
Jump of gun				15							
Residue of silk cartridge bag to that of serge				50							
Effect on crack in powder chamber				112							
Effect of position of band on accuracy of fire				6							
Velocity of projectile						11					
Test of carriage			54				99	21			
Total number of rounds	85	177	399	127	967	471	29	116	21	82	159



Table III.--Field guns.

Tests of	Muz- zle load- ing		Breech-loading rifles										Total rounds for object of firing			
	3-inch wrought iron	1.65-inch Hotchkiss	3.2-inch							3.6-inch No. 13	12-pdr. Driggs- Schroeder	75-mm. Hotchkiss				
			3-inch Hotchkiss	Driggs-Schroeder	Gerdom	No. 18	No. 32	No. 26	No. 1							
Primers in gun with axial vent							27					5				32
Frankford Arsenal point Percussion fuses		9							5	46						60
Gun and breech mechanism			56	154	63											273
Frankford Arsenal shrapnel								29	6	28						63
Frankford Arsenal base percussion fuses	6							24	22							52
Driggs base percussion fuses								6	7							13
Service canister			5													5
Cartridge cases brass					12	22										34
Leonard smokeless powder					6	7										13
Maxim smokeless powder					20	6										26
Peyton smokeless powder					4	8										12
DuPont smokeless powder						6										6
Walarode smokeless powder						4										4
Aluminum cartridge cases			7		3											10
Griswold delay-action percussion fuses												11				11
Sphero-hexagonal powder												5				5
To determine--																
Pressures								4		21			3			28
Charge to give standard velocity					6			13								19
Drift of shell & shrapnel									5							5
Suitability for field service													14			14
To ascertain--																
The effect of band of projectile on pressures																
The action of smokeless powder with reduced chamber space					45											45
For rapidity			8	57	83											148
Using defective cartridges			5	4	3											12
To compare pointing arc with the present service sights								22								22
Total	6	14	69	154	205	27	103	86	64	16	14	3				



Table IV.--Seacoast guns.

	Muzzle-loading smooth bore		Muzzle-loading rifles		Breech-loading rifles, steel								
	8-inch cast iron	10-inch cast iron	15-inch cast iron	7-inch Ames wrought iron	15-inch altered smooth bore	8-inch type	8-inch service	10-inch Crozier wire-wound	10-inch type	10-inch service	12-inch type	12-inch service	Total rounds for object of firing
Test of--													
Gun								188					188
10-inch Buffington-Crozier disappearing carriage								68					68
10-inch service barbette carriage								26					26
Maxis smokeless powder						8	8			2			18
Leonard smokeless powder						7							7
Rottweiler smokeless powder							7					9	16
Saluting powder	3	3	4										10
Emmissite in steel shell				1									1
Gun cotton in steel shell				1									1
15-inch carriage altered to hydraulic from pneumatic				5									5
Relative accuracy of bands of projectiles					24			20					44
Gun for accuracy					18			7	28				53
Chase-Gantt 9-inch steel plate							2						2
8-inch service barbette carriage						4							4
12-inch service barbette carriage												27	27
Grusonwerk minimum port carriage													11
Carpenter 12-inch steel shot against 13-1/2-inch armor plate													9
Midvale 10-inch steel shot against 11-1/4-inch armor plate									2				2
Pneumatic disappearing carriage before the board on disappearing carriage										1			1
Gordon disappearing carriage before Board on disappearing carriage										3			3
Gordon disappearing carriage										95			95
Proof of guns							106			104	44		254
To determine--													
The coefficient "C" ballistic data									22				22
Velocities and pressures						5							5
The effect of blast upon parapet in firing from disappearing carriages										4			4
The effect of Leonard's smokeless powder against armor plate				1									1
To test--													
The ability of high explosives in shell to withstand shock of discharge and impact				7									7
The ability of base percussion fuse (without plunger) in a shell to withstand shock of discharge and impact				1									1
The safety of firing a fulminate detonator				1									1
To obtain record with Sebert velocimeter							6					1	7
To prove Brown prismatic powder										12	12	22	46
Total	3	3	4	10	7	57	23	188	27	175	40	85	



Table V.--Breech-loading rifled mortars.

	12-inch							
	3.6-inch steel service	7-inch steel type	cast iron type	cast iron service	steel type	Steel service	12.2-inch cast iron	Total rounds for object of firing
Test of--								
Spring-return mortar, carriages, mfg. by West Point Foundry Co.				15	12			27
Gordon mortar carriage					133			133
Emmensite							2	2
Carriage and platform for 7-inch mortar	154							154
Wheeler Sterling 12-inch steel shell against 4-1/2-inch deck plate				1				1
Midvale Holtzer 12-inch steel shell against 4-1/2-inch deck plate				7				7
Carpenter 12-inch steel shell against 4-1/2-inch deck plate				1				1
Frankford Arsenal base percussion fuses				15				15
15-inch carriage No. 1 altered to receive 12-inch B.L. mortar				7				7
To obtain--								
Targets for Board of Ordnance				37				37
Ballistic data				1				1
Data for computing range table	94							94
To determine--								
whether a charged shell would penetrate a 6-inch plate without exploding			2					
Charge		27						
Proof of--								
Mortars				100	124	30		254
Powder						14		14
Test of mortar		154						154
Total	94	154	2	169	145	30	2	



Appendix B

Table I.--Field siege rifles and howitzers, breech-loading, rifled

	5-inch steel service	7-inch steel service	Total rounds for object of firing
Test of Raskazoff disappearing carriage	25		25
Maxim smokeless powder	3		3
To determine velocities and pressures		11	11
Proof of guns	22		22
Total	25	11	

Table II.--Tests in explosion chamber and sand

	<u>Number</u>
2.2-inch shrapnel, Frankford Arsenal exploded in cylinder	20
Shell containing explosives: exploded in explosion chamber	8
exploded in wooden box, 6 feet deep in sand	2

Table III.--Machine guns

Maxim machine gun, caliber .303-inch

444 rounds

Table IV.--Breech-loading rifled rapid-fire guns

	6-pdr.			4.7-inch					Total rounds for object of firing
	6 pdr. Skoda	Hotchkiss	Seabury	Hotchkiss	Schneider	Seabury	Canet	Armstrong	
Test of --									
Guns and breech mechanism	56	22	322	36	74	14	14	8	546
Guns for accuracy at 1 mile		22			12				34
Guns for rapidity				12	20				32
Guns for rapidity with accuracy					11				11
Carriage				9	10				19
To determine --									
Charge using French and service gauges					7				7
Velocities and pressures			9	14					23
Exhibition of gun before Board of Ordnance				1	1				2
Total rounds	56	22	322	36	74	14	14	8	

Appendix C

List of Proving Ground Structures, circa 1909

The dates of the erection of the principal buildings and groups of buildings and their cost, after the house for chronoscope, are as follows, the numbers given being those by which the buildings are designated on the present map of the Proving Ground:

<u>No.</u>	<u>Name and Use of Building</u>	<u>Date of Erection</u>	<u>Cost</u>
	Office and instrument house, wood (Burned August 1889)	1874	\$ 4,000.00
	Machine shops, wood (Torn down in 1900)	1875	2,500.00
29	Small building, one story, wood, in use as church, originally built by Engineer Department for use as wash house. (In 1919 used as coal bin)	1875	300.00
5	Officers' Quarters, brick Addition to same	1876 1904	12,500.00 16,600.00
11	Storehouse, wood, formerly used as carpenter shop, storehouse and Quarters for laborers. (Stable in 1919)	1876	5,700.00
18	Quarters and extension, master workman, wood, two stories	1877	2,500.00
8	Stable, wood	1876	2,000.00
9	Carriage shed, wood	1878	1,000.00
10	Wagon shed, wood	1878	1,000.00
28	Small building, one story, wood, in use as school house, formerly used as a bath house	1880	1,500.00
35	Watchman's house, wood, one story	1884	200.00
40	Shell house, wood, one story	1885	1,500.00
46	Small shed, wood, latrine	1885	300.00

No.	Name and Use of Building	Date of Erection	Cost
47	Bath House, one story, wood	1886	\$ 500.00
1	Office, two stories, wood	1892	13,200.00
	Addition to same	1903	10,000.00
14	Ammunition shed, wood, one story (razed)	1892	1,000.00
32	Quarters, enlisted men, wood, two stories	1892	16,000.00
58	Magazine, corrugated iron, one story	1892	1,965.00
16	Mortar carriage shed, wood (cement and lime storehouse 1919)	1893	2,500.00
26	House, dwelling, two stories, wood, foreman's	1894	2,000.00
41	Tool House, wood, one story	1894	1,800.00
42	Breech Block Shed, wood, one story	1894	1,800.00
43	Field gun shed, wood, one story	1894	2,500.00
57	Observation tower, formerly searchlight tower (moved in 1901)	1894	2,250.00
2	Photograph house, wood, one story	1895	500.00
3	Fire engine house, wood, one story	1895	500.00
13	Locomotive shed, wood, (Razed in 1914 to make way for brick warehouse)	1895	1,000.00
	Electrical Laboratory and storage battery house, one story, wood	1897	1,500.00
	Addition to same	1902	2,500.00
	Original building now in use as a Post Exchange and addition is used as house for motor cars		
56	Magazine, brick, one story	1899	6,000.00
	One (1) machine and carpenter shop, wood, one story, 140'10" x 38' with following "L" additions	1900	15,795.68
	One (1) 81'6" x 30'		
	One (1) 65'6" x 26'6"		
	One (1) 30'0" x 26'		
	One (1) 70'0" x 26'6"		

No.	Name and Use of Building	Date of Erection	Cost
	One (1) coal bin, wood, 57' x 26'	1900	\$ 840.00
	One (1) paint shop, wood, one story 32' x 20' (Destroyed by fire November 1905)	1900	1,200.00
	One (1) plumbing shop, wood, one story, 31' x 23'	1900	1,069.09
	One (1) lumber shed, wood, one story 30' x 19'	1900	500.00
	One (1) scale house, wood, one story 13'2" x 5'2"	1900	175.00
33	Refrigerating and heating plant, wood, and concrete (renumbered 78)	1902	6,000.00
44	Coal bin for locomotive coal	1902	245.95
54	Water tank	1902	1,300.00
12	Storehouse, brick	1903	8,000.00
38	Magazine, brick, one story, for fixed ammunition	1903	8,000.00
39	Magazine, powder, wood, small	1903	2,000.00
36	Pressure House, wood, one story	1903	500.00
22	Chemical Laboratory, two stories brick	1904	25,581.00
7	Green house, wood and glass	1904	750.00
45	Coal bin, for stove coal	1904	200.00
50	Shed for storing gasoline	1904	200.00
52	Railroad scale	1904	1,500.00
59	Observation Tower	1904	2,500.00
6	Laundry building, one story, wood	1905	700.00
17	Locomotive round-house, brick	1905	6,000.00
21	Quarters for locomotive engineer, two stories, wood	1905	4,000.00
53	Sand well	1905	850.00

<u>No.</u>	<u>Name and Use of Building</u>	<u>Date of Erection</u>	<u>Cost</u>
37	Tool shed, one story, wood	1905	\$ 400.00
48	Range tower	1905	6,000.00
49	House for motor cars, one story, wood formerly addition to storage battery building (renumbered 85)	1907	1,000.00
70	Carpenter, Plumbing and Paint Shops, brick		
71	Machine and Blacksmith Shops, Officers' School, brick	1907	107,602.27
68 & 72	Power Plant, brick		
4	Post Exchange, formerly storage battery building	1908	1,500.00
67	Barracks for enlisted men, two stories, brick	1909	52,000.00

Appendix D

Buildings at Sandy Hook Proving Ground, July 1919

1. Office
2. Photo Laboratory
3. Instrument Room
4. Post Exchange & Y.M.C.A. Recreation Room
5. Officers Quarters (brick house)
6. Laundry
7. Green House
8. Stable
9. Carriage Shed
10. Wagon Shed
11. Stable
12. New storehouse
13. New warehouse
14. Lumber Storage Yard
15. Motor Car Shed and Garage
16. Cement and Lime Storehouse
17. Locomotive Round House
18. Dwelling
19. Dwelling
20. Dwelling
21. Dwelling
22. Laboratory, Chemical, and Electrical
23. R.C. Church
24. Dwelling
25. Tennis Court 26
26. Dwelling, occupied by G. Gerdon
27. Shelter House
28. School
29. Coal Bin
30. Ordnance Detachment Garden
31. Hose Cart House
32. Quarters for Civilians and Married Enlisted Men
33. Storage Shed
34. Photograph Gallery (Occupied by Pvt. Heath)
35. Guard Officers House
36. Pressure House
37. Fireproof Vault
38. Ammunition Magazine
39. Bag Sewing Room
40. Shell House
41. Tool House
42. Breech Block Shed
43. Field Gun Shed
44. Coal Bin
45. Coal and Scrap Bin
46. Latrine
47. New Chronograph Wire House
48. Range Tower Station "A"
49. Stock Shed

50. Gasoline Storage, 125-gallon tank
51. Watchman's House
52. R.R. Scales
53. Cow Shed
54. Water Tower
55. Oil Store House
61. Dwelling (Engineer Department)
62. U.S. Engineer's Office
63. Building (Property of L.H. Department)
64. Lumber Shed (Engineer Department)
65. Paint Shop
66. Blacksmith and Carpenter Shop (Engineer Department)
67. New Ordnance Barracks
68. Coal Storage (Part of Power Plant)
69. Ordnance Department Wharf
70. Carpenter, Plumbing, and Paint Shop
71. Machine and Blacksmith Shop
72. Power Plant
73. Engineer Department Wharf
74. Unloading Room
75. Velocity Screen Track (Narrow Gauge)
76. Tide Gauge
77. Coal Bin
78. Corral and Shed
79. Constant Temperature Magazine
80. Proof Battery
81. Lumber Shed
82. High Explosive Loading Sheds (three)
83. U.S.L.S.S. Boat House
84. Fuel Oil Storage Tank
85. Motor car shed
86. Enclosed Manure Pit
87. Artesian Well, Filter House, and Tank
88. Igniter Storage House
89. Bag Filling House
90. Water Tank for R.R. Cranes
91. Old Chronograph Wire House
92. Extension to Traverses
93. Concrete Wall
94. Vegetable Garden
95. Vegetable Cellar
96. Pheasant Cage
98. Projectile Sectionalizing Shop
99. Oil Storage House
100. Igniter Houses
101. Pump House (Refrigerating)
102. Kitchen and Dining Room for Enlisted Men
103. Quarters for Enlisted Men
104. Wood House
106. Office of Labor Division
107. Crane Repair and Storage Houses
108. Service Bag Storage House
109. High Explosive Magazine
112. Ordnance Depot Barracks

- 113. Guard House
- 114. Auxiliary Tool House
- 115. Ash Pit for R.R. Cranes
- 116. Hose Cart House
- 117. Transportation Office

The following Buildings are not located
within the boundaries of this map.

- 56. Powder Magazine
- 57. Observation Tower Station "B"
- 58. High Explosive Magazine
- 59. Observation Tower Station "C"
- 97. Sandy Hook Ordnance Storage Depot

Appendix E

Photographs and Drawings of Proving Ground
Found in Executive Documents

Executive Documents, Serial 3083, Appendix 29.

- Plate I. "Batteries and Buildings, Sandy Hook Proving Ground."
Plates II-III. "Plans, Office Building, Sandy Hook Proving Ground."
Plate IV. "Plan, New Barracks, for Ordnance Proving Ground,
Sandy Hook Proving Ground, Sandy Hook, N.J."
Plate V. "80 Ton Gantry Crane."
Plate VI. "Gantry Crane: Carrying 12-inch B.L. Rifle and Proof
Carriage, Complete, Sandy Hook Proving Ground."

Executive Documents, Serial 3025, Appendix 29.

- Plate I. "Firing Butt for Field and Siege Guns."
Plate II. "Renewal of Wharf at U.S. Ordnance Proving Ground,
Sandy Hook, N.J."

Executive Documents, Serial 3303, Appendix 18.

- Plate I. "Photograph Showing Tower and Searchlight Complete."
Plate II. "Photograph Showing the Locomotive and Two 10-inch B.L.
Rifles Mounted on Cars as Received from the Gun Factory.
Watervliet Arsenal."

Executive Documents, Serial 4097, Appendix 21.

- Plate I. "Drawing Showing the Location of the New Firing Battery
Relative to the Position of the Old."

Executive Documents, Serial 4285, Appendix 32.

- Plates I-III. "Three Photographs, Showing General Views of New Firing
Battery."

Executive Documents, Serial 4641, Appendix 8.

- Plates I-III. "Three Photographs Giving a General View of [16-inch] Gun
Mounted on Its Proof Carriage and Illustrating the Loading
Operation."

BIBLIOGRAPHY

PRIMARY SOURCES

Manuscript Materials

Consolidated Correspondence File. Records of the Quartermaster General, United States Army, National Archives, Record Group 92.

"History of Sandy Hook Proving Ground." Records of the Office, Chief of Ordnance, National Archives, Record Group 156.

Letters Received, Chief Engineer, United States Army, National Archives, Record Group 77.

Letters Received, Chief of Ordnance, United States Army, National Archives, Record Group 156.

Letters Sent, Chief Engineer, United States Army, National Archives, Record Group 77.

Letters Sent, Chief of Ordnance, United States Army, National Archives, Record Group 156.

Returns from U.S. Military Posts, 1800-1916, National Archives, Microcopy M-617.

Maps and Charts

"Comparative Map Showing Shore Changes of Sandy Hook, New Jersey, from 1860 to 1883, compiled and drawn under direction of Major G.L. Gillespie." National Archives, Record Group 77.

"Sketch of Shore Line of the North Eastern Part of Sandy Hook, N.J., showing line of bulkhead as built under the direction of General H.W. Benham, U.S. Engineer, March to June 1878." National Archives, Record Group 77.

Published Materials

Executive Documents of the House of Representatives, 3d Session, 42d Congress, 1872-73. Washington, 1873. Serial 1558.

Executive Documents of the House of Representatives, 1st Session, 43d Congress, 1873-74. Washington, 1874. Serial 1599.

Executive Documents of the House of Representatives of the 1st Session of the 44th Congress, 1875-76. Washington, 1876. Serial 1677.

Executive Documents of the House of Representatives for the 2d Session of the 44th Congress, 1876-77. Washington, 1877. Serial 1746.

Executive Documents of the House of Representatives for the 2d Session of the 45th Congress, 1877-78. Washington, 1878. Serial 1797.

Executive Documents of the House of Representatives for the 3d Session of the 45th Congress, 1878-79. Washington, 1879. Serial 1844.

Executive Documents of the House of Representatives for the 3d Session of the 45th Congress, 1878-79. Washington, 1879. Serial 1847.

Executive Documents of the House of Representatives for the 2d Session of the 46th Congress, 1879-80. Washington, 1880. Serial 1907.

Executive Documents of the House of Representatives for the 2d Session of the 46th Congress, 1880-81. Washington, 1881. Serial 1956.

Executive Documents of the House of Representatives for the 1st Session of the 47th Congress, 1881-82. Washington, 1883. Serial 2014.

Executive Documents of the House of Representatives for the 2d Session of the 47th Congress, 1882-83. Washington, 1883. Serial 2095.

Executive Documents of the House of Representatives for the 1st Session of the 48th Congress, 1883-84. Washington, 1884. Serial 2186.

Executive Documents of the House of Representatives for the 2d Session of the 48th Congress, 1884-85. Washington, 1885. Serial 2282.

Executive Documents of the House of Representatives for the 1st Session of the 49th Congress, 1885-86. Washington, 1886. Serial 2374.

Executive Documents of the House of Representatives for the 2d Session of the 49th Congress, 1886-87. Washington, 1887. Serial 2465.

Executive Documents of the House of Representatives for the 1st Session of the 50th Congress, 1887-88. Washington, 1889. Serial 2538.

Executive Documents of the House of Representatives for the 2d Session of the 50th Congress, 1888-89. Washington, 1889. Serial 2633.

Executive Documents of the House of Representatives for the 1st Session of the 51th Congress, 1889-90. Washington, 1890. Serial 2720.

Executive Documents of the House of Representatives for the 2d Session of the 51th Congress, 1890-91. Washington, 1891. Serial 2856.

Executive Documents of the House of Representatives for the 1st Session of the 52th Congress, 1891-92. Washington, 1892. Serial 2928.

Executive Documents of the House of Representatives for the 2d Session of the 52th Congress, 1892-93. Washington, 1893. Serial 3083.

Executive Documents of the House of Representatives for the 2d Session of the 53th Congress, 1893-94. Washington, 1894. Serial 3205.

Executive Documents of the House of Representatives for the 3d Session of the 53th Congress, 1894-95. Washington, 1896. Serial 3302.

Executive Documents of the House of Representatives for the 1st Session of the 54th Congress, 1895-96. Washington, 1896. Serial 3378.

Executive Documents of the House of Representatives for the 2d Session of the 54th Congress, 1896-97. Washington, 1897. Serial 3485.

Executive Documents of the House of Representatives for the 2d Session of the 55th Congress, 1897-98. Washington, 1898. Serial 3637.

Executive Documents of the House of Representatives for the 1st Session of the 56th Congress, 1899-1900. Washington, 1899. Serial 3911.

Executive Documents of the House of Representatives for the 2d Session of the 56th Congress, 1900-01. Washington, 1900. Serial 4097.

Executive Documents of the House of Representatives for the 1st Session of the 57th Congress, 1901-02. Washington, 1902. Serial 4285.

Executive Documents of the House of Representatives for the 2d Session of the 57th Congress, 1902-03. Washington, 1902. Serial 4448.

Executive Documents of the House of Representatives for the 2d Session of the 58th Congress, 1903-04. Washington, 1903. Serial 4641.

Executive Documents of the House of Representatives for the 3d Session of the 58th Congress, 1904-05. Washington, 1904. Serial 4790.

Executive Documents of the House of Representatives for the 1st Session of the 59th Congress, 1905-06. Washington, 1905. Serial 4950.

Executive Documents of the House of Representatives for the 2d Session of the 59th Congress, 1906-07. Washington, 1906. Serial 5110.

Executive Documents of the House of Representatives for the 1st Session of the 60th Congress, 1907-08. Washington, 1907. Serial 5275.

Executive Documents of the House of Representatives for the 2d Session of the 60th Congress, 1908-09. Washington, 1908. Serial 5425.

Executive Documents of the House of Representatives for the 2d Session of the 61th Congress, 1909-10. Washington, 1910. Serial 5721.

Executive Documents of the House of Representatives for the 1st Session of the 62th Congress, 1910-11. Washington, 1911. Serial 5956.

Executive Documents of the House of Representatives for the 2d Session of the 62th Congress, 1911-12. Washington, 1912. Serial 6197.

Executive Documents of the House of Representatives for the 3d Session of the 62th Congress, 1912-13. Washington, 1913. Serial 6378.

Executive Documents of the House of Representatives for the 2d Session of the 63d Congress, 1913-14. Washington, 1914. Serial 6608.

Executive Documents of the House of Representatives for the 3d Session of the 63d Congress, 1914-15. Washington, 1915. Serial 6798.

Executive Documents of the House of Representatives for the 1st Session of the 64th Congress, 1915-16. Washington, 1916. Serial 6917.

Executive Documents of the House of Representatives for the 2d Session of the 64th Congress, 1916-17. Washington, 1917. Serial 7140.

Executive Documents of the House of Representatives for the 2d Session of the 65th Congress, 1917-18. Washington, 1918. Serial 7341.

Executive Documents of the House of Representatives for the 3d Session of the 65th Congress, 1918-19. Washington, 1919. Serial 7479.

SECONDARY SOURCES

Cullum, George W. Biographical Register of the Officers and Graduates of the U. S. Military Academy from 1802 to 1867 . . . New York, 1879.

Lewis, Emanuel R. Seacoast Fortifications of the United States: A Introductory History, Washington.

Newspapers and Periodicals

Harper's Weekly

New York Herald

New York Times

PHOTOGRAPHS

All photographs are located in the Sandy Hook Museum photograph archive collection.

Photograph No. 1. Panorama looking south, showing wall and guns lined up. Proving Grounds, ca. 1881.



Photograph No. 2. Panorama looking south, showing wall, tower, and buildings. Continuation of photograph No. 1. Proving Grounds, ca. 1881.



Photograph No. 3. Panorama showing west end, wall, and residence.
Continuation of photographs Nos. 1 and 2. Proving Grounds, ca. 1881.



Photograph No. 4. Sandy Hook Proving Ground railroad train on elevated trestle, ca. 1900.



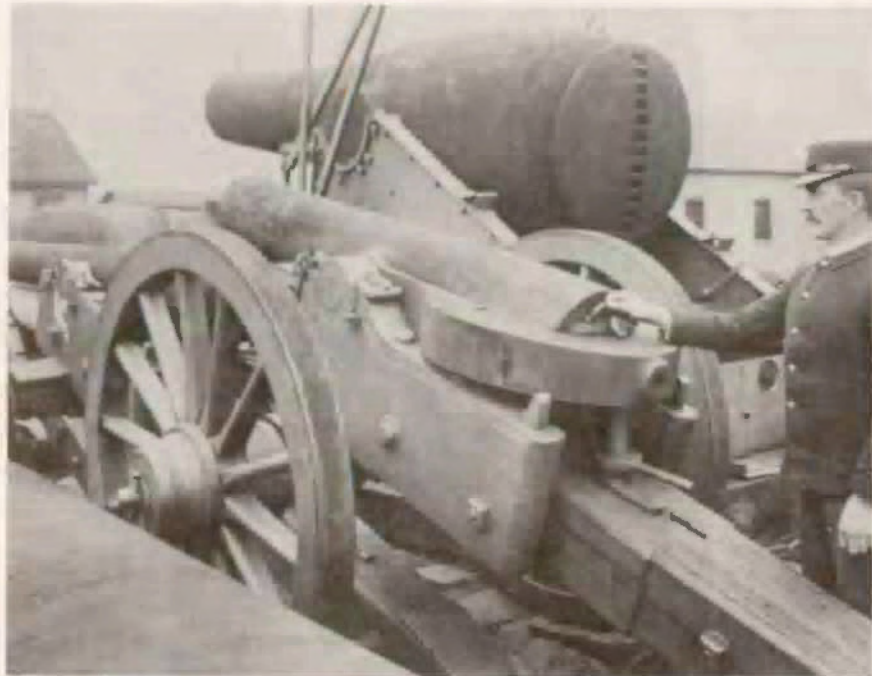
Photograph No. 5. Second Proving Ground proof battery at Sandy Hook, ca. 1902.



Photograph No. 6. Stair cases and platforms of second proof battery, ca. 1902-05.



Photograph No. 7. Soldier standing at experimental breech loading gun (note: gun ahead is marked "I. C.", "Inspected and Condemned") - with other obsolete armament at the Sandy Hook Proving Ground "Ordnance Grave Yard."



Photograph No. 8. Soldier peering out of muzzle of 20-inch No. 2 Rodman Gun stored at the Sandy Hook Proving Ground "Ordnance Grave Yard," ca. 1900-01.



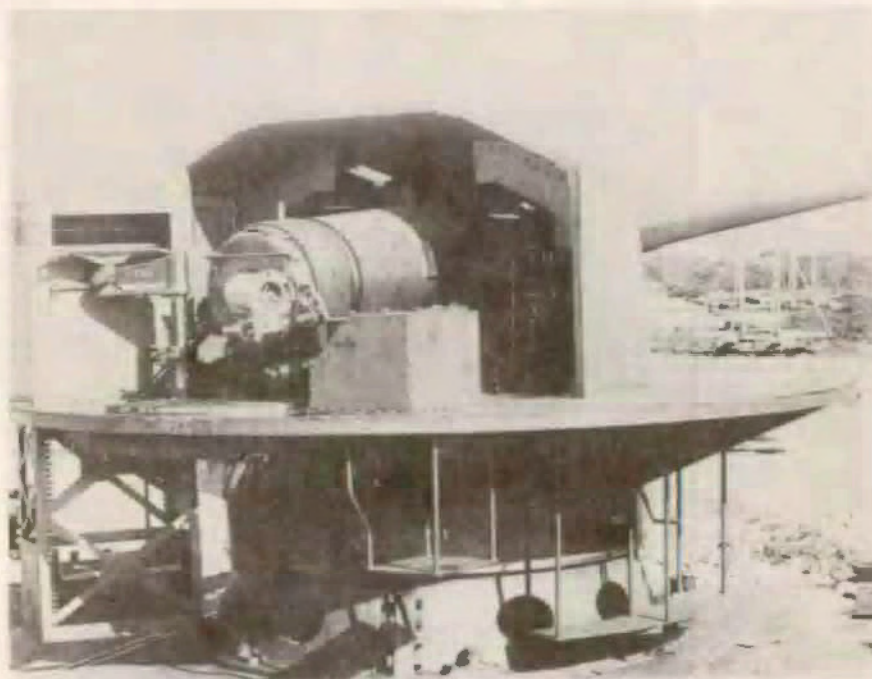
Photograph No. 9. A 3-inch Rapid Fire Gun at Sandy Hook Proving Ground.



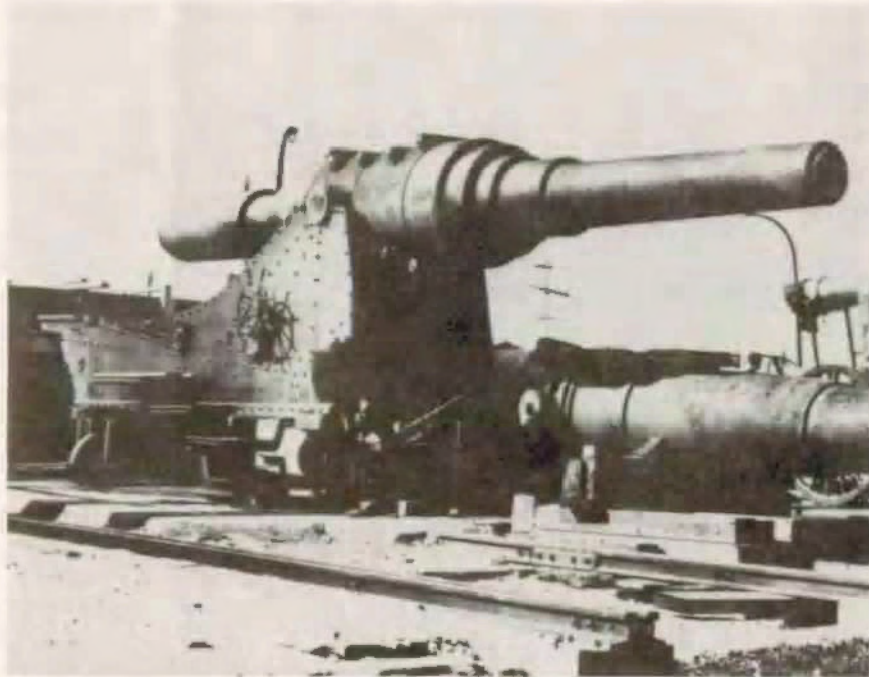
Photograph No. 10. A 6-inch Howitzer Model 1908 No. 3 at Sandy Hook Proving Ground, ca. 1908.



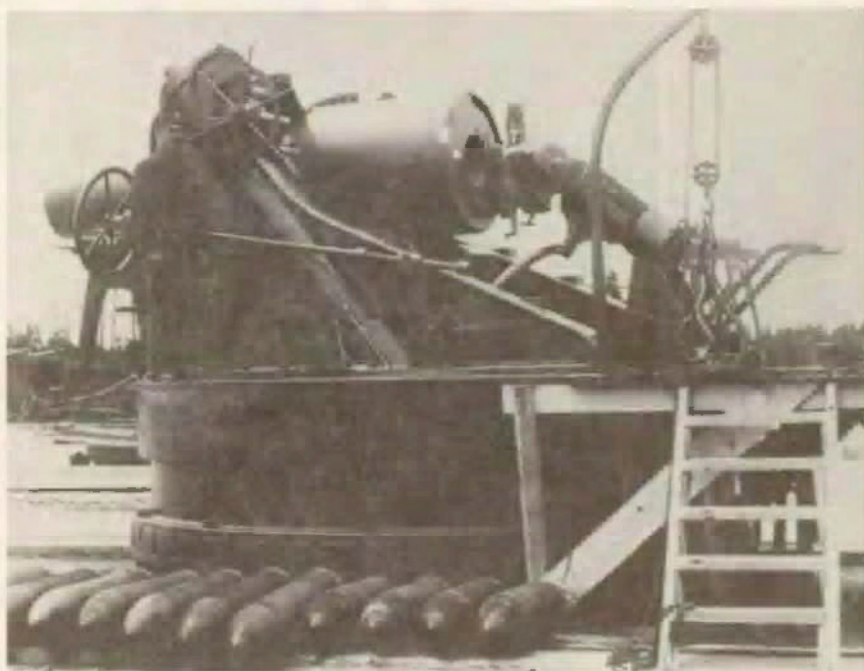
Photograph No. 11. A possible 6-inch rifle with shield and experimental loading hoist mechanism seen to the left of the breech.



Photograph No. 12. Experimental large calibre gun at Sandy Hook Proving Ground, ca. 1890-91.



Photograph No. 13. Ordnance soldier posing with 12-inch mortar at Sandy Hook Proving Ground.



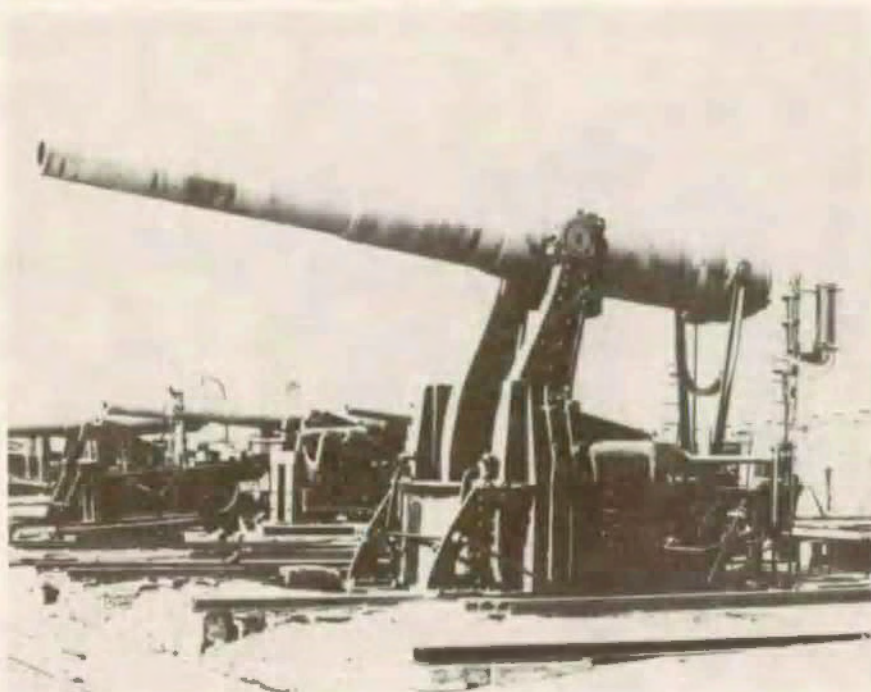
Photograph No. 14. Buffington-Crozier counter weight carriage field tests, ca. 1894.



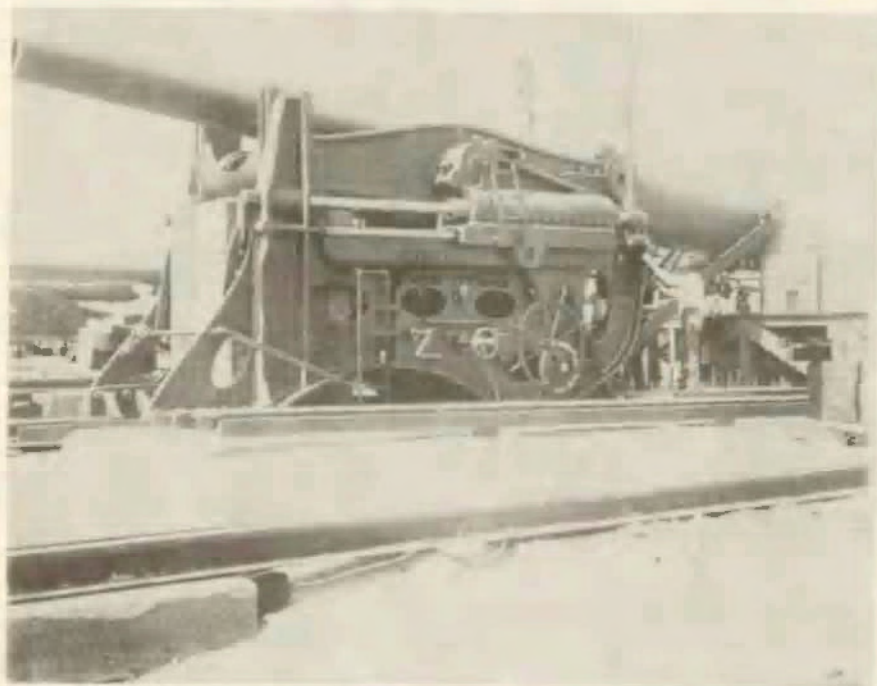
Photograph No. 15. Buffington-Crozier counter weight carriage field tests, ca. 1894.



Photograph No. 16. Buffington-Crozier counter weight carriage by possible 10-inch rifle mounted for testing.



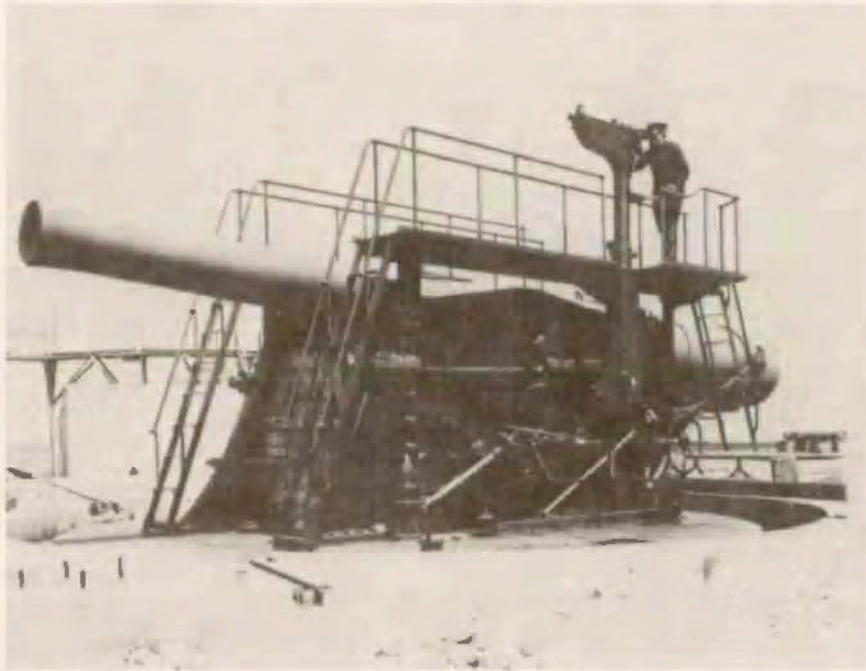
Photograph No. 17. Possible 12-inch Buffington-Crozier counter weight gun, ca. 1895-1900.



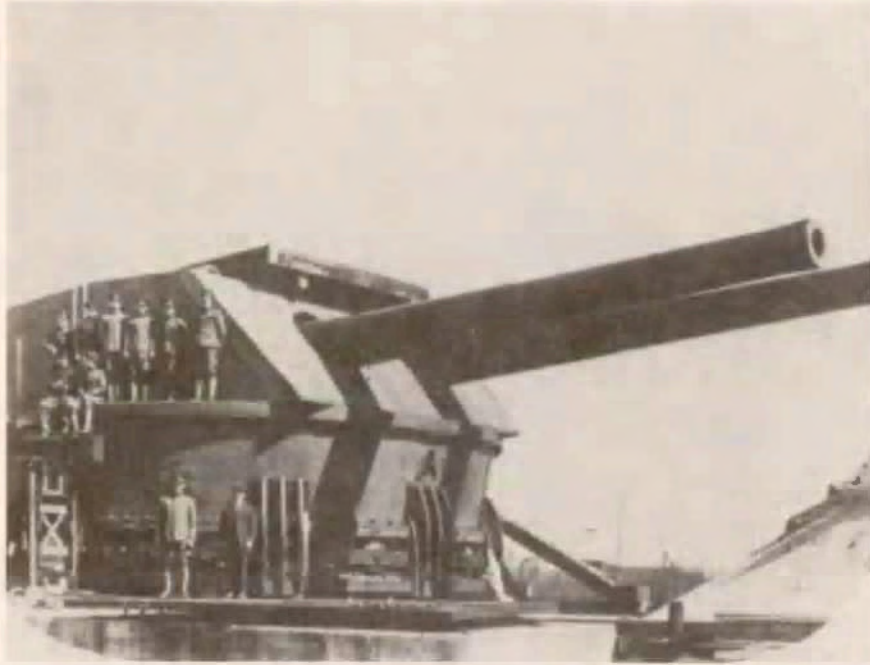
Photograph No. 18. Search light tower built atop the southeast bastion of the old Civil War masonry "Fort at Sandy Hook," ca. 1890-92.



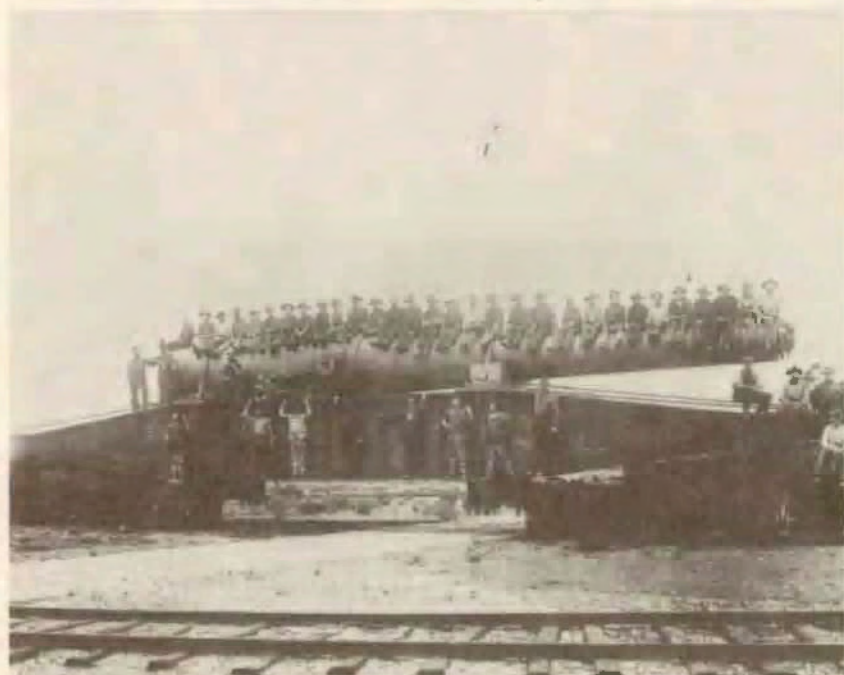
Photograph No. 19. A 12-inch rifle mounted on Buffington-Crozier counter weight carriage tested at Sandy Hook Proving Ground, ca. 1902-08.



Photograph No. 20. Army designed turret mounted 14-inch rifles tested at Sandy Hook Proving Ground, ca. 1908-10.



Photograph No. 21. Soldiers of the Sandy Hook Proving Ground Ordnance Detachment pose with, and on, a large calibre rifle being delivered to the Sandy Hook Proving Ground on specially designed railroad flat car, ca. 1908.



Photograph No. 22. Crane on barge unloading large calibre rifle at Sandy Hook Proving Ground wharf, ca. 1900-10.



Photograph No. 23. Ordnance Sergeant (right) and Ordnance Corporal (left) prepare powder charge at Sandy Hook Proving Ground, ca. 1890-99.



Photograph No. 24. Interior view of dining room looking northeast, Officers' Quarters, Sandy Hook Proving Ground, ca. 1900.



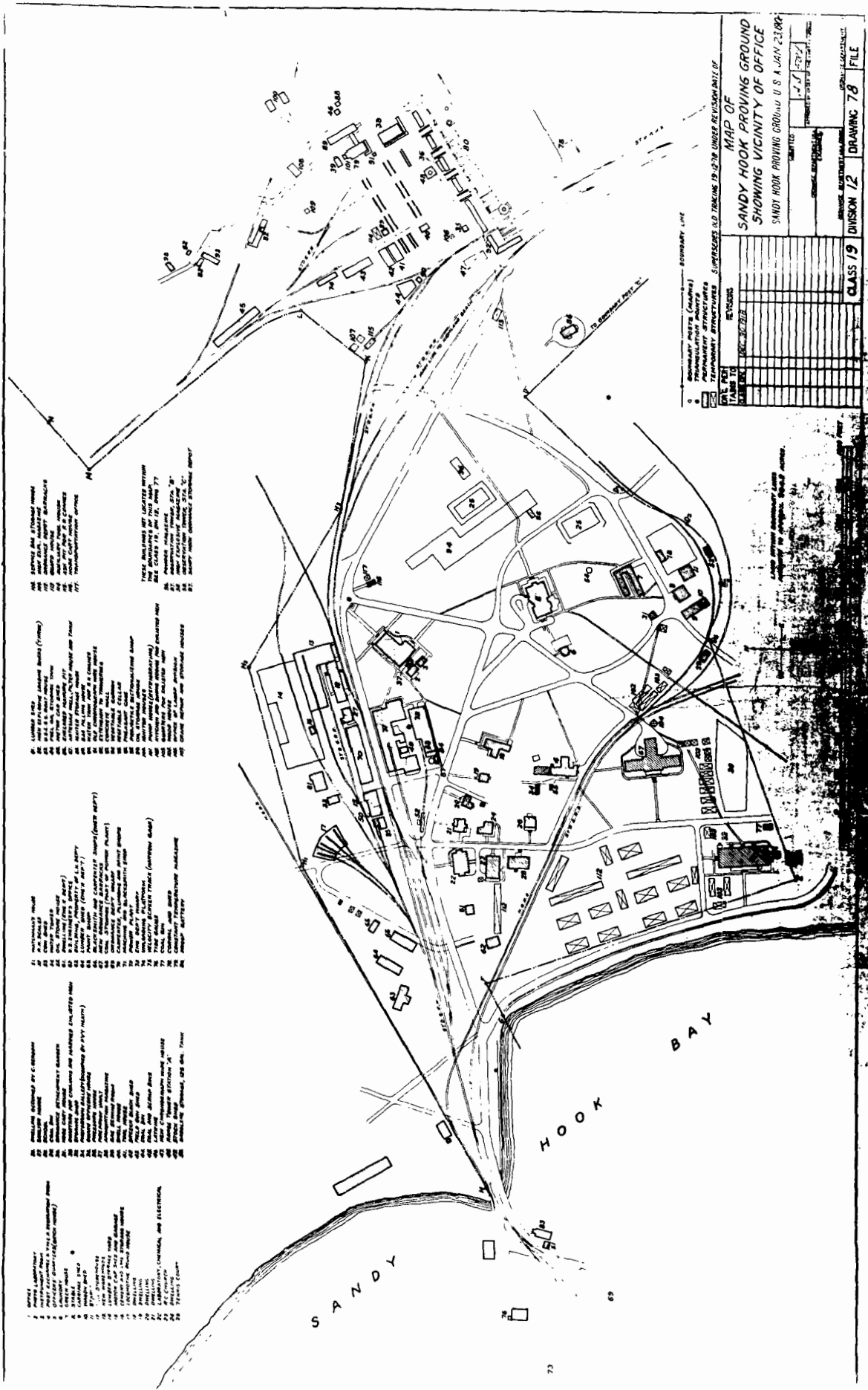
Photograph No. 25. Sandy Hook Proving Ground - operated steamboat,
Ordnance, ca. 1900-10.



Photograph No. 26. Sandy Hook Proving Ground fire, November 28, 1905.



"Map of Sandy Hook Proving Ground Showing Vicinity of Office . . .
Jan. 23, 1908." Revised December 30, 1918, Class 19, Division 12,
Drawing 78, Catalogue No. 407.2, Record Group 156, No. 93-2.



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MAP OF SANDY HOOK PROVING GROUND SHOWING VICINITY OF OFFICE SANDY HOOK PROVING GROUND U S A JULY 23, 1942

CLASS 19 DIVISION 12 DRAWING 78 FILE

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As the nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, parks and recreation areas, and to ensure the wise use of all these resources. The department also has major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration. NPS 2109