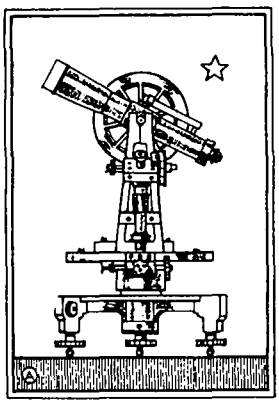
GEODETIC LETTER



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R.S. PATTON · Director

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National Oceanic and Atmospheric Administration

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GEODETIC LETTER

March, 1936.

Volume 3 Number 1

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THE WHITE MAN'S GADGET INTRIGUES

WEST LOOKS EAST AND SEES A TOPSY-TURVY WORLD

A Yakan Moro on the Island of Basilan employed as a packer by a Coast Survey party, catches, through a theodolite, his first upside down view of a familiar mountain. Pono Cobung.

- NOTICE -

Due to a serious reduction in the personnel of the Coast and Geodetic Survey, with a consequent increase in the duties of the regular staff, it has been found necessary to issue the Geodetic Letter as a quarterly publication instead of once a month as heretofore. The March issue is the first one for the year 1936.

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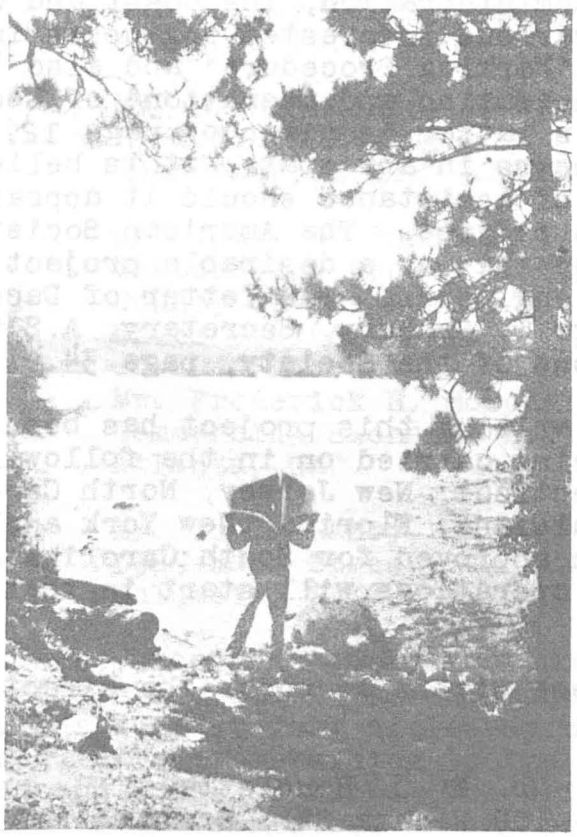
EASTER BONNET - LARGE HEAD SIZE



Portage on Basswood River along the Canadian boundary. During reconnaissance work, a distance of 125 miles was covered in 5 days with the aid of the 100-pound canoe shown above.

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LOCAL CONTROL SURVEYS

H. W. Hemple

The Local Control Surveys which were initiated by the Coast and Geodetic Survey as a part of the original Civil Works Administration program in November, 1933, are being recommended to the various State W.P.A. Administrators by the Federal Works Progress Administration, as suitable projects to be adopted for the relief of unemployed engineers and others of the so-called "white collar" class.

A "Working Procedure" pertaining to these surveys has been sent to each of the State Administrators. A copy of this is given on page 9. At the request of officials of the Works Progress Administration, the Coast and Geodetic Survey has sent to various interested engineers in each state a copy of the "Working Procedure" and also "Suggestions Regarding Organization and Operation" of Local Control Survey parties. This latter is given on page 12. If there are unemployed engineers in any state, it is believed these suggestions will be of assistance should it appear desirable to inaugurate such a project. The American Society of Civil Engineers recommended this as a desirable project should there be unemployed engineers. See letter of December 2, 1935, from Mr. George T. Seabury, Secretary, A.S.C.E., to various local sections of the Society, page 34.

At the present writing this project has been approved and field work is being carried on in the following states: Massachusetts, Connecticut, New Jersey, North Carolina, Oklahoma, Alabama, Louisiana, Florida, New York and Georgia. The project has been approved for South Carolina and it is expected that field operations will start in that state in the near future.

The work in these states is under the direction of the following engineers:

Massachusetts:	Mr. E. C. Houdlette, 100 Nashua St., Boston.
Connecticut:	Prof. C. J. Tilden (Consultant), 51 Prospect St., New Haven.
New Jersey:	Prof. Philip Kissam (Consultant), 31 University Place, Princeton.

N. Carolina:	Mr. O. B. Bestor, State Highway and Public Works Commission, Raleigh, N. C.
Oklahoma:	Prof. N. E. Wolfard, University of Oklahoma, Norman, Okla.
Alabama:	Prof. J. A. C. Callan, Alabama Polytechnic Institute, Auburn, Ala.
Louisiana:	Mr. D. G. W. Ricketts, Project Supervisor, 126 Carondelet Street, New Orleans, La.
Florida:	Dr. Blake R. Van Leer, University of Florida, Gainesville, Fla.
New York:	Mr. L. R. Holden, 1460 South Avenue, Rochester, N.Y.
	Mr. James R. Rundell, Westchester County Emergency Work Bureau, County Office Building, White Plains, N. Y.
Georgia:	Mr. Frederick H. McDonald, Commercial Exchange Building, Atlanta, Ga.
S. Carolina:	Mr. T. C. Hamby, 1325 Main Street, Columbia, S. C.

The conditions concerning employment on this project in the individual states are quite varied. The State Administrator in general, has a great deal of leeway concerning interpretations of regulations pertaining to the selection of personnel, salaries and hours of work. The original intention was that only 10% of the employees on any project could be selected from non-relief sources. At the present time if the State Administrator feels that more employees from non-relief sources are necessary to insure the successful operation of any project, he may allow the employment of a greater percentage. It was originally specified that 40 hours of work per week would be required. At present, the State Administrator can regulate the hours of an individual employee so that he need work only a sufficient number of hours to total the maximum salary

allowable, figured on the basis of the prevailing hourly rate of pay for the type of work done. In some of the states the surveys are carried on by shifts of two parties working three days per week. In such cases, one party will work Monday, Tuesday, and Wednesday; the other party will work on the same line on Thursday, Friday, and Saturday.

The maximum salary for the men chosen from relief sources varies from $94.00 per month in the north to $75.00 in the southern zone for technical positions. Skilled employees may be paid from $85.00 in the northern zone to $68.00 in the southern zone. The intermediate classification of employees provides for wages of $65.00 per month in the northern zone to $49.00 in the south. Unskilled employees are paid $55.00 in the north to $30.00 in the southern zone. There are 4 zones; the northern region being zone 1; the southern region being zone 4. Salaries in zones 2 and 3 are intermediate to those quoted above. The men from non-relief sources are paid from $100.00 to $150.00 per month, depending upon the position held. All salaries must have the approval of the State Relief Administrator.

If conditions warrant the consideration of this project, the procedure is as follows: An estimate is prepared on forms of the Works Progress Administration. This must be signed by the sponsors of the project. It is then sent to the State office of the W. P. A., where it is analyzed as to man-year cost, suitability for relief purposes, conflict with other projects, availability of personnel, and whether in general the work can be carried on under regulations prescribed for the conduct of projects under the W. P. A. Should it be approved by the State Administrator, it is sent to the Washington office of the W. P. A. for further study. If approved by the Federal W. P. A., it must have the approval of the Budget Bureau, the President, and the Comptroller General of the United States. An allotment is then issued to the State Administrator after which the project is ready to be carried out.

A requisition for personnel is prepared and forwarded through the State W. P. A. to the United States Employment Service local offices. Specifications concerning the type of employee desired should accompany this requisition. The Employment Office then assigns men with the proper qualifications to report for work on the project in the localities mentioned on the requisition sheet. The employment of men from non-relief sources must also be approved by the United States Employment Service. This is also handled through the State W. P. A. office. All pay rolls are prepared in the field and then sent to the state W. P. A. office where the checks are drawn and then sent to the individual projects for distribution. Salaries are

on a monthly basis, and employees are expected to work the required number of hours per month specified for the rate of pay obtained. If any employee's services are unsatisfactory, his services may be dispensed with. If any of the men assigned to the project by the United States Employment Service are found upon examination to be deficient in the desired qualifications, it is not necessary that they be employed.

Requisitions for materials are handled through local state offices of the Procurement Division of the Treasury Department. All purchases of materials are made through this organization. Arrangements to purchase materials on the site of the work can be made through special authority granted by the Procurement Division, provided there is danger or the party being delayed due to non-arrival of supplies. Such authority is granted only in special cases. Allotments for purchases of materials are kept as small as possible consistent with obtaining satisfactory results. In several states, funds have been advanced by state organizations or from local sources, to supplement the amount from federal appropriations. Such funds have been advanced by State Highway Departments, State Public Works Commissions, etc. The availability of such supplemental funds is especially desirable since the funds for expenditures for materials and supplies from federal sources is usually very limited. Such funds may be used for the rental of surveying instruments, office equipment, computing machines, etc., which ordinarily may be a sizable amount. Insurance on trucks and surveying equipment may also be handled through such funds.

The clerical work in connection with requisitioning personnel and procurement of supplies and materials is considerable. In addition, various reports are required to be submitted weekly and monthly to the Works Progress Administration. The Regulations prescribed for Works Relief operations are voluminous and one or two employees in the project office should be required to make a study of such rules. A good sized office force will be required to attend to the various clerical duties in connection with the project.

The project having been approved for adoption, does not necessarily mean that the State Administrator will carry out such work. Generally, more projects are approved than there are funds available to carry them out. If the surveys are started, the State Administrator can stop the project at any time he sees fit. If funds are running low, and he feels that other projects are more worthy, he can discontinue the survey work, or any other project. This may not be a serious consideration at the commencement of the project when available funds are ample, but several months from now when funds become depleted it may loom very large.

Specifications for traverse, leveling, and triangulation are given on pages 17 and 28 of this issue of the Geodetic Letter.

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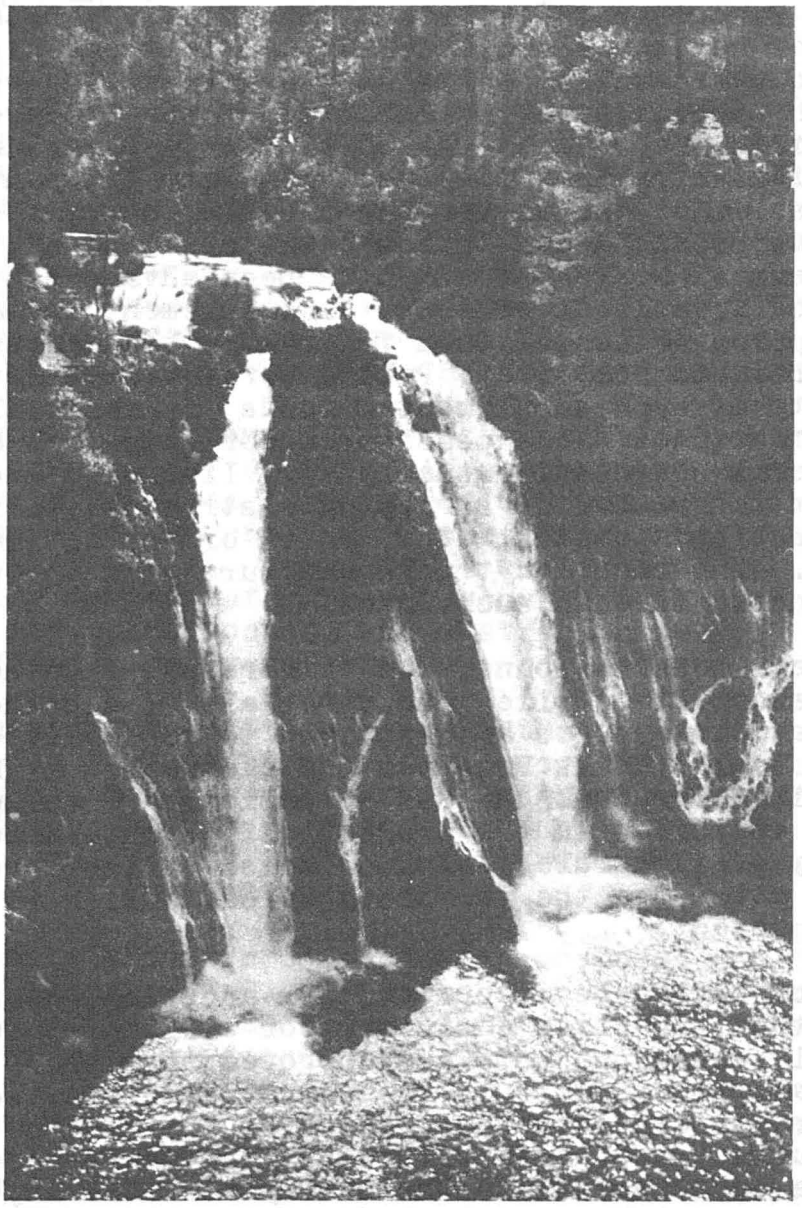
SUNSHINE AND RIPPLES



BURNEY FALLS, CALIF.

Unusual picture taken by E. O. Heaton, showing in detail the sunlight caught on the rippling waters beneath the falls with the resulting effect of wet leaves heaped together.

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WORKS PROGRESS ADMINISTRATION WORKING PROCEDURE

Code No. 1865
11/22/35

Geodetic Local Control Surveys

DESCRIPTION:

Triangulation and traverse surveys for horizontal control with an accuracy of one part in 10,000 in distances surveyed; leveling with an accuracy of .05 of foot times the square root of the distance in miles to furnish elevation. The work is designed to supplement fundamental horizontal and vertical control surveys carried on by Coast and Geodetic Survey.

SPONSOR:

State Public Works Commission; Engineering Departments of States and other political subdivisions and municipalities; State Educational Institutions; State Highway Department; State and City Planning Boards; with the cooperation of National and State Engineering organizations.

PLANT AND EQUIPMENT:

Space for central office; storage room for supplies and transportation facilities; necessary surveying instruments, (transportation equipment and instruments in limited quantities may possibly be loaned by the Coast and Geodetic Survey); camping equipment where necessary.

MATERIALS:

Necessary books and supplies for office and field work; cement, sand, gravel, and metal tablets for monuments; food stuffs when necessary to establish camps for field work.

SAFETY:

The Works Progress Administration Safety Division should be notified before project is put in operation.

PERSONNEL:

Qualified supervisor, who should be experienced engineer; qualified superintendents, engineers, rodmen, chainmen, draftsmen, accountants, and clerical assistants. Engineers of the Coast and Geodetic Survey will be available upon request to give advice to state supervisors on administrative and technical matters.

SCHEDULE:

1. Supervisor and superintendents should inspect various field units, and instruct them in procedure.

SCHEDULE: (Continued)-

2. Superintendents, engineers, field and office forces should conduct work according to instructions given by supervisor.
3. Where practicable, survey should start from existing triangulation stations and bench marks of Coast and Geodetic Survey, and supplement fundamental horizontal and vertical control surveys carried on by that agency.
4. Routes may follow railroads and principal highways, forming loops approximately five miles across. When the work is done within or close to city areas the loops may be smaller. Surveys may be done in any part of the State, but preferably in most highly developed areas in order to produce greatest usefulness.
5. Monuments should be set in pairs with azimuth or direction between the two monuments determined by the traverse. The pairs of monuments should be set at intervals of from one to two miles along routes surveyed. When the lines lie within or close to city areas there should be a closer spacing of the monuments.
6. Monuments of concrete, into each of which is set an inscribed rustproof metal tablet, should be established in places least liable to disturbance (on land, engineering structures, or outcroppings of rock); the monuments should be of such size, and be set in such a way as to insure permanence.
7. The same monuments should serve for the traverse and the leveling.
8. A central computing office should be organized in each state where the inspection of survey records and the descriptions of stations may be made, following closely the field work. The computation of lines of traverse and leveling should be made as soon as possible after their completion. The original field records and computations must be forwarded to the Coast and Geodetic Survey at Washington, D. C., as soon as practicable after the field and office work has been completed. Duplicates may be made and retained in the state offices.
9. The work contemplated would follow very closely the specifications prepared by the Coast and Geodetic Survey in 1933 for the geodetic local control surveys carried on under the Federal Emergency Relief Administration. Copies of these specifications will be furnished upon request by the Director of the Coast and Geodetic Survey.
10. Upon request state administrators of the Works Progress Administration will be given information by the Director of the Coast and Geodetic Survey as to engineers in the states who are familiar with geodetic local control surveys.

PRODUCT:

1. Will provide base for topographic and other maps and starting points for surveys for all classes of engineering operations.
2. Will provide the basis for surveys of boundaries of private and public land, and will be a further step in surveying and mapping the country.
3. Will aid in future utilization of land and natural resources.

REFERENCE:

FERA NO. F2.7

This procedure may be approved or modified to meet local conditions. Suggested alterations should be sent to:

Works Progress Administration
1734 New York Avenue, N.W.
Washington, D. C.

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RETURN OF THE FORTY-NINERS

After the descent from Laramie Peak, Wyo., where a station was established at an elevation of 10,274 feet above sea level. Due to the combined roughness, steep slopes and brush-filled deadfall, with the accompanying disastrous effect on clothing, the above picture was the only one passed by the censor.

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SUGGESTIONS REGARDING ORGANIZATION AND OPERATION OF LOCAL CONTROL SURVEYS UNDER WORKS PROGRESS ADMINISTRATION

The Coast and Geodetic Survey long has been and still is a crusader for control surveys. It conceives of their results as tools necessary to every engineering project which requires accurate knowledge of the configuration of an extensive area of the earth's surface. Preexisting control assures the accuracy and reduces the cost of the myriad measurements which must be made to acquire that knowledge.

For many years the Survey has been working on a Federal control surveys project. It has recognized that the 25-mile spacing of the basic nets was too wide to bring its points within convenient distance of most local projects, and its program has contemplated that in connection with other engineering work, additional intermediate points would be established, and thus there would gradually develop intensive and closely-spaced systems of horizontal and vertical control, all based on and tied into the basic Federal nets.

The need of providing work for the unemployed affords an additional incentive for work of this character because money spent for surveying normally makes a considerably larger direct contribution to labor than do funds spent for construction. Unemployment relief has been the principal incentive for large Federal programs of control surveys carried on during the past two years.

Under the present set-up it has not been possible to continue the control surveys as a national project. Works Progress activities are decentralized on a state-unit basis. Information essential to the effective planning and execution of a project is not available in Washington. It is not known, for example, to what extent engineers and other workers of the required caliber are available in the various states. It is not known to what extent instruments can be borrowed, motor transport secured, and supplies and materials obtained to keep operating costs within the man-year limit fixed.

We believe, however, that alert engineers throughout the country know the answers to these questions as pertaining to

their respective states. We believe that wherever these local conditions are sufficiently favorable it is distinctly worth while to set up local control survey projects on the basis both of the unemployment relief to white-collar workers thereby afforded and of the permanent public value of the results of the work.

Therefore, we have been working recently with officials of Mr. Hopkins' office on a working procedure for local control surveys to be accomplished under the various state Works Progress Administrators. This procedure is being sent to the State Administrators for their guidance in connection with carrying on such work as a relief measure.

It is probable in some of the states that the Works Progress Administrator may be unfamiliar with the work done in the past on the local control surveys and as a consequence, he may select engineers to organize this project who are not well versed in control surveying. For this reason, the officials of the Works Progress Administration are sending to this Bureau a number of copies of the working procedure for control surveys which will be forwarded by this office to a number of key men in each State. These men can then take such steps as might be necessary to properly organize the project to obtain the best results. The first consideration should be the selection of a competent engineer to handle the entire job as the State Director. This man should have a capacity for organization and leadership and in general, have considerable executive ability. He should have a thorough knowledge of control surveys and their uses.

As you know, ten percent of the persons employed do not have to be taken from relief rolls. These men would be the chiefs of parties and inspectors. There are possibly enough engineers on the relief rolls to fill in as observers. Any bright young man could be taught to do chaining, rodding, recording, etc., and such work is admirably adapted to the employment of the white-collar class.

The Coast and Geodetic Survey had quite a number of engineers from various parts of the country employed on triangulation and leveling parties until recently. This office would be glad to furnish the names and addresses of such men who may be available in your state. These men could be employed to assist in training chiefs of parties and observers.

It may be rather difficult to secure a sufficient number of instruments to properly conduct surveying operations, but under present conditions there should be a surplus of such instruments owned by individuals, engineering departments of railroads, street railways, highway departments of counties and states, civil engineering departments of universities and technical schools, and engineering departments of cities and towns which are not in use and could possibly be obtained on loan. The Coast and

Geodetic Survey may have some instruments, other than transits and levels, that might be loaned providing the shipping charges are paid from Works Progress Administration funds or local sources. This Bureau could not pay transportation expenses and would have to obtain assurance that the instruments loaned would be returned in good condition at the expiration of the field work and at other than the expense of this office. Such instruments which are now available in limited quantities consist of thermometers, spring balances, hand levels, level rods and 100-foot steel tapes.

In some of the states where these surveys have been conducted the officials of towns of a few thousand or more inhabitants would be contacted regarding the possibility of cooperating. They would be told that some ten to twenty men in that community would be put to work on the local control surveys if the town or city would furnish the instruments, usually a transit, level with the necessary rods, and a 100-foot steel tape. These local officials in some cases also furnish transportation facilities. In many cases men who were on relief but had automobiles or motor trucks would be glad to use such equipment on the job because of the employment offered them. Gasoline and oil were sometimes furnished by the local municipalities or the men employed on the parties contributed the few cents a day necessary to defray such expenses.

In this way the work could be started in a number of places. The traversing and leveling need not be carried beyond certain distances, say 20 miles from the center, thus making it possible for the members of the surveying parties to return to their homes each evening. The surveying should be done, if practicable, near existing triangulation stations and bench marks, but if this is not possible the work could start in communities where there are no monuments and the starting station could be tied into the national scheme of control at a later date.

It is possible that in many cases rather extensive traversing can be done by having two communities, say 40 or 50 miles apart, each do the local control surveying and join their work half-way between the settlements. Each community could eventually have a sort of spider web of survey lines around its area. These lines could be at intervals of from 5 to 7 miles apart, at a distance of 20 to 25 miles out, but they could be spaced more closely as the city or town limits are approached. Near the municipal boundaries it might be well for the survey lines to be spaced at intervals of two to three miles. The stations along the routes should be set at intervals of a mile or two. They should usually be established in pairs in order that at each station an azimuth would be available for any other surveying that might be started from these local control survey stations. There would be some stations where objects such as church spires, water tanks, courthouse cupolas, etc., could be used for this purpose, in which case it would not be necessary to establish a separate azimuth mark. Both traverse and leveling should be run over each

line of stations. The station marks would then serve for both the horizontal and vertical control surveys. Specifications for the conduct of the surveys may be obtained from this office.

It is possible, owing to the value of these control surveys to the highway department of your state and counties, that such organizations would furnish sand, cement and gravel for the station monuments, or possibly the local municipalities may defray such costs. It would involve only a comparatively small amount of materials, but it would save a few dollars cost that might be rather helpful to the director of the local control surveys.

Monuments may be set in several ways. Until a year or so ago the field parties of this Bureau mixed and poured the concrete at the station site. Recently, however, the practice has developed of using precast marks. Wooden forms were made that could be used over and over again, and in some cases the cost in labor and materials for making the precast marks was only sixty cents each. Monuments are in general about four feet long and in high latitudes even more. The cross sectional dimension varies from 6 x 6 or 8 x 8 inches at the top to 12 x 12 or 15 x 15 inches at the bottom. Precast monuments should be set in a bed of concrete placed in the bottom of the hole. In general, the monuments should be sufficiently heavy and stable to prevent disturbances should they get a slight knock.

In the top of each monument an inscribed metal tablet should be set to mark the station. The advantage of the metal mark is that the person seeing one of them recognizes at once that it is a survey mark. These tablets should be comparatively small and inexpensive and should be so designed that their removal from the concrete monuments would be most difficult. They should be cast from a non-corrosive material such as brass or bronze. The Coast and Geodetic Survey will upon request, furnish specifications for such marks which have cost from 13 to 18 cents each in the past.

Each surveying party should make such computations as are necessary to insure that the loop closure of the traverse or leveling is within the desired accuracy. There should be a central computing office in the state where the work of the individual parties could be inspected and correlated so that satisfactory results would be obtained. The traverse computations should be on the plane-coordinate system. The plane coordinates of triangulation stations have been determined in a number of states and these could be furnished by this office. In those states where plane coordinates have not been computed such work could be done in the central computing office.

Under the initial Civil Works Administration set-up, this Bureau had printed a supply of record books for traverse and leveling and computation forms. Some of this material is still available and could be furnished to the State Directors as long as the supply lasts. Perhaps later on as this supply is exhausted, it might be possible to secure a small allotment of funds with which to print additional record books and computation forms which could be sent out to the state local control survey projects. At least this Bureau would be willing to make an effort to secure funds for this purpose if necessary. This Bureau would not be able to furnish other stationery, such as tracing cloth, drafting paper, envelopes, typewriter paper, etc. Only such computation forms as are peculiar to these surveys and the use of which will lead to uniformity of results, could be furnished by this office.

The difficulties of organizing and conducting the local control surveys project under the Works Progress Administration Regulations should not be minimized. For this reason it is important that a capable man be selected as the State Director of the project. If the travel expenses of an officer of this Bureau can be paid from State Works Progress Administration funds or from local sources, the Coast and Geodetic Survey will, upon request from a state, arrange to send an engineer experienced in control surveys to act as a consultant on technical matters. He would assist in planning field operations, help organize a central computing office, and assist in instructing both field and office personnel in the proper methods of conducting control surveying operations. Once the state organization is functioning properly he would return to this office or go to another state. His salary would be paid by this office but all other expenses in connection with his services to the state project would have to be paid from other sources.

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GALLANTRY AMONG THE MOROS

- △ -

PRELIMINARY SPECIFICATIONS FOR TRAVERSE AND LEVELING

FOR

LOCAL CONTROL SURVEYS UNDER WORKS PROGRESS ADMINISTRATION

The purpose of the Local Control Survey Projects is to fill in the unsurveyed areas between the triangulation stations and bench marks established by the U. S. Coast and Geodetic Survey with supplemental stations that will serve satisfactorily for the control of detail surveys. The positions and elevations of these stations will be determined by surveys based on the triangulation stations and bench marks of the national control survey. For determining horizontal positions, traverse lines or triangulation will be run between triangulation stations, while the elevations above sea level of the bench marks will be determined by lines of levels between the bench marks of the national level net. The following specifications are intended to apply to the traverse and leveling work. Specifications covering triangulation are treated in a separate article.

LOCATION OF STATIONS

The traverse stations along the route of the survey should be placed in locations carefully selected in a reconnaissance made in advance of the actual survey operations. In all cases permission to establish a station in the selected location should be procured from the proper authority (public or private) controlling the property.

In making the reconnaissance for the location of the traverse stations several considerations must be kept continually in mind. The stations must be intervisible and so located that the distance between them may be measured economically and rapidly. Each station should be placed where there is the least chance of its being disturbed through changes such as road improvement, public utility construction or other structural changes, or through natural changes such as soil erosion. The use of the stations in local surveys should also be considered. Two stations should be established near each town or village to control the local surveys and one station should be established near each crossroad.

Experience has shown that good locations are found along highways, close to and on the highway side of the right of way fence line, in similar locations along railroads, in public parks, school yards, college grounds, between curbs and property lines, etc. In some cases where stations are established in

cities, it will be advisable to inquire if local authorities can supply manholes and removable covers, so that the marks can be placed well below the ground surface and protected and made accessible.

In some cases it may be necessary to use offset stations, that is, to make the tape measurements to a point opposite the traverse station and then measure the offset distance and angle so that the distance between the traverse stations can be computed. Also it may be necessary sometimes to measure the distance between traverse stations as a broken line with several intermediate stations, forming a closed loop with all the angles measured, so that the measured distances between the intermediate stations can be projected on the line between the traverse stations.

Connections should be made with all existing survey marks along the route of the traverse. Most important of such marks are state, county and city boundary monuments, land survey marks used as starting points for local surveys, section and township corners, etc.

CONNECTIONS WITH TRIANGULATION STATIONS

Traverse lines will usually be run between triangulation stations or in closed loops starting and ending on a triangulation station. The connection with the triangulation station should be made in both position and azimuth if possible. At most recently established triangulation stations, azimuth marks have been set which are visible from the ground and can be used to connect the traverse in azimuth. At many other stations where azimuth marks have not been established, prominent objects such as church spires, cupolas, water tanks, etc., are visible from the ground and have been observed on from the triangulation station and can be used for the azimuth connection.

Many triangulation stations are located on hills and it would be difficult to make the connection in position by measuring directly to the station. In this case the connection can be made by a triangle, using one of the traverse lines as the base and the triangulation station as the third point of the triangle and measuring all of the angles in the triangle.

MARKING OF STATIONS

The stations should be marked with standard metal disks set in rock or concrete so as to effectively resist extraction, change of elevation, or rotation. Each station should be designated by a number stamped upon the mark, preferably before it is set in place. In addition to these standard marks, intermediate stations should, where deemed advisable, be marked

in a semi-permanent manner with pipes, spikes, or other marks.

When the station mark is set in rock outcrop or a large boulder, the disk should be countersunk and well cemented in.

Where it is necessary to establish concrete monuments, they should be prepared as follows: The concrete should be composed of cement, sand and gravel in the proportion 1:2:4, all of the proper quality, and free from dirt or other foreign substance that would in any way effect the quality and permanence of the monument. They should be precast in post form of the following dimensions: 6 inches square at the top and 8 inches square at the bottom and at least 3 feet long. These dimensions are to be the minimum and should be exceeded in northern states where the frost action is deeper. They should in all cases extend below the frost line and should be set in a footing of wet concrete placed in the bottom of the hole.

The standard marks of the Local Control Surveys should be placed in pairs, and there should be not less than one pair of monuments for every two miles of traverse. The two marks of a pair should be main traverse stations, should be intervisible, and should not be less than 1/4 mile apart. Where it is impracticable to place two such stations along the main traverse in a desired locality because of local conditions, one of the pair may be set as an azimuth mark in any convenient direction from the other, subject to the distance limitation given above, and connected with the main station with the same standards of accuracy for distance and azimuth as are prescribed for the main traverse.

ORGANIZATION OF PARTY

It is thought that a party of 10 men, including the chief of party, would be the most efficient size. This party should select and mark the stations, make the tape measurements and angle observations and also do the necessary leveling. It should be divided into subparties for these various operations and the men should be shifted from one subparty to the other as necessary to complete the various operations.

EQUIPMENT

Distances should be measured with a 100-foot steel tape. A balance and tape stretchers will be required for maintaining the tension on the tape and a thermometer for determining the temperature of the tape. Movable tripods are also recommended for marking the tape ends. A clinometer is needed for determining the inclination of the tape.

Angle measures should be made with engineer's transits, except where a theodolite of higher order of accuracy is available. Symmetrical rods should be used as targets and a tripod is recommended for maintaining the rod in a vertical position. For short sights a plumb line suspended over the station permits accurate pointing.

Level lines should be run with wye levels, or dumpy levels capable of producing results of the required accuracy. Level rods that can be read from the instrument should be used if available.

MEASUREMENT OF DISTANCES

The tape should be supported at the 0 and 100-foot points, except where conditions render it advisable to use it supported throughout its length, such as measuring along a paved highway or street or along a railroad track. A uniform tension of 5 kilograms (11 lbs.) should be applied to the tape by means of the tape stretchers when supported throughout, and 10 kilograms (22 lbs.) when supported at the 0 and 100-foot points. A tension of 5 kilograms should also be applied to all lengths less than 50 feet. The temperature of the air should be read and recorded once for each tape length. This record of temperatures forms a valuable check on the number of tape lengths. Tape ends should be marked on movable tripods or on the pavement or rail if the tape is supported throughout. The tape should be used on grade and the inclination of the tape determined with a clinometer.

To avoid gross errors, due to the erroneous recording of a set-up as a set-back, or vice versa, no set-backs should be measured. All partial tape lengths should be measured and recorded as set-ups, or plus corrections to the measured length.

Each section of the traverse should be measured twice, once in the forward and once in the backward direction. Two such measures must agree within 0.01 foot per 100 feet, and they must be repeated until the desired agreement is secured. The error in closure of a loop of traverse, whether it closes on itself or on triangulation stations, must not exceed one part in 10,000.

Each tape used must have a distinct identification stamped or tagged on each end, such as Va. 3B, which means that it is the second tape (B) used by the third party organized in Virginia. The numbers are to be assigned by the State Director of the project. Each state will have a standard tape which has been standardized by the Bureau of Standards and the working tapes should be compared with the standard tape before being used and as often as possible while being used. The tapes should be carefully handled while in use, should not be kinked or injured, and should be kept on a reel when not in use.

INSTRUCTIONS FOR RECORDING THE MEASUREMENT OF DISTANCES

These specifications call for a uniform tension of 5 kilograms (11 lbs.) to be applied to the 100-foot steel tape when supported throughout, and 10 kilograms (22 lbs.) when supported at the 0 and 100-foot points. This was done to make the corrections for sag as small as possible since the tape is not to be supported at the 50-foot point.

Since the master tapes are to be standardized under the above conditions for comparative purposes it is necessary that the proper tensions are given the tapes as called for above, and also that the method of support and the tension used be clearly recorded for each 100-foot tape measurement. This will give a check against any possible error. The tension-chainman and the recorder should properly cooperate against any mistakes being made regarding this question, by calling back and forth the correct information to be recorded. The air temperature and slope of each tape length are also to be clearly recorded.

Furthermore, the recorder should bear in mind at all times that the final corrections are to be made in the office, and it is very necessary that the method of support for each tape length be clearly shown in the record book, as well as all other data called for in the specifications, so there will be no doubt in the minds of the computers as to what methods were followed in the field. For brevity, let "T" denote when tape is supported throughout, and "2" when supported at both ends only. A sample record is shown on page 26.

The chief of each party should investigate the records of all the taping done, and make any additional entries regarding methods of support and tension that might be lacking, while they are still fresh in his mind. This necessary data will be of much value to the Computing Division in assisting in a quick and clear interpretation of the field records.

ANGLE MEASUREMENTS

At each traverse station always measure and record the angle in a clockwise direction, pointing on the rear station first. At least two sets of observations should be made on each angle and the angle closing the horizon, each set consisting of six repetitions of the angle with the telescope direct and six repetitions of the explement with the telescope reversed. The circle should be read and recorded at the initial and at the first, third and sixth repetitions. The initial settings should be about 90° apart.

The horizon closure if satisfactory, should be divided equally between the angle and the explement. If the two sets of observations, before the horizon closures have been applied, should not agree within a satisfactory limit, the observations should be repeated until the required agreement is obtained.

Great care must be taken in centering the instrument and the targets over the stations. Large errors are caused by slight eccentricities of instrument and target, especially where the lines of sight are short.

Angles at intermediate stations should be measured by two sets of three repetitions direct and reversed.

Observations should be made on water tanks and any other natural objects that can be seen from the station. One set of three repetitions direct and reverse should be taken on such objects.

LEVELS

A single line of levels shall be run over each traverse line, and the standard monuments of the traverse shall also be bench marks of the level lines. In addition thereto, elevations shall be determined of bench marks of engineering organizations (public and private) along the line of progress, and additional supplemental bench marks, such as monel-metal rivets, shall be established on permanent structures (bridge abutments, public buildings, retaining walls, etc.), as may seem desirable. All level lines shall, if possible, be run between bench marks of the national level net, or, where this is impracticable, they shall be run in loops. In either case an error of closure is obtained which should not exceed 0.05 foot times the square root in miles. The level instrument shall be frequently tested for collimation and adjusted when necessary. Length of foresight and backsight at each instrument station shall be kept as nearly equal as may be determined easily by pacing. Rods should preferably be of the self reading type, the observer estimating to thousandths of a foot. Extended rod is to be avoided as much as possible and used with extreme care to avoid any slipping of the upper section of rod. Rod length should be checked at stated intervals - say, once each week - using the traverse tape or some other tape if available. Temperature readings should be made and recorded when such check measures are made and also when the line is being run in the field. When leveling run under these instructions is tied to the control net, connection should be made with at least two bench marks which have maintained their relative difference in elevation as shown by the new leveling.

FIELD RECORDS AND COMPUTATIONS

Sample forms for the recording of the observations of the traverse measurements, angles and leveling, are shown on pages 25 to 27. The successful measurement of a traverse depends to a very great extent upon the accuracy, legibility, and clearness of the records. The chief of party should inspect the records and make sure that all necessary data are accurately and legibly recorded.

The record book should contain a description of the instruments used, giving manner of graduation of the transit, how closely read, etc. It should also give the name of the chief of party, recorder, rodmen and other members of the party, with proper designations.

The observed angles should be computed to the nearest second. Distances should be measured and recorded to hundredths of a foot. Inclination corrections to reduce the slope measurements to the horizontal should be made by the use of inclination tables furnished by the Coast and Geodetic Survey. When the inclination angle is beyond the scope of the table, the correction should be computed from the formula accompanying the tables. Temperatures should be averaged for each section of traverse and the temperature correction computed and applied as a single correction for the section. Plane coordinates of the traverse stations should be computed, using the plane coordinates of the triangulation stations. If these are not available, an origin of coordinates may be adopted for temporary use, and the computations carried far enough to determine the closure. Detailed instructions for computing traverse lines on the plane coordinate systems are given in Special Publication Nos. 193, 194, and 195.

Elevations of the bench marks should be computed on the mean sea level datum as determined from the bench marks of the national level net.

All traverse stations and bench marks whether marked in a permanent or temporary manner, should be described in such a way that they may be recovered easily. The description should include the distance and direction from the nearest city or town, milepost, highway crossing, fence line, railroad, and any other objects which would be of assistance in recovering the station. Distances to nearby objects should be measured and not paced or estimated.

Preliminary descriptions should be written in the record books. The final descriptions should be typewritten on cards, Form 525, "Description of triangulation stations", and Form 638, "Description of bench mark".

Whenever a triangulation station or bench mark established by the Coast and Geodetic Survey is recovered or searched for, Form 526, "Recovery note, Triangulation Station", or Form 685, "Report on condition of Bench Mark" should be filled out and transmitted to the Office of the Coast and Geodetic Survey. Any deficiency in accuracy in the original description, any change in the marking of the station or in the surroundings, and any additional information which will make the station more readily recoverable in the future should be recorded on the recovery note. If the station is looked for but not found, the recovery note should describe in some detail the completeness of the search in order that the Office may know whether or not to mark the station as "lost" in the records.

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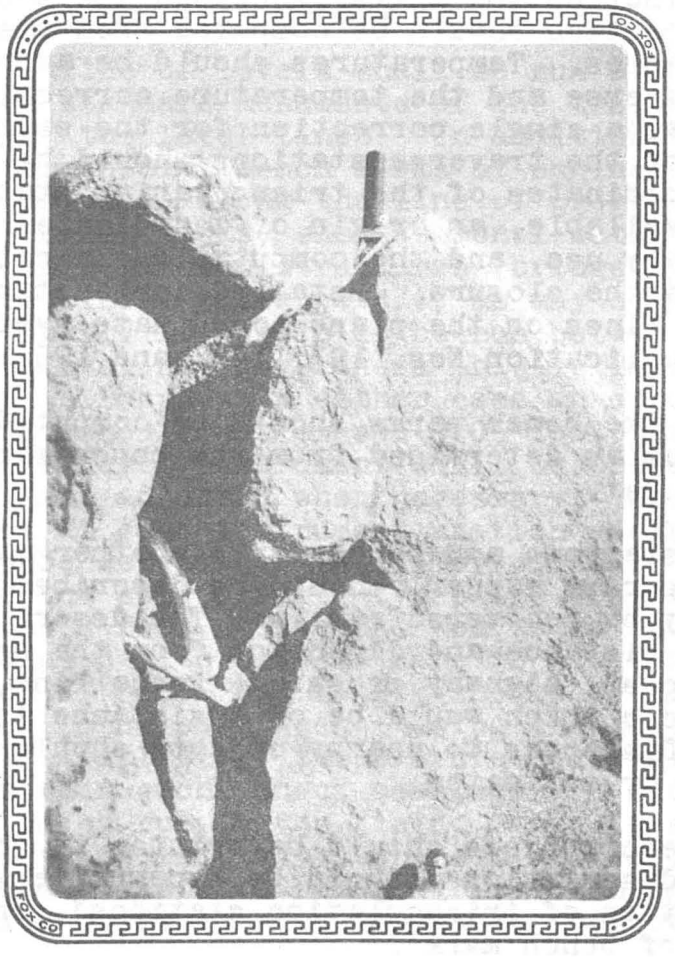
STATION LARAMIE PEAK



Station established on the top of Laramie Peak, Wyo., 10,274 feet above sea level. Note ladder made of logs to reach top.

- △ -

(Sample

LEVELING

Date Dec. 21, 1933 Time 8:05 A.M.

Station	B.S.+ Feet	H.I. Feet	F.S.- Feet	Elevation Feet
USC&GS BM Q 17	4.841	745.628		740.787
T.P.1	3.787	744.414	5.001	740.627
T.P.2	3.202	740.990	6.626	737.788
T.P.3	5.129	739.005	7.114	733.876
T.P.4	5.777	739.974	4.808	734.197
T.P.5	6.021	741.754	4.241	735.733
T.P.6	5.943	743.580	4.117	737.637
T.P.7	7.084	746.661	4.003	739.577
T.P.8	7.217	750.020	3.858	742.803
T.P.9	7.444	753.405	4.059	745.961
BM 101	*****		2.202	751.203
	56.445		46.029	
	46.029			
	10.416*			

* Elevation check on notes

Record)

LEVELING

From BM USC&GS Q 17 To BM 101
VIA State Highway and Township Line Road

Descriptions of Stations and Notes

B.M. Q17 recovered. Found in good condition. The old description still applies. Two additional references were made. The bench mark is 205 feet east of a new semaphore (No. 37). A new highway has been built along the north side of the railroad right of way. The B.M. is 121 feet southwest of the west end of the south abutment of a large concrete culvert on this highway. This culvert is 3.4 miles by road (speedometer distance) west from the west town line of Vernon. (Above notes to be used in making up Form 685).

J.J.Johnson - Observer. Earl Eton - Rodmen
S.V.Jones - Recorder. Dumpy level used. Instrument adjusted at beginning of day's work. Temp. at 8:05 A.M. 57 Degrees Fahr.

B.M. 101 is 3.0 miles by road south of the village, Neal; 4.2 miles west and 1.1 miles north of the town hall in Vernon in the northwest corner of the intersection of section line roads. The mark is 37 feet east of the center line of the North-South road and 34 feet south of the center line of the East-West road. The mark is in the northwest corner of James Hilliard's farmyard. It is 71 feet west of the northwest corner of his house and 49 feet NW of the center of his well. It is 184 feet east of the NE corner of Plainview M.E. church. The mark is a standard disk set in a precast concrete post 8" square and 60" long, projecting about 4" above the surface of the ground.

(Above notes to be used in making up Form 638).

(Sample Record)

TRAVERSE MEASUREMENTS

From Station Caboose to Station Cable

Date 12-21-33 Time 10:45 Tape No. 316

Section		Temp. Fahr.	Set up Feet	Tape Support	Inclination. Feet	Remarks
From	To					
Bench						Tension
Caboose	1	40.2		2	-2.7	22 lbs.
1	2	40.4		2	-1.1	except
2	3	40.1		2	-1.8	noted
3	4	40.0		2	-1.3	below
4	4'	----	20.000	2	-0.1	11 lbs.
4'	5	40.0		2	-0.7	
5	6	40.1		2	+0.6	
6	Bench	----	6.237	2	+0.3	11 lbs.
	Cable	40.1	26.237			

N. B. No temperature is recorded for fractional tape lengths.

(Sample Record)

TRAVERSE — ANGLES

Station Cable State Minn. County Renville Date 12-20-23

Observer J. S. Jones Instrument Berger 424

Objects Observed	Time	Tel. D or R	Reps.	Angle ° '	A "	B "	Mean of Verniers	Angle Mean D & R ° ' "	Remarks
Caboose to Cold	9.25A	D	0	0 00	:00	:00	00		
			1	173 45	:40				
			3	176 17	:10	:00			
			6	352 34	:10	:00	05	:178-45-40.8	
Cold-Caboose		R	6	0 00	:10	:10	10	39.2	40.0+0.4=40.4
Cold-Caboose		R	0	0 00	:10	:00	05		
			1	181 14	:30				
			3	183 43	:00	:00			
			6	7 26	:00	:$\overline{50}$	$\overline{55}$	:181-14-18.3	
Caboose-Cold	10:05A	D	6	0 00	:00	:$\overline{50}$	$\overline{55}$	20.0	19.2+0.4=19.6
								:359-59	59.2+0.8=60.0

The above comprises one complete set.

N.B. 0-00-$\overline{50}$ is the same as 359-59-50.

PRELIMINARY SPECIFICATIONS FOR TRIANGULATION TO BE EXECUTED BY LOCAL CONTROL SURVEY PARTIES UNDER WORKS PROGRESS ADMINISTRATION

In some states detailed horizontal control surveys can be extended by triangulation with greater facility than by traverse. In those cases it would be well if the surveying parties organized for triangulation would connect their work with existing triangulation stations of the Coast and Geodetic Survey. However, there may be cases where an area could be covered by detailed triangulation that is rather far removed from existing stations. In this case the local net can be executed with the assurance that within a few years an arc of triangulation of the Coast and Geodetic Survey can be connected with the detailed work.

Where the work is to be connected with a line of the existing net, consideration should be given to whether the line from which the work would start is of such a length as to satisfactorily control the lengths of the detailed triangulation. If the line is moderate in length it will be satisfactory for such length control. If, on the other hand, the length of the triangle side of the existing triangulation is twenty or more miles in length, it would be well to start the detailed triangulation from a single station, but an azimuth should be transferred from the existing work to the work contemplated. This can readily be done by having an automobile headlight or a signal lamp of the Coast and Geodetic Survey placed at the distant station and at night an angle involving the existing line and a triangle side of the new scheme can be measured. If desired by the State Director, a signal lamp can be furnished him for this purpose.

Where detailed triangulation cannot have its lengths controlled by a long line of the existing net, then a base line should be measured for the new scheme. A set of base tapes can be sent from the Washington Office of the Coast and Geodetic Survey for this purpose. Such a base should be measured with an accuracy of at least one part in 150,000. This can be done if the engineer in charge will follow the methods outlined in the manual of the Coast and Geodetic Survey dealing with base lines, (Special Publication No.145) a copy of which will be sent to each State Director upon request.

Triangulation of a satisfactory degree of accuracy can be executed with a surveyor's transit rated only to minutes, but this accuracy can be obtained with such an instrument only by making many repetitions of the angles. It would be well in the triangulation to use higher grade instruments, preferably those that read to 10 seconds, 20 seconds or 30 seconds. Such a number of repetitions of the angles should be made as will give closing errors that are seldom greater than eight seconds. If eight seconds is used as the maximum closing error it is reasonably certain that the average closing error will be somewhere between two and four seconds. With such closing errors the accuracy in the determination of the length of a triangle side should be at least as great as one part in 10,000.

A set of observations should consist of six repetitions of the angle with the telescope in the direct position, followed immediately by six repetitions of the explement of the angle with the telescope in the reversed position.

Measure only the single angles between adjacent lines of the main scheme, including the angle necessary to close the horizon. With this scheme of observing no local adjustment is necessary, except to distribute each horizon closure uniformly among the angles measured in that series.

The procedure used in making a set of observations is given on page 27. Two sets will usually give the necessary accuracy with an instrument graduated to 10 seconds, provided the observer has had experience in angle measurements. With instruments graduated only to 30 seconds or one minute, a correspondingly greater number of sets or repetitions per set should be taken.

It is very desirable in triangulation to have targets or banners that are well centered, large enough to be seen over the lengths of lines used, and that are free from phase. In general, it is better to have a board rather than a square pole as the target. A foot-wide board painted in black and white squares, or with black and white signal cloth wrapped around it should be visible at distances of ten miles or more where the atmosphere is clear. The face of the board should be centered over the station mark, and should be at right angles to the line joining the station with the observer's station. This will mean perhaps that every time the observer goes to a new station the targets will have to be turned in azimuth.

The triangles should be well shaped, especially those through which the length is carried from one triangle to another. In other words, the distance angles of a triangle should not be very small or very large. Preferably they should range between 30 and 140 degrees. It is suggested that the engineers in charge of the laying out of the triangles study the instructions for reconnaissance given in Coast and Geodetic Survey Manuals Special Publication Nos. 120 or 145.

A line of levels should be run over the base line to determine the grades of the individual tape lengths, and the levels should be tied in to existing lines of levels in order that the base may be referred to sea level. Even elevations determined from railroads would be satisfactory for this purpose.

The stations should be marked in a substantial manner with a view to their being permanent. A metal tablet set into firm outcropping rock is most satisfactory. It would be well at each triangulation station to put in a second mark at a distance of three or four hundred yards which can be used as an azimuth mark. A triangulation net is of particular value to local engineers and surveyors if they can start from a station with both a position and an azimuth. In any case, however, where the lengths of triangle sides are comparatively short the engineer can sight over a line to an adjacent station. In such a case it would not be necessary to establish an azimuth mark.

The triangulation stations should be so well described that there would be no difficulty in finding the hill or ridge on which the station is located or in identifying the station marks.

From the triangulation stations occupied with the transit or theodolite, observations should be made on any objects such as church spires, water towers, chimneys of houses or other objects that would make good stations for the control of topographic maps or surveying in general.

Where it would be difficult for a local engineer to start a traverse from a triangulation station it would be advisable to establish a supplementary station along a highway in each of the triangles or quadrilaterals of the scheme. If such stations are established it would be well to occupy them with a transit or theodolite and establish near each one an azimuth mark if the distances from the supplementary station to the other stations of the net run too great.

It is probably undesirable to determine the trigonometrical elevations of hills and ridges on which the triangulation stations are established. Such elevations would only be approximate and besides in most communities there would be lines of levels along highways or railroads from which elevations could be obtained.

If a chain of triangles is to be carried from one locality to another, it would be well to observe additional lines in order to provide checks in the angle work, and also to provide against mistakes being made in the computations. Where, however, the area method of triangulation is to be carried on the overlapping triangles are not needed.

It is generally known that the Coast and Geodetic Survey in extending its arcs across country, use what is called the quadrilateral system. This provides for a double chain of triangles from one place to another, thus giving greater strength to the work.

Even if triangulation is done in an area it will probably be desirable to run traverse lines along railroads and principal highways. Such work can be done at a smaller expense per station established than the triangulation, but the triangulation net furnishes a splendid check on the traverse and provides for stations from which a traverse can start and end.

Where a network of triangulation is to be established that is not close to existing triangulation of the Coast and Geodetic Survey, it would be desirable to assume a latitude and longitude for some one station scaled from the best map available, and determine by observations on the sun or Polaris an approximate azimuth. Then a base line should be measured to control lengths. From the assumed geodetic position, the observed azimuth, and the measured base computations could be made of the net. Later on when an arc of national triangulation net is carried across such area, connections would be made with two or more of the local triangulation stations in order that a final adjustment of the local net could be made that would give standard azimuths and positions. The length of the local net would no doubt be controlled by the local base line, even when connections between the local net and one of the fundamental arcs is made.

Record books for recording the observations for the triangulation and forms for the computations of triangulation and geographic positions will be furnished by the U. S. Coast and Geodetic Survey upon request.

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MORO LOCAL CONSTABULARY

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HORIZONTAL ANGLE MEASUREMENTS

The following information is given to illustrate the mechanics of measuring horizontal angles.

Refer to the sketch, and also to sample record sheets on page 27. The instrument is set up at Station "B" and the angle from "A" to "C" is desired. Set and clamp your upper plate as near 0°00'00" as possible. Point with the telescope direct on "A", using the lower motion tangent screw, and clamp. Loosen the upper plate and, using a clockwise motion, point and clamp the telescope on "C" (using the upper motion). Read and record this angle. Loosen the lower motion, and with the upper plate remaining clamped, again point on "A". Bring on with the lower tangent screw and clamp. Then loosen the upper plate and point and clamp on "C". Loosen the lower motion again and point on "A", etc. Repeat this six times, reading the measurements at the start (D-0), at the first (D-1), third (D-3), and sixth repetitions (D-6).

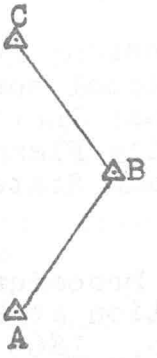
Now with the upper plate still clamped on the reading of the sixth repetition, plunge the telescope and point and clamp on "C" with the lower motion. Loosen the upper motion and point and clamp on "A". Loosen the lower motion and point and clamp on "C", etc. Repeat six times, and read and record as R-6. The reading on R-6 will ordinarily come back very close to the reading with which you started as recorded under D-0.

Now with this reading, recorded as R-0, on your upper plate, and your telescope still reversed and your lower motion loose, point and clamp on "C"; loosen the upper motion and point and clamp on "A". Record this reading as R-1. With this reading still on your upper plate, loosen the lower motion and point and clamp on "C". Again loosen the upper motion and point and clamp on "A". Repeat this operation six times, reading and recording your values at the start, R-0, at the first repetition, R-1, at the third, R-3, and at the sixth repetition, R-6. Then with this value still on the upper plate, loosen the lower motion, plunge the telescope (it will now be in the direct position) and point and clamp on "A". Loosen the upper motion and point and clamp on "C". Loosen the lower motion and point and clamp on "A", etc. Repeat this operation six times and record the last reading as D-6. This reading ordinarily should be very close to that at which you started, R-0. All operations and records so far constitute one set.

The sum of the two angles measured should, of course, equal 360°. Closing errors should seldom exceed eight seconds. If this value is accepted as the maximum closing error, it can reasonably be assumed that the average closing error will be between two and four seconds. Such a number of sets of observations

should be observed as will give the closing errors mentioned above. Usually from three to four sets will be found necessary.

With four sets the initial settings should be: for set No. 1 - 0°00'00"; for set No. 2 - 45°07'30"; for set No. 3 - 90°15'00"; and for set No. 4 - 135°22'30". With three sets, the initial settings would be: for set No. 1 - 0°00'00"; for set No. 2 - 60°10'00"; for set No. 3 - 120°20'00". With initial settings such as these, the observations will be spread over the circle and any errors in graduation of the plate circle will be minimized.



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BELLE OF SAMAR

"An' I seed her fust a-smokin' of a whackin' white cheroot"

AMERICAN SOCIETY OF CIVIL ENGINEERS

ENDORSES GEODETIC LOCAL CONTROL SURVEYS

* * *

December 2, 1935

TO THE PRESIDENTS AND SECRETARIES
OF THE LOCAL SECTIONS OF THE
AMERICAN SOCIETY OF CIVIL ENGINEERS

Gentlemen:

Word has just been received from Washington to the effect that WPA has given approval to Geodetic Local Control Surveys. The "Sponsors" are to be as follows:

> State Public Works Commission; Engineering Departments of States and other political subdivisions and municipalities; State Educational Institutions; State Highway Departments; State and City Planning Boards; with the cooperation of National and State Engineering organizations.

Announcements of the "Working Procedure" can be obtained from the Works Progress Administration at Washington, D.C. Reference should be made to Code No. 1865 11/22/35

The work is to be under the general guidance of the Coast and Geodetic Survey which will provide members of its staff as advisors, will furnish some instruments and forms for field and office work and will supply general rules of good practice to the end that the work done will be useful and worthwhile.

The relationship of persons on the relief rolls and of engineers is not fully clear to me but apparently the latter will be supervisory of the former to the extent of 10%. In general this has been interpreted that the total of salaries of those in supervision may be equal to 10% of the cost of the work including the salaries of those on relief.

There may be engineers on the relief rolls in your neighborhood who will wish to engage in this work either in field or office, and there may be engineers desirous of acting in the supervisory positions. It is urged that you make a definite search not only among Society members, but also among those not Society members, to the end that as many engineers as possible may thus have re-employment. If there shall be found those to whom this work would be of help it is also urged that you present the project to some of the suggested "Sponsors" for acceptance.

Very truly yours,

George T. Seabury
Secretary

Copies to Members of the Board of Direction.

THE GEODETIC SURVEY OF HARTFORD COUNTY, CONNECTICUT

* * *

The introduction to a report issued by the Commission on Regional Planning of The Metropolitan District of Hartford County, Connecticut, and entitled "The Geodetic Survey of the Metropolitan District", tells a story that up to a certain point might well be the story of most American cities. It is a story of growth from a small community to size and importance by processes which were largely unplanned; a story of early land surveys which were crudely made and unrelated with nearby surveys; and a story of an awakening to the needs for accurate coordinated surveys and maps for regional planning. But from this point on, the story is one of only a few American cities, and in a measure almost exclusively Hartford's story, for Hartford found a way to secure a control survey with which to coordinate and correlate its various surveys and maps by utilizing to a large extent its own engineering forces. The specifications for city control surveys and the methods for making such surveys have now become so well standardized and the quality of surveying instruments so improved, that it should not be many years before Hartford's example will have found so many followers that the following "Introduction" will tell the story of most, if not of all American cities.

---Editor's note.

INTRODUCTION

This report describes the triangulation portion of a controlling survey of The Metropolitan District in Hartford County, called the Geodetic Survey for the reason that the curvature of the earth is considered in its computations. It provides a framework of very precisely determined and well marked survey positions, by means of which accurate base maps may be assembled, and all future surveying, both by public and private agencies, may be coordinated.

Work on this survey was begun in April, 1931, with The R. H. Randall Co. of Toledo, Ohio, as consultants. The Randall Co. are specialists in geodetic surveying and the assistance and advice rendered by them was very valuable in assuring that this rather unusual type of survey work was started in the proper manner. The original triangulation net was established, computed and adjusted, some first-order traverse and first-order levels run, and a start made on plane-table mapping. This connection was discontinued on January 1, 1933 and the Department of Engineering has continued the work with its own men and equipment.

Like most American cities, Hartford has grown from a small community to its present size and importance by processes which

were largely unplanned. In the early days land surveys incident to the layout of streets and property boundaries were crude, as compared with modern methods, were usually concerned with small areas and were entirely unrelated with surveys of adjoining areas. With the formation of The Metropolitan District, which includes the City of Hartford and the towns of Windsor, Bloomfield, Newington and Wethersfield, the need for an accurate, lasting basis for the coordination of all various surveys and maps in the different divisions of the District was at once apparent. It was recognized also that the work of planning for the extension and improvement of highways and other public utilities, commonly called city planning, would require first, an accurate and reliable map of the District and second, similar accurate large scale topographic maps of many portions of the District's area.

The Geodetic Survey fulfils these two principal functions. It provides a framework upon which all surveys may be coordinated with corresponding improvement in quality and economy in execution. It also establishes, for the first time, a basis upon which the topographic maps necessary for the modern planning may be constructed.

The schedule of the Geodetic Survey consists of triangulation, first-order traverse, and first-order levels. This report describes the triangulation established to date.

In addition to the control described in this report, about 250 miles of precise traverse have been established. Data on this traverse are available at the office of the City Engineer in Hartford. It is planned to issue a report at a later date covering the traverse data.

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BROOKLET BEGINNING OF THE MISSISSIPPI

SELECTION OF MARK FOR LAPLACE AZIMUTH STATION

C. L. Garner

Within the last two or three years it has become the custom to have all azimuth observations made by the astronomical parties. The triangulation parties are usually large ones, and since they are frequently delayed in obtaining the necessary weather to make azimuth observations, the efficiency of their entire party would be considerably reduced in those cases where delays are occasioned by cloudiness. Therefore, the triangulation parties have been authorized to select suitable Laplace stations and, where an adjacent triangulation station is not intervisible with the Laplace station without the use of towers at either of the stations, to establish an azimuth mark at a distance of not less than one mile, preferably more but usually not exceeding five miles, and make regular first-order observations of sixteen positions on this azimuth mark, which is later used as the initial by the astronomical party in making the azimuth observations.

It has been suggested that it would be well to establish such azimuth marks, where conditions permit, to the north of the Laplace station so that the astronomical party could make the observations with the greatest facility. Obviously it requires a little less effort to make azimuth observations when the initial is almost in line with Polaris than when it forms some large angle which requires the observer to constantly walk around the instrument. This procedure would also undoubtedly add to the accuracy of the work as well.

At least one of our recent field parties has gone a step further in the selection of the azimuth mark. In each case it has made a supplemental station of the azimuth mark by locating a point which is visible from at least two of the main scheme stations and closing the triangle with first-order observations. Without doubt this is the best method of all and should be followed by all triangulation parties in the future. It is believed that only a few cases will be found where it will not be practicable to locate an additional point which will be visible from at least two of the main scheme stations without the necessity of a tower being built at the supplemental station and at one of the main scheme stations. In those cases where such a point cannot be located and it becomes necessary to resort to the azimuth mark, which is not determined in position, then it would be particularly desirable that the azimuth mark be nearly north of the Laplace station. Of course, it would expedite the azimuth observations always to have this mark nearly north of a Laplace station, but where this procedure would require that the azimuth mark be practically at right angles to the scheme of triangulation, it might be impracticable to obtain such a point on a closed triangle.

The supplemental station with the closed triangle is the most acceptable, as the triangle closure gives some measure of the accuracy of the observations, concerning which there might be some question raised by azimuths failing to agree properly. In connection with this it is necessary of course, that the parties constantly bear in mind the fact that the astronomical party is not prepared to build signals and, consequently, stations selected should be such that stands in excess of 10 or 12 feet in height will not be required.

Where the simple azimuth mark is used, without any determination of its positions, at least 24 directions should be obtained to it. That is, a full set of directions from 16 positions of the circle and an additional set of 8 positions so that observations may be in uniformity with the requirements for azimuth determinations. In case of rejections, additional positions should be taken.

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CONSERVATION OF SURVEY MARKS

The following letter shows such a commendable spirit of cooperation and appreciation of the value of triangulation station and level bench marks that it is felt that it should receive wide publicity.

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Department of Highways
Jackson, Minnesota

November 16, 1935.

Department of Commerce,
U. S. Coast and Geodetic Survey,
Washington, D. C.

Gentlemen:

Would you kindly send me data relative to the location of all your triangulation stations and reference marks located within Jackson County, Minnesota? I desire this information because we find that in the construction of new roads and also in reconstruction, we oftentimes run across reference marks which are within the highway right-of-way. Unless we know something of the location of these monuments, there is a possibility of their being disturbed in construction of the highways, so if you could furnish this information for me, we will do our utmost to try to conserve and protect these monuments.

Thanking you, I am

Very truly yours,

J. S. Wagnild,
Assistant Highway Engineer.

TABLET STATION MARKS IN PAVED ROADS

(Extracts from letter of J. S. Bilby, Chief Signalman.)

"You will be interested to know the result of tablet station marks set in concrete or macadam paved roads on highways or city streets.

"During the season of 1920, I extended first-order traverse from the vicinity of North Vernon, to the vicinity of South Bend, Ind. The work followed the railroads except through several of the larger cities where it was necessary to follow the paved streets and set the station marks in the street pavement.

"The stations were marked with the standard tablet station marks. A hole was drilled for the shank about one inch in diameter and the disc was countersunk level with the surface of the pavement. The hole was filled with a thin paste of pure cement and the tablet shank inserted slowly.

"Indianapolis, Ind., was one of the cities through which we followed the paved streets. The traverse line left the railroad about five miles south of the center of the city and followed the paved streets east and north through the suburbs of the city to 38th Street, then west on 38th Street to Keystone Avenue, then north on Keystone Avenue to the Lake Erie and Western Railroad crossing about 6.5 miles north of the center of the city. The length of this section measured on the paved streets is about 15 miles. Fifteen stations were established. Twelve of the station marks were set in the street pavement. Some of the marks were near the edge of the pavement, others were in the line of the travel where hundreds of motor cars, trucks and vehicles of all kinds have passed over them daily during the past fifteen years.

"One spur of my reconnaissance recently passed through the southern suburbs of Indianapolis, and connections were made with the traverse stations. While in the vicinity of Indianapolis, I visited all the traverse stations on that section through Indianapolis. As stated above, 12 of the station marks were set in the street pavement, 11 of the 12 station marks were recovered; 8 of the stations I recovered before I got out of my car. All the marks were in good condition. The station marks in line of travel where hundreds of motor cars pass over them daily, have a high polish and reflect the sun like a $141. gold piece. The triangle, letters and name of the station on the tablets were plainly visible. The tablets when set (1920) were flush with the surface of the pavement. I expected to find the pavement had worn away from around the tablets. However, "believe it or not", all the tablets were found flush with the surface of the pavement, and the face of the tablets had not worn enough to obliterate the letters. As stated, one station was not recovered. The station was at the

intersection of 38th Street and Keystone Avenue, and was destroyed during the past summer when the two streets were torn up."

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STATION MARKS IN PHILIPPINE ISLANDS

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In the annual report dated September 8, 1934, by the Chief of Party, Charles Shaw, who was engaged on combined operations in the waters to the north of the island of Luzon, the following statement is found:-

> "Many former triangulation stations and bench marks recovered in all areas this season were found in poor condition. These were all improved, rebuilt, or additional ones added. In every case where brass or copper marks were used these had been removed, showing it is still poor practice to use anything but drill holes in rock or concrete marks."

It is quite evident that where metal, especially copper, brass or bronze, appeals to the people living in the vicinity of a survey monument, the metal is likely to be removed. In such places it would be well to use a large steel nail with the head imbedded in the concrete and with the point projecting approximately half an inch above the surface of the monument. Even though this nail should rust away, the center of the station would be indicated by the hole that is left.

It might be well also, when a mark of this kind is made, to scratch a circle or a triangle around the center of the station in order that the nail hole may be positively identified.

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PUBLICATION

A number of copies of an interesting pamphlet "The Massachusetts Local Control Survey", a reprint of a paper presented by Mr. E. C. Houdlette at the meeting of the Boston Society of Civil Engineers and printed in the Journal of that Society, has been received at the office of the Coast and Geodetic Survey.

Mr. Houdlette was formerly the State Representative of the Coast Survey and now holds the position of Administrator for Massachusetts of the Local Control Survey ERA Project Xs-F2-U4.

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GEODETIC CONFERENCE

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General Report

Washington, D.C.
February 28, 1894.

"Sir: The Geodetic Conference called by you convened at Washington on January 9, 1894. The details of its organization are appended as a preface to the reports of the committees to which the duty was asigned of collating necessary facts and formulating them for the consideration of the Conference.

"An invitation was extended to members of the office and field force not members of the Conference, as well as to others interested in the subjects under consideration, to give expression to their views on matters relating to the geodetic operations of the Survey.

"The Conference desires here to make grateful acknowledgement to those who responded in writing, as well as to those who, by personal attendance and verbal communications, gave their valuable time.

. . . . . .

"The task assigned to the members of the Conference was the consideration of the geodetic methods as now practiced, the discussion of the application of these methods to the duties assigned by law to the Coast and Geodetic Survey, and the comparison of the means employed in foreign countries for similar purposes, with the object of suggesting improvements in regard to accuracy and economy."

--(From the Appendix to the Report of the Superintendent of the Coast and Geodetic Survey for the fiscal year ending June 30, 1893.)

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With the above Conference in mind, the Chief of the Division of Geodesy sent the following type of letter to all chiefs of party:-

"Since you have had a long period in the field in charge of first- and second-order leveling, you must have devised methods and improvements in equipment that have helped you on your work.

"I am writing this to ask that you write me fully on anything that you have done that is not in general use on leveling parties, and tell me also what additional changes in organization, planning, instruments, equipment, operation of trucks, observing and setting bench marks, computing, etc., that you think would improve the efficiency of our leveling parties.

"The chiefs of parties are very apt to see how improvements can be made which would not come to the attention of the officials here in Washington. You are up against the problems daily and undoubtedly can help us develop first- and second-order leveling beyond what they now are.

"Feel perfectly free to write just what is on your mind. Anything that you say will not be considered as a criticism but as helpful suggestions."

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The response was very gratifying and showed that the chiefs of party are continuously striving to improve their methods of operation. Due to the lack of space, it was impossible to print all of the letters. However, it is hoped that what is given here will serve as a "clearing house" of ideas which may be of use to others in the future conduct of field parties. Other replies will be printed from time to time.

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From letter of Maurice A. Hecht:-

In compliance with your letter there are enumerated below reports on a number of changes in triangulation procedure that have been put into effect on this party, and a number of recommendations and suggestions for further changes. During the period of our operation many new things were tried which did not work. Only those changes which were successful are listed.

New methods or improvements that have been put into effect:

Additional holes bored: Before using the steel towers furnished the party, a number of additional holes were bored in the anchor legs in order that the first section could be bolted nearer the anchor plates. This allowed the lower ends of the diagonals of the first section to be lowered to the ground even though the digging was such that the anchors could not be set down to the usual depth. In such cases the diagonals were then covered with earth or rock cribbing. A great deal of additional anchorage strength was given the tower in this manner.

Dye for straightening steel: The towers that have been purchased recently appear to be made of lighter steel than the towers that were furnished the parties a number of years ago. Consequently, the members were easily bent and required a great deal of straightening. In order to do this work economically, using party hands, and to weaken the steel as little as possible, a set of special dyes or tools were made. A dye machined to just fit inside of the angle of the tower member was held stationary on a heavy block. The steel tower member to be straightened was placed over this dye, and another dye machined to fit the outside of the member, was placed on top and against the inside dye. The straightening was produced with a large sledge hammer, the tower member being held at the points that were bent out of shape.

Dual wheels: While the party was operating in Mississippi, dual wheels were installed on the tractors of the semi-trailer trucks in an effort to determine whether they would be of benefit in traveling the muddy roads which were made almost impassable by heavy rains. They proved so satisfactory, under all conditions encountered, that dual wheels were also installed on the trailer wheels on one truck. It is believed that dual wheels should be installed on all steel semi-trailer trucks for the following reasons: Greater traction is secured which aids in pulling on muddy or slippery roads and also gives more braking power. The greater bearing surface diminishes the tendency for the truck to sink in and "bury itself" in a soft spot. It was noted that the trucks were more economical in the use of tires than with single wheels.

Signaled schedules: With a single or double observing unit on mountain triangulation it has been customary to prepare a written schedule in advance. It was found that with four regular observing units and an emergency fifth observing party that a written schedule was soon "out of date" and confusing. Therefore, the observing party signaled the schedule to all other units at the close of each night's work. This system worked so well that this party was enabled to complete 413 miles of mountain triangulation in a single month.

One reobservation: It has been field practice to close the triangles at the stations by signaling the directions to the observing party. If high closures resulted, the observing party would then have the observers reobserve those directions that were apparently in error. On other parties, I have known the observers to reobserve several times during the same night in an effort to improve the closures. It is felt that this produces a tendency on the part of the observers to "squeeze" their results in order to get good closures, usually with the result that the sides will then not check. Therefore, on this party the observers were instructed to reobserve only once. This was done because it was felt that quite often observations are started at twilight, a time when the temperature is changing rapidly, and the atmosphere is apt to be the most turbulent and unsettled of the entire day. A number of

times I have personally noted a marked change in a direction that was reobserved later in the evening. If good triangle closures are obtained by reobserving, an extra night on the same stations is avoided. However, if no change results at this time, it is best for the parties to come in. In reobserving at a station, a different observer was usually sent out with instructions to make a special investigation to find if there was anything which the first observer overlooked and which might be causing the poor results.

Recommendations for further changes and improvements:

Leveling arrangement for light plate: The leveling plates furnished by the office for use in leveling the lights on the tower light plate are difficult to use. With this attachment the lightkeeper has difficulty reaching his top light when he is showing four or five lights. The leveling plate is particularly hard to manage on windy nights and on shaky towers. I believe that new towers could be designed with a leveling arrangement for the light plate, and that all the lightkeeper would need would be a small pocket level, such as was furnished, to level the plate.

U-bolts for floor boards: In a number of cases strong winds have blown the floor boards on the observer's platform up against the inner tower (in a vertical position). This undoubtedly makes the wind more effective and may be the cause of some tower failures. It is recommended that the floor boards be equipped with U-bolts which would permit them to be securely bolted in place.

Safer towers: Due to the large number of recent tower failures, resulting in the loss of towers, instruments and other property, it is felt that more effort should be expended to make the towers safe. I believe that a set of guy wires should be used with each tower. The guys could be anchored in most cases to trees, substantial buildings, or other similar objects. Turnbuckles could be provided for tightening the wires. Where no natural object was available for anchoring, "dead men" could be set. A building party crew supplemented by possibly one extra man could still erect the tower in a day, and the extra cost would be negligible compared to the loss of an instrument, the tower or the lives of some of the men.

Base camp: With a large steel tower triangulation party, I believe that the base camp, for various reasons, is the best method of operation. In working from a base camp, smaller (one-half ton) trucks could be used for transporting the observing parties and lightkeepers. The use of these trucks would result in a saving in purchase price, use of fuel, tires, repairs, etc. They are also easier to handle on narrow mountain or woods roads, and are more easily towed out of mud holes. At present the one and one-half ton trucks used by the observing parties and lightkeepers travel about 90% of the time with practically no load. They are used in moving camp, but this could very easily be done by the extra steel trucks.

Mess and bunk trailers: I believe that the accomodation of a large party would be facilitated by the use of mess and bunk trailers in place of the tents. In addition to facilitating moving day, the men would be much more comfortable than in tents, especially in inclement weather. The spirit and energy of the party members depends largely on their contentment with the living conditions. I also believe that over a long period that the trailers would prove more economical than tents. They would last much longer, and there is not the danger of fire in a trailer that there is in a tent. The fire hazard is ever present in a tent, with the probability of the destruction of valuable records and government property.

New improved standard form of description card: One of the most difficult things to teach a new observer is the art of writing a complete, concise, and accurate description of the triangulation station visited. In order to assist the new observer and to keep the old one from getting lax, I believe that a new standard form could be furnished which would specifically outline the information required. The form should be so arranged that no section of the description could possibly be omitted, and with little notes that would prevent the observer from making some of the errors that have been called to our attention in the past. Sections might be headlined:

General locality of station.
How to reach.
Distances and directions from station mark to PERMANENT objects, etc.

Space could be provided for the recorder to check the distances and directions as listed. Some of these precautions would probably not be necessary if the observing was done by experienced, permanent officers of the Survey. But they would help materially for the use of civilian observers who have been rapidly trained, and who have done most of the observing during the past two years.

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From letter of Curtis Le Fever:-

In replying to your letter I respectfully mention the following changes which might increase the efficiency of level operations.

Manual of second-order levels needed: I am sure there is an urgent need for a manual of second-order levels. In this manual an exact procedure in running second-order levels should be outlined. The importance of accurate descriptions of bench marks should be stressed, also careful marking of the bench marks in the field; such as, building a circle of loose stones around the mark, when the stones are available. The use of a sun shade in running second-order levels I believe should also be stressed. Some of

the observers have the idea that they can run second-order levels without a shade over the instrument. I talked to one man who worked on one of our level parties who said the umbrellas were used very little. The importance of having the chief of party watch more closely the quality of the marks being set by his different units should be stressed. I have encountered some very poor marks during the last three years, however, most of them are very good. A chapter in this manual on reconnaissance for levels, outlining the different information which should be obtained for each line, I am sure would be helpful and would make the writing of instructions for such lines more accurate and much easier.

Suggested changes in new geodetic level:- On the new type of geodetic level I suggest the following changes: Better material in the tripod tension plates, which will not lose its tension and will not wear so quickly where the screws pass through. Harder material in the leveling screws I believe would be an improvement. I would also suggest that the split legs of the new tripods should have a second cross brace near their top. It should be so placed that it would rest on the shoulder when the instrument is being carried between set-ups.

Universal bubble level:- The use of the universal bubble level for setting all bench marks will make our marks much easier to hold a rod on and in this way, of more value.

Precast marks:- For precast marks I am sure there should be a standard type of square wood form used. The practice of casting marks in round metal pipe or tile should be discouraged. Such a mark is too smooth on the outside surface and the soil will not fill around and set to it to make it more solid as it will to a concrete surface. There also seems to be a tendency to set such marks too shallow. Perhaps it is because it is difficult to get pipe or tile of a proper length.

On a precasting unit I have found that an open express truck with a long wheel base and dual wheels is very practical. On such a truck 30 to 40 precast marks can be hauled at one time. I believe that a precasting party should consist of three men. They can cast 40 marks per day by hand. Forty forms are about all that can be hauled on one truck. If handled carefully they can be removed each day and be set up for another casting the next day. This party also distributes the cast marks to points on the different lines where they can be picked up by the bench mark setters.

I have found that for all other purposes on a level party the shorter wheel base (around 131 inches) should be used. When trucks are purchased I suggest that the lower gear ratio be insisted upon. The higher gear ratio has too much speed and not enough power unless in the lower gears.

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From letter of E. E. Stohsner:-

In reply to your letter, the following is a brief discussion of the practices that may not be conventional on all of the leveling parties but which I think have improved the efficiency and accuracy of our work.

The descriptions of the bench marks set is a very important part of the work. They are part of the record of the levels that are in the files long after the field work is forgotten; they must be concise, accurate, permanent, and complete. They must be more permanent than the mark itself or there is no use in setting such lasting marks. In the past years, levels were usually run along railroads or at least on very well traveled and known highways. Lately, however, level lines of the 7-1/2 mile spacing and even the last of the 25-mile spacing, must be run in many cases along unimproved roads and trails. For this reason it is exceedingly difficult to make clear descriptions of bench marks. There are cases where lines run over roads and trails for a distance of 50 or 75 miles without passing through any named settlement or town of any sort. Trails are so numerous in many places that several will branch off the level route within the distance of one mile. In order to guide the person who later recovers the mark, through such a maze of possible routes, bench marks have been described differently from the way in which they have been in the past. In the first part of the description the distance and direction to the nearest town is given and also references to any objects, natural or otherwise, that may be near. Then instead of trying to give a detailed account of how to reach the mark from the nearest town by a series of "thences" and "forks", the mark is described in detail from the mark previously set. This second part or paragraph of the body of the description really only covers the distance of one or two miles, whatever the distance to the last mark is, but it is very complete. In this way, even under the poorest conditions, a person having the list of descriptions on the line can follow from mark to mark until the desired mark is found. This method of describing marks is only used however, in cases where the ordinary method of describing marks is hardly adequate.

Use of molten lead:- In setting bench mark disks in structures during freezing weather, molten lead has been found to be much more satisfactory than neat cement for holding the tablet shank in place. Molten sulphur was also tried but is not as successful as lead. An ordinary gasoline blowtorch and a tinner's ladle is all the equipment necessary. A few drops of lubricating oil in the bottom of the drill hole before the molten lead is poured in will prevent sputtering due to moisture and will make a better finished job. Excess lead can be trimmed off by pointing the torch flame at the disk a few seconds and brushing off with a wire brush. If it is desired to readjust or reset the mark it can be easily accomplished by heating the mark with the torch until the lead is again melted. Using this method, disks have

been set at temperatures as low as 0°F when the setting with ordinary neat cement would have been impossible.

Precast bench marks:- It is probably more economical to have a precast bench mark party casting our own marks than to have the marks made on the outside. The price per post may be about the same but the time saved in having the marks cast at the correct time and at the correct places just when wanted, would often amount to more than the cost of the post themselves. The equipment necessary to outfit such a party would amount to only a concrete mixer and a truck, or probably two old trucks that are no longer serviceable for observing or regular bench mark setting work. The truck or trucks are used in delivering the ready made posts to vantage points along the lines. This would be a great help in isolated areas and on poor roads and trails.

Accuracy:- In organizing an observing unit, about the most difficult problem after an observer has observed a month or two, is to keep the matter of accuracy in his mind at all times. The feeling of competition for progress between the units usually runs high. An observer, in his eagerness to make more miles than some other observer, often lets the accuracy slide a little although truly it is not intentional.

* * * * * *

From letter of G. R. Fish:-

The following methods of procedure may, or may not be in use by other level parties but I do not believe that all of the field parties use the methods described below:

Computing elevations:- Since the field parties have been supplied with adding machines which will not subtract, we have used the following procedure for subtracting when running up elevations:

Take the number of digits in the meters from four and the remainder indicates the number of nines to punch initially; then take the reciprocal of the mean elevation (secured by subtracting all digits except the last from nine and the last from ten) and place it on the machine and crank.

This method is fast and accurate, especially when two men are engaged and the one reading the figures indicates which figures to place on the adding machine. There will be a few superfluous figures printed on the left hand edge of the tape but usually a cipher will appear between them and the correct elevation.

Carrying rod boxes:- Rod boxes are carried in brackets fastened to the right hand side of the truck body. The brackets are placed about 12 or 18 inches from each end of the body to prevent the box from sagging in the middle and so that the box clears the fender by about 1 inch. They extend out only far enough to make the inner upright clear the edge of the flare board. The brackets are made of 1-1/2 by 3/8 inch strap iron, bent to form a right triangle and welded together, one side of the right angle placed against the side of the body and the other extending outward, the bottom of the triangle even with the bottom of the bed (gives a better angle of support than a flatter brace) and the uprights welded to the top of the horizontal piece. The width between the uprights should be about 8-1/2 inches and the length of the pieces about 8-1/2 inches with at least 2 inches of 1/2 inch threads on the end for a wing nut. The cross piece to fit on the uprights should be a piece of strap iron with about 5/8 inch holes in each end and the piece should be cut off about 1/4 inch outside the edge of the holes. The brackets are usually fastened to the body with three bolts each, and a heavy piece of strap iron, or wood, is placed inside the body to keep the body from weakening.

The benefits of the above are that the rod box is prevented from joggling around on rough roads (which helps prevent wear on the rods and rod box) and when moving camp the truck is easier to load; also the rod box is farther forward.

Using truck when leveling along highway:- A regular five-man level unit is operated and when working along a railroad, or road where it is not practical to use the truck, an extra man is hired to drive the truck. When working along the highway the recorder drives the truck and the other members of the party ride on the truck between set-ups. A small piece of rag is fastened underneath a lug bolt on each front wheel and the revolutions of the wheel are counted beginning as the truck passes the rear rodman (each rodman holds his own point). One rodman rides on the running board and counts the revolutions of the wheel on his side and begins to call them out about 8 or 10 revolutions before the correct interval is reached; the recorder being informed beforehand of the interval desired. The recorder drives about 15 miles per hour and begins to slow down when the rodman commences to count out loud and stops the truck when the correct interval is reached. During this time the observer is free to survey the slope of the highway and vary the interval if he thinks it feasible. When the truck stops, the rodman immediately begins walking forward and takes approximately 3 steps for each revolution of the wheel and adds or subtracts any steps necessary to correct the interval. The observer alights and uses a hand level to determine if the rear rodman is visible and approximately whether or not the front rodman will be visible. He then sets up the instrument opposite the truck, or moves backward or forward as necessary, calling out twice the change in steps to the front rodman. The umbrella man uses a hand level to place the front rodman while the observer

reads the rear rodman and as soon as the rear rod reading is checked, the rear rodman is called forward and rides on the truck to the next set-up. The umbrella man rides on a front fender and the observer on the running board.

This method is applicable to a variety of conditions, but on excessively steep or narrow roads or in heavy traffic it is expedient to hire an extra man to drive the truck.

The benefits of the above method are that one less man is required on each level unit and the work is also speeded up. Each rodman walks only half the distance leveled and although the observer is on his feet all of the time he is spared having to walk and thus becomes much less fatigued.

Carrying geodetic levels in the field:- The shipping boxes in which the geodetic levels are received are retained and the shredded paper packing is kept in the bottom of the box. The level boxes are carried in these boxes which are placed near the front end of the bed of the truck.

In this way both the instrument and the box are protected and, in my estimation, this is better than having the observer carry the level on his lap. I believe that a level receives about as many jars when being set up as it does in being transported to and from the working grounds and that it is a waste of energy for the observer to hold the box on his lap.

Transporting personnel:- Bucket seats, which may be purchased cheaply at a junk yard, are more satisfactory than the side seats installed as original equipment in some screen body trucks. The seats are not fastened to the floor and the men usually sit with their backs against the front end gate.

These seats are more comfortable for the men and take less room when moving camp. (In my estimation side seats should never be installed in a truck as they are not usable except on very smooth roads.)

Levels received from office:- It is suggested that each level be tested for stability of collimation adjustment before being sent to a field party. The instrument might be tested about as follows: adjust for "C", jar by slapping with hand, or some other means, and again take "C". A stable instrument will require a "C" adjustment only once every two or three months but an unstable instrument will not stay within .01 for the value of "C" for more than several set-ups, and usually requires adjustment every day. It has been noted that this defect may be caused by a looseness of the cork wedging at the ends of the level vial, or by the improper placing of the metal contacts supporting the level vial.

If the above is done in the Instrument Division it will save having to remove the level from the instrument in the field with the resultant probability of poor adjustment when the level is replaced in the instrument. So far the only level adjusted in the field was fixed by placing a single thickness of cloth over the ends of the level and inside the cork wedges. Since that time the level has stayed in adjustment for weeks at a time while before it would not stay in adjustment from one set-up to the next.

Cross hairs:- The interval between the hairs sent out for replacement is now satisfactory but the size of the hairs is variable in a set and between sets, and mainly too large. Some of the hairs appear double when viewed in the instrument. A hair which covers several millimeters at 100 meters makes reading the rod a bit difficult and may tend to introduce errors in the line. If feasible it would be advantageous to determine which make of levels certain diaphrams will fit as some diaphrams will not allow the cross hairs to be moved far enough forward to come within the focus of the eye piece.

* * * *

From the letter of H. J. Oliver:-

In replying to your letter all I can do is briefly outline our methods and setup.

The party was operated in 15 units at the time it was disbanded; 9 single observing parties, 5 bench mark parties, and the office. It has been our experience that single parties operate with less confusion, less moves, and consequently more efficiently than do larger parties. Six men have been employed consistently on each observing party and on single-run levels six men are almost indispensable to effective operation. By keeping a careful analysis of cost and output for bench mark parties our experience has been that 2 men to a bench mark truck is the the most effective setup. It is believed that such a bench mark party should be supplied for each observing unit under the present specifications for spacing of bench marks. Cast-in-place marks have proven more satisfactory than precast marks. Perhaps the psychological effect of setting a larger more permanent mark encourages the men to take more care not only with the selection of the location but with finish and building of the mark in general. It has been our practice to purchase round forms of IC Tin, 12 inches in diameter. These have been purchased in lots of 1000 knocked down and nested, at 25 cents each. Complete discussion of these forms has been furnished you from time to time as the idea developed.

Several methods have been tried for carrying water but the most successful was a square tank built on the side of the truck.

The water is drawn out in a bucket and carefully measured to the amount of cement. The most effective type of truck for operation along good roads has been found to be a steel bed on a 157 inch wheel base with dual wheels. In setting marks along mountain roads on 7-1/2 mile spacing, 131 inch wheel base, single wheel trucks gave the best performance. Each job and type of country encountered requires different treatment, in fact, as has often been said, "rule of thumb cannot be substituted for intelligence". Systems that will work on one party will often be a failure on another. For this reason it was my practice to allow each party to work out its own problems with as little supervision as possible. It is, of course, necessary to point out bad practices promptly and make such suggestions for their correction as seemed desirable. Under this general plan I was able to keep the men interested in their work, and to retain well trained men. During the four years I operated a level party only one observer and two recorders left the party.

The office carefully divided up an assignment and furnished each party complete copies of all the material they would need. The work when received from the field parties, was carefully checked and an effort was made to forward everything to the office complete and without blunders. It is possible that some unnecessary rerunning was extended by the party but believing that the easiest time to pick up a blunder is at the time it is made and the party is convenient, sections where a reasonable doubt occurred were often rerun rather than to risk an error.

Some experimenting with an amber eyepiece and colored rods was made near the end of August. Our work indicated that an additional red eyepiece was very effective in eliminating heat waves. Our trial with a "red rod" indicated that it was of some assistance, especially to less experienced observers. Some observers were in favor of having different colored stipes for each meter, and having both rods colored the same. This was designed for elimination of "meter busts" rather than a "cross sight" as in the case of the "red rod".

It is suggested that from the standpoint of a field man, some very definite and decided effort should be made to eliminate inferior equipment. It is suggested that state highway departments be contacted in the same manner in which railroads are contacted before assigning level parties to work over highways.

* * * * *

From letter of W. R. Tucker:-

Having had a long period in the field in charge of first- and second-order leveling, I can write, in the main, only praise and commendation of the methods and equipment now in general use on this type of work. When I took charge of my first level party about three years ago, our first-order leveling had been developed

to a high degree of efficiency, especially as applied to the small parties that were then employed in the field. The changes made since that date have been made to apply chiefly to the larger units employed and to the increase in the amount of second-order leveling. The new type tripods, the new abstract forms, the complete weekly and monthly report forms, the precast bench mark posts, the use of a second recorder on second-order levels, the use on railroads of different types of nails driven in center of cross ties as turning points in place of the rail spikes, the increase in the number of bench marks, and the greater stress given to the correct placing and description of locations of bench marks, have in my estimation, all been necessary and useful changes or improvements.

This party soon after assignment of second-order work, employed the common wire fence staple driven in the center of cross ties as turning points on railroad work and found them very satisfactory. We have also found that by having the bench mark setters write up the description of the location of bench marks when placed, there resulted better locations, more accurate and complete descriptions, and less loss of time than when the descriptions were written by the observing units. The increase in the number of extra foresights for topographical features, has resulted in the level abstracts being practically covered with barred off sections to designate these extra foresights. The inking in of these bars requires an unusually large amount of night work for the recorders and observers, a part of which time could be more usefully employed in checking the work if a satisfactory ink of different color could be used to designate these sections in place of bars. The "Red Rod Method" as an aid to avoid transpositions was not put in use by this party in time to give it a fair trial, but it was the general opinion of most observers and recorders that this method would not only reduce the number of transpositions but would also be a great aid in catching them where they occurred.

The 1-1/2 ton observing trucks are rather heavy and cumbersome for transporting units to and from work, but a truck of this capacity is required to move a unit from camp to camp, so I doubt the efficiency of using lighter trucks in the greater number that would be required.

On these large parties, it is believed that the personal element or the types of men that make up each observing unit, have more to do with the amount and accuracy of the work than ever before. It has been my practice when an observing unit showed a deficiency in either accuracy or amount of work accomplished, to make a study of the work and disposition of each member of that unit to determine if some method employed or lack of coordination was not causing the deficiency. In some cases lack of ability of some members of the party caused the trouble, but in most cases one member's inability to adapt himself to the practices, methods, and dispositions of other members of the unit, seemed to be the difficulty. The results obtained by early transference or shifting of personnel from one

unit to another were often surprising and proved to my satisfaction that a man of ability might delay the work of one unit and yet when transferred to another unit this man would often increase the efficiency and coordination of the new unit.

We have tried on this party, to instil in the men a spirit of cooperation and an element of pride in their work. I will say here, that it has not been a job but more of a pleasure to work with most of the members of this party. The cooperation and assistance rendered this party by the Washington Office has been all that could be asked for.

* * * * * *

From letter of John Bowie, Jr.:-

Improvements in steel towers:- In my opinion, the steel towers are in need of improvement. Since the failure of station Tuckerman in June 1934, I have reinforced the vertical legs of the outside tower by cutting pieces of steel 5-1/2 feet in length and bolting them on the vertical legs from the 64 foot section down, when the heights of the towers exceed 90 feet. Since this procedure has been adopted, I have not lost any towers and consequently I recommend that the design of the vertical legs of the outside tower be made of a larger size in order to increase the bending strength by 50%. Another point in the future design of towers which should be made permanent practice is a device for bolting the platform boards in place in order to prevent strong winds from lifting them up and acting as a sail at the top of the tower. My building parties have been tying the platform down by rope but it seems to me that a few U-bolts provided in the design of the tower, would hold the platform in place.

Truck driven by one man:- I find that a truck will be best taken care of if driven by one man only, who knows he is to drive the truck for a long period and consequently will take care of it and have a certain amount of pride in its appearance and performance. Also, should anything go wrong with the truck there would be no one else on whom to "pass the buck".

Azimuth marks: Due to the increasing importance of azimuth marks, a bench is built over each mark on which a flash light signal lamp is carefully centered by a plummet. Pointings are then taken on the lamp, which has been hooked up to batteries, thus assuring that no error will be caused in the observations by not having the object observed upon correctly centered over the azimuth mark.

Pay scale:- One thing that I would like to see changed is the present group system of pay scale. At present a man cannot get a raise in pay unless advanced to a higher group. I would like to

see this changed so that a man can get a raise after staying in a group a certain length of time. I also think the pay for observers should be higher as their work is directly responsible for the figures and results which come from the record books.

(Additional subjects treated by Lieut. Bowie are as follows:

1. Double observing party.
2. Building parties.
3. Office trailers.
4. Night driving.

As the subjects mentioned above were covered in his article "Party Organization" printed in Volume 2, No. 8, page 15, they are omitted in this issue of the Geodetic Letter.)

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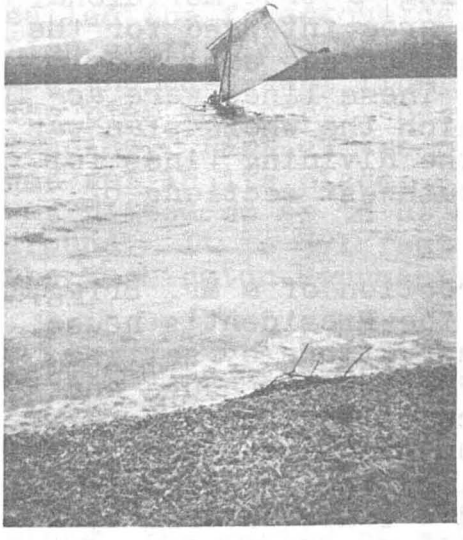
THE MORO VINTA



Native boat scooped out of a solid log and equipped with outriggers and sail. These little vessels are capable of a considerable amount of speed.

Same boat all dressed up by the groom for his wedding on the Isle of Jolo. Note the use of parasols placed at the four corners of the canopy for decoration.

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MERIDIANS OF WASHINGTON

Frank L. Culley

- - -

On L'Enfant's plan of the Federal city there is plotted the letter B on the site of the Emancipation Statue in Lincoln Park, about one mile east of the Capitol. A marginal note indicates that on this site was to be:

> "An historic column; also intended for a mile or itinerary column, from whose station (a mile from the Federal house) all distances of places through the continent are to be calculated."

This is the only evidence that it might have been L'Enfant's idea to have the primary meridian of the United States pass through this point. On the same map, however, the longitude of the Capitol is given as 0°00', indicating that the primary meridian should pass through the Congress House which, of course, could not also pass through a point one mile east.

The task of laying off the streets, avenues and reservations was performed according to L'Enfant's plan in 1891 and 1791 1792 by Andrew Ellicott. He began by drawing "a true meridional line by celestial observation, through the area intended for the Congress House; this line he crossed by another due east and west, which passes through the same area. These lines were accurately measured and made the bases on which the whole plan was executed". Incidentally, these are also the dividing lines for the northwest, northeast, southeast and southwest sections of the city.

In 1804, Nicholas King, under the direction of a Mr. Brigg, laid out a meridian through the center of the President's house. This was also established by celestial observations by setting up a transit at the northern door of the President's house and pointing to the star "in the tail of the constellation Ursa Minor at its eastern elongation, and, continuing the vertical circle to the ground, he determined the bearing, in line of which on very low stand was placed one of Argand's lamps covered by a tin cylinder, in which a small slit was made for a sight, and the line from the light toward the instrument was drawn upon the stand". This stand was located on the northern side of I Street at the intersection of Sixteenth Street. Turning back toward the west with the transit through the horizontal angle formed

by the eastern elongation and the upper culmination of Polaris, a point was found on top of a hill nearly two miles due north of the President's house, on the lands of Mr. Robert Peter. This line was temporarily marked with wooden posts and later, with Mr. Peter's permission, a small obelisk of freestone was placed so that its apex was in the true meridian from the center of the north door of the President's house. From this survey the names "Meridian Hill" and "Meridian Park" were derived.

The line was extended south of the President's house to intersect the east and west line through the Capitol. Since the Capitol could not be seen from this point, an obelisk known as the Capitol Stone was established at the intersection of the meridian and the east-west line passing along the south edge of the "old Capitol". A distance equal to half the length of the Capitol was then measured northward from the Capitol Stone to establish the point which is the intersection of the meridian of the President's house and the west line from the Capitol. This was marked by a small pier covered by a flat freestone on which the lines were drawn. This pier was on the south bank of Tyber Creek.

It is not known why this meridian was established. Some think it might have been President Jefferson's idea to have the principal meridian of the United States pass through the President's house and that the line was marked at his instigation.

In his centennial history of Washington, Commissioner Webb called the freestone cap on the pier, which marked the intersection of the President's house (or, Sixteenth Street) meridian, and the east-west line through the Capitol, the Jefferson Stone. The pier was partly destroyed and covered during the process of grading. Part of the pier was recovered later and a new stone was set in its place. During further grading in 1935, the stone was raised so as to be almost flush with the new surface of the ground. It is 371 feet west and 123 feet north of the center of the Washington Monument.

In 1889 the Office of Public Buildings and Grounds placed a 17-inch square of granite stone marked "U. S. Meridian 1890" within the "Ellipse" south of the White House in the meridian of the Jefferson pier, and 1505 feet, 4-1/2 inches north of it.

On June 4, 1923, with appropriate ceremonies, a zero milestone, the center of which is the starting point for the measurement of distances over all highways radiating from Washington, was unveiled. (L'Enfant had in mind the placing of such a marker in what is now Lincoln Park. See first paragraph.) A description of this stone in the "Program of Exercises attending the Unveiling and Dedication of the Zero Milestone Monument" states:

"The location of the stone is on the Meridian of District of Columbia as marked by the 'Jefferson Stone' placed south of the Ellipse in 1804."

According to the position of the Zero Milestone as determined by the Coast and Geodetic Survey, its center is 0.3 meter (1 foot) west of the meridian through the White House.

More than a century ago various nations reckoned their longitude usually from their own capitals. Congress by act approved September 28, 1850, ordered -

"That hereafter the meridian of the observatory at Washington shall be adopted and used as the American meridian for all astronomic purposes and . . . . . Greenwich for all nautical purposes."

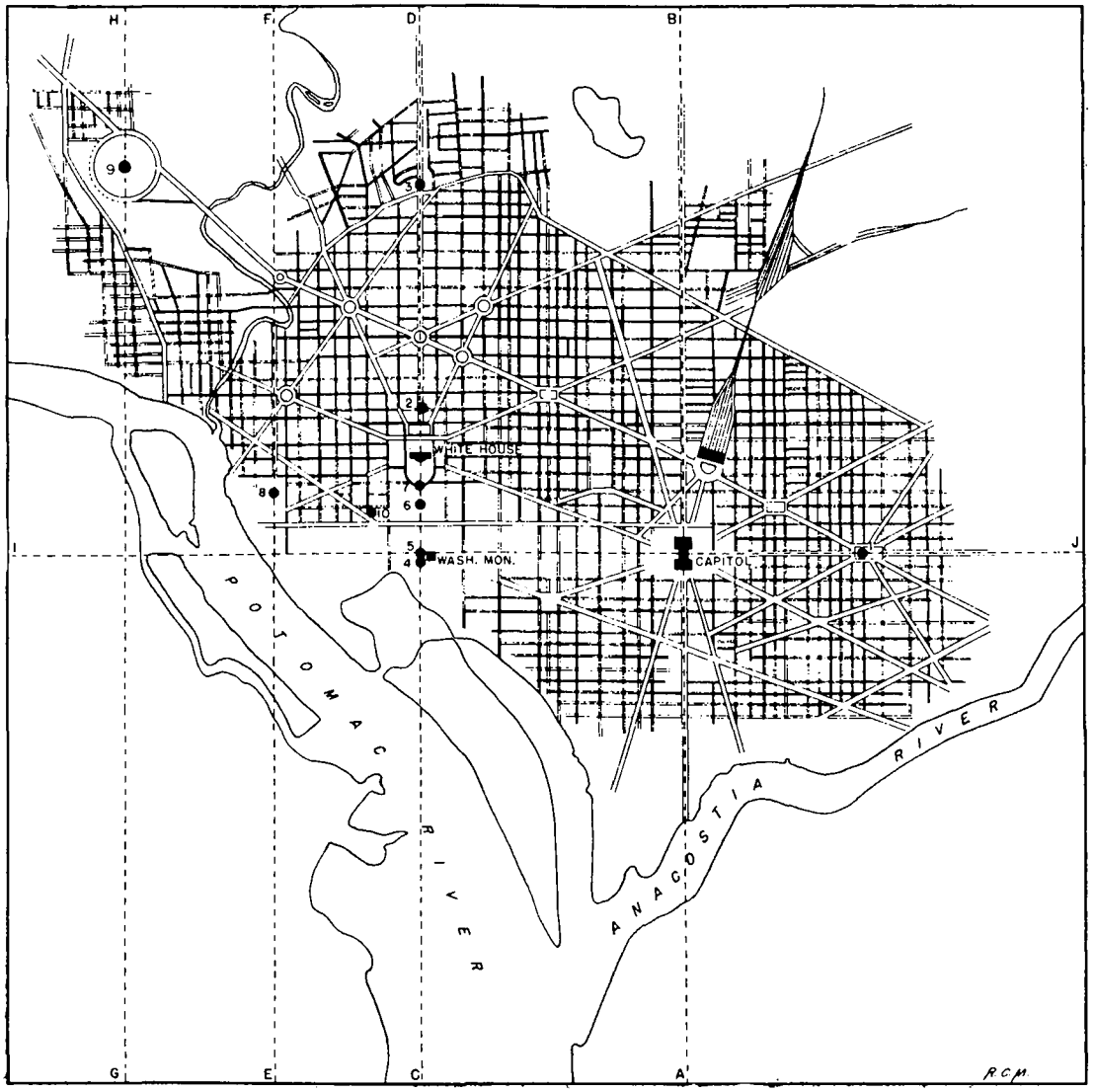
The longitude of the North American datum of this meridian, which passes through the old Naval Observatory (now one of the buildings on the grounds of the U. S. Naval Hospital), is 77° 03' 06".119.

The boundaries of several states and territories were defined with reference to the meridian of Washington. The act was repealed August 22, 1912.

In 1882, Congress recognized the advantage of having a common initial meridian for all countries and by a joint resolution, authorized the President of the United States to call a conference for this purpose. This conference met in Washington in October, 1884, with 26 nations represented. It recommended the adoption of the meridian of the Royal Observatory, Greenwich, England. This is now almost universally used. All points in the United States are referred to this meridian. It was adopted by France in 1911.

The "Meridian of Washington" referred to in the "American Ephemeris and Nautical Almanac" is that one which passes through the center of the clock room of the present U. S. Naval Observatory.

(Sketch and legend given on following page.)



1. Site proposed by L'Enfant for an itinerary column from which all distances on the continent were to be measured.

2. Stake set at the intersection of "Sixteenth and north I Street".

3. Meridian Hill stone marking the north end of the White House meridian as established by Nicholas King in 1804.

4. Capitol Stone on the meridian through the White House and the east-west line through the south end of the Capitol as it existed in 1804. The mark is now nonexistent.

5. Jefferson pier on the meridian through the White House and the east-west line through the center of the Capitol. It is now marked with a granite post 123 feet north of the Washington Monument and 371 feet west of it.

6. Stone marked "U. S. Meridian 1890" set in the meridian of the White House 1505 feet, 4-1/2 inches north of the granite post marking the site of the Jefferson pier.

7. Zero Milestone, the center of which is one foot west of the White House meridian.

8. Old Naval Observatory (the building still exists) on the grounds of the U. S. Naval Observatory. The meridian (EF) of the center of the dome served as the initial meridian for the boundaries of several states and territories. It was intended as the prime meridian of the United States.

9. Center of the clock room of the present U. S. Naval Observatory.

10. Center of the original District of Columbia - a point unmarked but at about 18th and C Streets northwest.

AB Meridian of the District of Columbia established by Andrew Ellicott to serve as a base for laying out the streets of the Federal city.

CD Sixteenth Street, or White House, meridian through the center of the north door of the "President's house" - marked by 4 and 5.

EF Initial meridian of the United States, through the center of the dome of the old U. S. Naval Observatory.

GH "Meridian of Washington" through the center of the clock room of the U. S. Naval Observatory.

IJ East-west line through the center of the Capitol

VALUES OF ASTRONOMICALLY DETERMINED LONGITUDES WEST OF GREENWICH

Name of Station	On Meridian	Longitude
Old U. S. Naval Observatory, center of dome.	EF	77° 03' 02".30
U. S. Naval Observatory, center of clock room.	GH	77° 03' 56".76

VALUES OF GEODETICALLY DETERMINED LONGITUDES WEST OF GREENWICH ON THE NORTH AMERICAN DATUM

Name of Station	On Meridian	Longitude
Capitol, head of Statue of Freedom	AB	77° 00' 33".533
Jefferson Pier	CD	77° 02' 12".48
Meridian Stone of 1890	CD	77° 02' 12".478
Zero Milestone	one foot west of CD	77° 02' 12".492
Old U. S. Naval Observatory, center of dome	EF	77° 03' 06".119
U. S. Naval Observatory, center of clock room	GH	77° 04' 02".24

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TYPICAL YAKAN MORO FAMILY

- △ -

OPERATION OF TRUCKS

Mr. J. S. Bilby, Chief Signalman, recently reported the sale of his truck No. 79. This truck was purchased in July, 1929, and has a mileage of 121,006 recorded on its speedometer. Most of this mileage was made personally by Mr. Bilby while engaged on reconnaissance in various sections of the United States.

Mr. William Mussetter also submits a summary of operating costs for truck No. 60 which he has driven more than 106,000 miles. Mr. Mussetter has been the only person to drive this truck during its life time which is also practically true of the truck driven by Mr. Bilby and shows the advantage to be gained where only one person operates a vehicle. Mr. Mussetter also reports that he used one automobile tire for 61,300 miles. The tire is still in serviceable condition although of little value.

Summary of Operating Costs - Truck No. 60

Year	Miles run.	Miles per gal. gas.	Miles per qt. oil.	Cost repairs, tools, etc.	Cost tires	Total cost incl. dep.
1928	4030	18.06	366	$ 11.14	$ 25.00	$ 196.26
1929	15,401	15.20	261	140.81(a)	2.95	810.09
1930	11,971	15.80	240	21.79	88.48	599.75
1931	14,009	13.4	181	54.94	20.38	463.70
1932	16,771	12.8	180	69.51	16.25	295.17
1933	13,599	12.5	151	86.84	14.25	276.76
1934	15,844	13.52	162	147.78(c)	-----	328.12
1935	12,596	14.04	307	39.81	31.26	207.54

Year	Depreciation charged per mile.	Operating cost per mile.	Total cost per mile.
1928	$0.03	$0.0187	$0.0487
1929	.03	.0226	.0526
1930	.03	.0201	.0501
1931	.03(b)	.0161	.0331(b)
1932	.00	.0176	.0176
1933	.00	.0204	.0204
1934	.00	.0207	.0207
1935	.00	.0165	.0165

(a) Includes repainting, new top and side curtains.
(b) Depreciation stopped at 38,333 miles.
(c) Includes repainting, new side curtains, and general motor overhaul.

The above are good examples of what can be obtained in the way of truck mileage by careful driving and proper care of truck.

NOTES

(From "Publications of the American Astronomical Society".)
- October, 1935 -

Variation of latitude. There has been no interruption of the observations for variation of latitude at the two international observatories in this country which are being operated by the Coast and Geodetic Survey. Mr. H. G. Wrocklage has continued the work at Ukiah, California, and Mr. E. L. Williams at Gaithersburg, Maryland. About the usual number of observations were made during the year. The best observing conditions occurred in July, August, and September at Ukiah, and June, August, and October at Gaithersburg. The poorest observing conditions were in February at both observatories. The original records were sent as usual directly to Professor Kimura of Japan, Chairman of the Joint Committee on Variation of Latitude of the International Astronomical Union and the International Geodetic and Geophysical Union.

Geodetic Astronomy. One astronomical party in charge of Mr. C. A. Whitten was in continuous operation throughout the fiscal year, and a second party in charge of Mr. E. H. Swick was organized in the spring of 1935 and has been in continuous operation since that time. All of the geodetic astronomy has been done to furnish Laplace stations to be used in the adjustment of the new arcs of triangulation in this country. Since the work could be done at very little additional expense, latitude observations were made also at most of the stations. These will be useful in the future investigations of the figure of the earth. During the fiscal year, 63 longitudes, 62 azimuths and 54 latitudes were determined at triangulation stations in 23 different states. Computations of the final results at these stations, including the final Laplace azimuths to be used in the adjustment of the triangulation, have been completed at the Office of the Coast and Geodetic Survey.

--R. S. Patton, Director.

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