National Cooperative Soil Survey Newsletter

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In This Issue—

Editor's Note

Issues of this newsletter are available on the World Wide Web (http://soils.usda.gov/). Under Quick Access, click on NCSS, then on Newsletters, and then on the desired issue number.

You are invited to submit stories for this newsletter to Stanley Anderson, National Soil Survey Center, Lincoln, Nebraska. Phone—402-437-5357; FAX—402-437-5336; email—stan.anderson@lin.usda.gov.

NPS Park Spotlight: Wild and Wonderful West Virginia Scenic Rivers

By Susan Southard, NRCS, National Liaison to the National Park Service, Davis, California, and Steve Carpenter, NRCS, MO Leader/State Soil Scientist, Morgantown, West Virginia.

The soil survey program of West Virginia has been busily updating soil mapping in three National Park Service units in the State. These parks include the Bluestone National Scenic River, the Gauley River National Recreation River, and the New River Gorge National River. Recently, the parks have been set up as non-MLRA soil survey areas to facilitate the delivery of park-specific information about soils to the National Park Service Soils Resources Inventory program. This information will be made available to the public via Web Soil Survey and Soil Data Mart.

The project leader for the three parks is Eileen O'Neill, based in Oak Hill, West Virginia. The main crew assisting her are soil scientists Aron Sattler, also of Oak Hill; Rob Pate, resource soil scientist in Beckley, West Virginia; and Charles Delp, Assistant State Soil Scientist from Summersville, West Virginia. Overseeing quality assurance are David Kingsbury, MO Soil Data Quality Specialist, and Steve Carpenter, MO Leader/State Soil Scientist, both from Morgantown, West Virginia, and quality control is the responsibility of Skip Bell, MLRA Project Leader, also from Morgantown.

As with most projects in National Parks, the West Virginia units offer unique challenges in gaining access because most of the land is rugged and roadless. Crews have to hike in carrying tools and food for the day. Don't even think about leaving your lunch in the truck!

The New, Gauley, and Bluestone Rivers are all part of the greater New

An area of the Bluestone River.

Skip Bell (MLRA Project Leader), Tom Bailey (USFS soil scientist), and Eileen O'Neill (project leader for the three parks) pause for a picture while running a transect.

Soil scientist Aron Sattler taking a breather from digging.

MO Leader Steve Carpenter making amoozemeter measurements. The three watches on Steve's right arm are for timing all the amoozemeters.

River watershed that begins in the North Carolina mountains near Boone, North Carolina, and then flows through the mountains and pastoral farm lands

Resource soil scientist Rob Pate helping with lab sampling.

Assistant State Soil Scientist Charles Delp providing advice about monolith sampling.

of Virginia and then north to West Virginia. Eventually, the waters flow westward into the Ohio River, passing Indiana and Illinois, and eventually meet the Mississippi River near Cairo, Illinois.

It is believed the New River is one of the oldest river systems in the world.

A visitor center sign.

The Bluestone River is named for the deep blue limestone streambed of its upper reaches in Virginia. It has an impressive gorge 1,000 feet deep in West Virginia. The 25 miles of the free-flowing Gauley River pass through scenic gorges and valleys that create several class V+ rapids, making it one of the top white-water boating rivers in the East.

This past April, the West Virginia soil survey program had a combination all soil scientist meeting and field week in which all soil scientists in the State (and some enthusiastic GIS specialists and cartographic technicians) as well as cooperators from the U.S. Forest Service and West Virginia University all worked in teams to cover predesignated sites selected by the project leader. The teams dug and described soil pits, ran transects, collected a monolith, and gathered amoozemeter data in many different areas of the parks. These data are now being compiled and will help to create the SSURGO data that will be delivered to the National Park Service and will also be posted to the Soil Data Mart in the next couple of years.

The enthusiasm exhibited by this group is sure to guarantee excellent soil survey products when the project is completed! ■

A Blast From the Past

By Stanley P. Anderson (a.k.a "Columbo), Editor, NRCS, National Soil Survey Center, Lincoln, Nebraska.

Note the following from page 29 of the current online GPO Style Manual (2000)—

3.29. In soil science the 24 soil classifications are capitalized.

Alpine Meadow Bog Brown

From page 57 of the same document, more on capitalization—

soil classifications:
- Alpine Meadow
- Bog
- Brown
- Chernozem (Black)
- Chestnut
- Desert
- Gray-Brown
- Podzolic
- Half Bog
- Laterite
- Pedalfer
- Pedocal
- Podzol
- Prairie
- Ramann's Brown
- Red
- Rendzina
- Sierozem (Gray)
- Solonchak
- Solonetz
- Soloth
- Terra Rossa
- Tundra
- Wiesenboden
- Yellow

The 24 names are similar to but not identical with those in the classification systems in two USDA publications—C.F. Marbut's "Soils of the United States" (1935), which is Part III of *Atlas of American Agriculture*, and "Soil Classification," by Mark Baldwin, Charles E. Kellogg, and James Thorp, in *Soils and Men*, 1938 Yearbook of Agriculture.

The first time that soil names appear in a GPO Style Manual is in the 1935 edition. The list in this edition is nearly the same as that in the 2000 edition, but the name "Chernozem" is not followed by the parenthetical word "Black" and "Half Bog" is hyphenated. Also, the "rule" reads as follows: "Terms used in soil science for names of the 24 great soil groups are capitalized."

Editions of the GPO Style Manual that are relevant to this question were published in 1933, 1934, 1935, 1937, 1939, 1945, 1953, 1959, 1962, 1967, 1973, 1984, and 2000. I was able to check all of these editions, except for the 1962 one, to determine when the three minor alterations described in the previous paragraph were made. I assume that all three of the changes were made at the request of soil scientists at the headquarters of the Soil Conservation Service.

The three changes first appear in the 1945 edition: "Half Bog" is no longer hyphenated, "Chernozem" is changed to "Chernozem (Black)," and the "rule" is changed to read, "In soil science the 24 soil classifications are capitalized."

One additional change appears in the 1984 edition. The term introducing the 24 names is changed from "soil names" to "soil classifications." I do not know what prompted this alteration. Making this minor change as late as 1984 is like straining at gnats and swallowing elephants.

I wrote an email to the GPO Style Board in which I asked that the 24 "soil classifications" be replaced by our current soil orders (the 12 "sols") if soil names are listed at all. After informing me that my request was "very timely" because a new edition will be out in late 2008 or early 2009, Michael Abramson, the "Foreperson/Style Board Chairman," asked me whether the 12 names are "orders" or "classifications." I told him that the names I specified are orders. I assume that they will be identified as such.

I had given the board the option of deleting all references to soils from the manual, since there is no great need to point out that "Alfisols" and the other coined proper nouns that serve as the names of soil orders are always capitalized. In his response, Mr. Abramson ignored this option. After 73 years (1935-2008), he apparently did not want a divorce. ■

North Central Regional Work Planning Conference

By Robert Ahrens, Director, NRCS, National Soil Survey Center, Lincoln, Nebraska.

Approximately 60 scientists participated in the North Central Regional Work Planning Conference, June 23-26, at Kansas State University in Manhattan, Kansas. The North Central Education/Extension Research Activity (NCERA) Committees 3 and 59 met concurrently in an effort to develop collaboration between committees and with the National Cooperative Soil Survey. NCERA-3 members are university pedologists, and NCERA-59 members are soil scientists and ecologists who focus on soil carbon and soil microbiology issues.

The presentations reflected the broad audience attending the conference and included discussions of measuring soil carbon with laser-induced spectroscopy, the effects and movement of treated wastewater for irrigation, organic carbon in alluvial valleys, and pedotransfer functions for estimating Ksat. The conference had an international flavor and included presentations by Michael Grundy on Australia's ambition for soil

information and by Telmo Amado on the potential for carbon sequestration in soils in Brazil with no-till. All the presentations were engaging and stimulated discussion and questions from the audience.

Wednesday morning's field trip to the Konza Prairie Research Natural Area showcased a native tall-grass prairie in the Flint Hills of eastern Kansas. At the Konza, we discussed the genesis and characteristics of a soil on the summit and one on a side slope. Staff from Kansas State University explained the scope of research and several of the research projects at the Konza.

Standing committees on standards, interpretations, new technology, and research needs convened, addressed their charges, and made recommendations. Participants were very active in the committee discussions and felt encouraged about their functions.

Feedback from the attendees was very positive. The conference was well organized and recognized the importance of the National Cooperative Soil Survey and its mission. Special thanks goes to the State Staff in Kansas and staff at Kansas State University for organizing and hosting a very successful and fun conference. ■

Northeast Regional Soil Survey Conference

By Marjorie Faber, Assistant State Soil Scientist, NRCS, Tolland, Connecticut.

More than 65 soil scientists from NRCS, universities, USGS, CSREES, the private sector, and the Agriculture and Agri-Food Agency of Canada attended the Northeast Regional Cooperative Soil Survey Conference at the University of Rhode Island Bay Campus in Narragansett, Rhode Island, June 2-5. The conference was sponsored by the NCSS partnership of Connecticut and Rhode Island. Participants were mostly from the Northeastern United States, from Maine to West Virginia and Washington, D.C., but some came from as far away as California, Nebraska, North Carolina, and Texas. This regional conference provided a forum for partners of the National Cooperative Soil Survey to transfer technology, highlight research projects, and discuss common soil issues and concerns.

The conference featured speakers, break-out sessions, a new technology demonstration, and a field trip. Reports were presented by the NRCS soils leadership. Many of the regional university cooperators reported on their research component of the joint Northeastern Hydropedology project. The research projects focused on soil carbon, subaqueous soils, and hydric soils. Additional reports focused on other local soil science research, the USDA National Research Initiative, and the upcoming 2009 International Urban Soil Conference, which will be held in New York City.

The new technology demonstration showcased tools that may help soil scientists in the field. These included tools that measure dynamic soil properties, a spectrometer that measures reflectance values of soil profiles or soil samples, and several different ground-penetrating radar and global positioning systems, including a system that assists with bathymetry and subaqueous soil mapping. Also, some new computer software was demonstrated.

The Silver Spade, an award presented to a member of the conference who has contributed outstanding regional and/or national service to soil survey, was presented to Dr. John Galbraith of Virginia Polytechnic University for his contributions to the National Cooperative Soil Survey. Bruce Thompson, recently retired MO-12 leader (Amherst) and Massachusetts State Soil Scientist, was recognized by NRCS headquarters and the Society of Soil Scientists of Southern New England for his 42 years of soil survey accomplishments.

The field tour visited sites highlighting soils and soil issues of Connecticut and Rhode Island. At the first stop, participants had the opportunity to examine quite a few long trenches dug on an archaeological site at the Mashantucket Pequot Tribal Property in Preston, Connecticut. Archaeologists from the University of Connecticut, the Mashantucket Pequot Museum and Research Center, and the Office of State Archaeology discussed soils and archaeology. Participants observed the variability of Connecticut's outwash soils as well as differences among the soils originating from human disturbances ranging from about 5,000 years BP to as recent as 2 years ago (fig. 1).

The next stop was Ninigret Pond, a coastal lagoon on the south coast of Rhode Island. University of Rhode Island and NRCS soil scientists

Figure 1.—Soil trench showing an example of the anthropogenic pit features common in the Preston Plains area. Photo courtesy of Steve DeGloria.

mapped subaqueous soils in Ninigret Pond. Core samples had been extracted in advance of the trip and were examined by participants. Subaqueous soil classification and interpretation issues were discussed. The beach and dune landscape also was discussed.

The tour proceeded north, over the Charlestown End Moraine, which was deposited as the glacier receded about 17,000 years ago. The Bridgehampton soil, which formed in silty loess underlain by fluvial deposits, was examined. The group then had the opportunity to walk to a commercial sod field and discuss the effect of turf production on soil (fig. 2).

Figure 2.—Turf production. Photo courtesy of Steve DeGloria.

The final stop was an area of carboniferous till soils on Jamestown Island, in the Narragansett Basin. The soils formed in very dark parent material.

The conference standing committees had time for members to discuss concerns and present reports and recommendations to the entire group. Committees included subaqueous soils, hydric soils, research needs, standards and procedures, new technology, and bylaws. The conference concluded with committee reports and updates from the three MO offices that cover the Northeastern Regional Soil Survey area. Pennsylvania will be hosting the next regional conference, in 2010.

Connecticut and Rhode Island NRCS soil scientists, Dr. Mark Stolt of the University of Rhode Island, and the Society of Soil Scientists of Southern New England were recognized for their efforts in hosting and organizing this conference. ■

Southern Regional Cooperative Soil Survey Conference

By Karl W. Hipple, National Leader for Soil Survey Interpretations, NRCS, National Soil Survey Center, Lincoln, Nebraska.

The 2008 Southern Regional Cooperative Soil Survey Conference (SRCSSC) was held July 14-18, 2008, in Gainesville, Florida. During the week, approximately 65 registered scientists met and discussed technical, scientific, and general questions and issues of importance to the National Cooperative Soil Survey. The conference was a mixture of a field trip, formal presentations, poster and demonstration sessions, committee activities, and informal discussions during breaks. The 2008 SRCSSC was successfully planned, coordinated, and hosted by the University of Florida's Institute of Food and Agricultural Sciences (UF-IFAS); USDA, Natural Resources Conservation Service; and the Florida Association of Environmental Soil Scientists (FAESS).

An all-day field trip on Monday opened the conference. During the field trip, conference attendees visited many sites where they observed and discussed Spodosols, ecological communities, hydric soil monitoring, and subaqueous soils. The field trip also included University of Florida presentations on geospatial statistical analysis of soil landscapes in development of remote sensing models. Dr. Willie Harris, Professor of Pedology and Mineralogy, UF-IFAS, provided stimulating highlights and facts on pedogenesis of Spodosols in Florida and gave information about each site's ecological community (fig. 1). Wade Hurt, UF-IFAS, discussed data gathering for water table studies (fig. 2). Dr. Sabine Grunwald and her graduate students from UF-IFAS, gave several interesting presentations relating to use and modifications of the SCORPAN model for remote sensing of landscapes and soil property mapping. At a pizza feed on Monday evening, Dr. Rex Ellis, UF-IFAS, provided basic information regarding studies of subaqueous soils in Florida.

The meeting included welcoming remarks from Florida NRCS and UF-IFAS officials and many presentations and status reports by agency heads, agency specialists, and NCSS partners. Luis Hernandez, Arkansas State Soil Scientist and MO-16 Leader, provided an international flavor to the conference with a presentation on soils of Mexico and Spain. A very enlightening evening poster and demonstration session was conducted on Wednesday evening (fig. 3).

Standing National Cooperative Soil Survey (NCSS) Conference

Figure 1.—Dr. Willie Harris, keynote luncheon speaker.

Figure 2.—Wade Hurt discussing water table study on the SRCSSC field trip.

Figure 3.—Poster session at the SRCSSC.

Committees, (Soil Taxonomy and Standards, Research Priorities, New Technology, and Soil Interpretations) plus an Ad Hoc Subaqueous Soils Committee met and provided the SRCSSC with subject matter and potential policy recommendations at the end of the conference. ■

West Regional Cooperative Soil Survey Conference

By Ron Myhrum, NRCS, State Soil Scientist, Spokane, Washington.

The 2008 West Regional Cooperative Soil Survey (WRCSS) conference was held in conjunction with the Western Society of Soil Science (WSSS) conference at the Red Lion Hotel at the Park in Spokane, Washington, June 16-20. The theme of the WRCSS conference was "Soil Survey and Ecological Site Classification." Washington State University's Center for Distance and Professional Education (CDPE) was hired to provide Web site development, registration services, financial reconciliation, and negotiations with the hotel used for the conference. The cooperating agencies handled all other planning and logistical needs for the conferences. A total of 84 people attended the conferences during the week.

The WRCSS conference included a mixture of agency and cooperator reports, technical presentations, and business sessions. Opportunities for cooperator interaction were provided through a full-day field trip, an evening poster session, an evening banquet, and an evening hospitality gathering. The WSSS sessions included technical presentations and papers concurrent with the WRCSS and participation in the evening sessions. The objective of the field trip was to view and discuss the challenges and procedures in developing Ecological Site Descriptions (ESDs). The trip included stops at both range and forest sites (figs. 1 and 2). Resource specialists from various disciplines described the processes and procedures that they employ to develop a fully populated ESD.

Figure 1.—Gary Kuhn, Washington NRCS staff Forester, discusses management practices on a Ponderosa pine/Idaho fescue ecological site on WA DNR land near Spokane.

Figure 2.—A Ponderosa pine/Idaho fescue demonstration site in the Turnbull National Wildlife Refuge near Spokane.

Recommendations and actions of committees, including Applied Technology, Soil Taxonomy, Research Needs, Ecological Principles (ad hoc), and Soil Change (ad hoc), are available on the Web at http://www.soils.usda.gov/partnerships/ncss/conferences/regional.html.

The theme of the 2008 conference came from recommendations of the 2006 conference in Park City, Utah. The demand for information contained in Ecological Site Descriptions (ESDs) and the increased interest in dynamic soil properties fit into the challenges we face with global climate change. All agreed that more resources are needed to focus on standards and consistency in the creation of ESDs.

The conference steering committee thanks all of those who participated in the 2008 joint conference and looks forward to the 2010 conference in Nevada. ■

Two 1899 Soil Surveys

By Stanley P. Anderson, Editor, NRCS, National Soil Survey Center, Lincoln, Nebraska.

Two of the earliest soil surveys of the National Cooperative Soil Survey (1899 to the present), both by Thos. H. Means, were published without maps. These are *A Reconnoissance in Sanpete, Cache, and Utah Counties*, *Utah* (1899), and *A Reconnoissance in the Cache a la Poudre Valley, Colorado* (1899). Note that "reconnoissance" is not a misspelling. It is a Frenchified version of "reconnaissance." The first of these "reconnoissance" surveys is less than six pages long, and the second is less than four pages long.

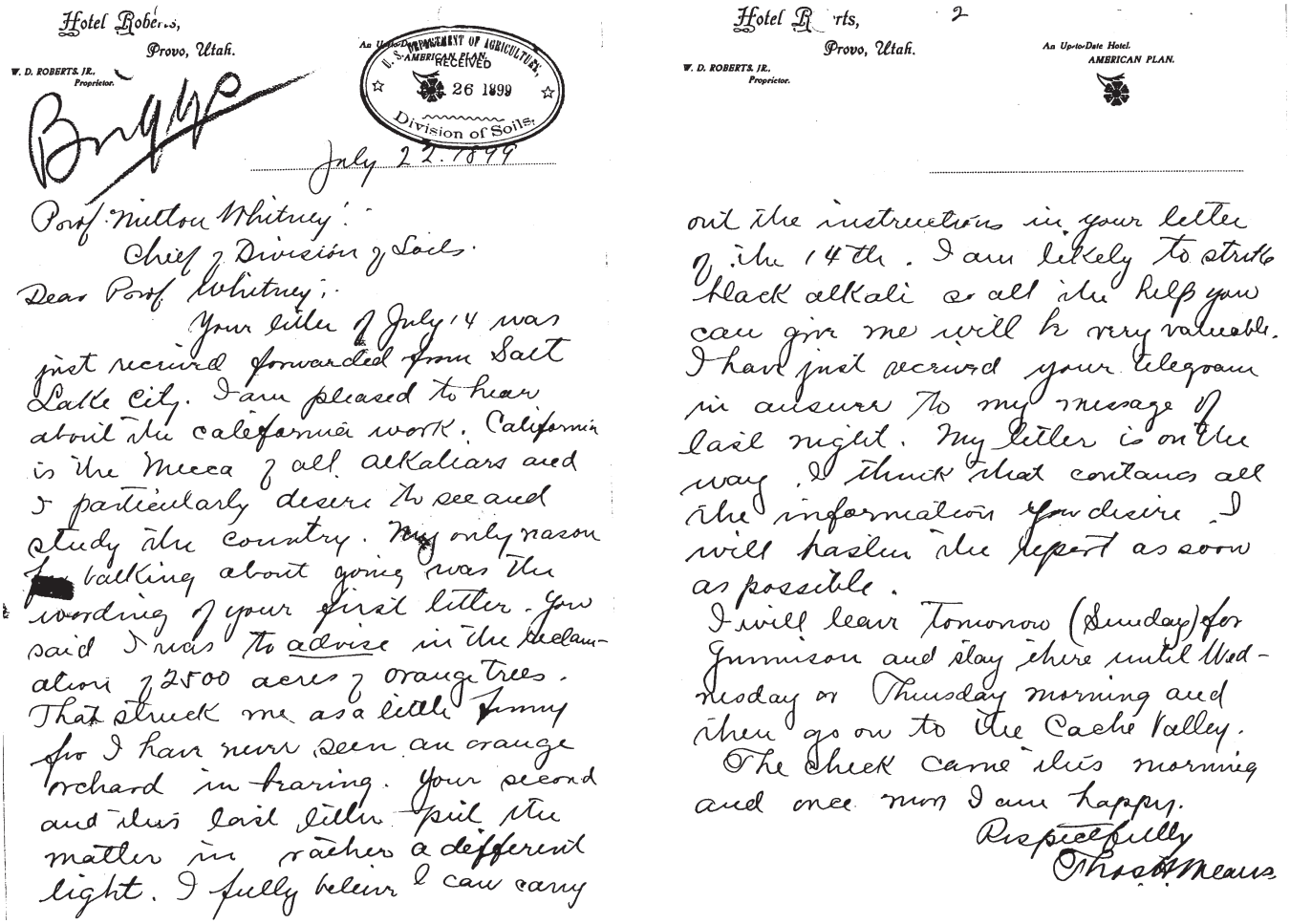
The author describes the Cache a la Poudre Valley as "the Greeley country." The National Soil Survey Center has two copies of the document about this valley. A typewritten note on a half piece of onionskin paper is stapled to the third page of one of these copies. The note is dated 6/1/60 (more than 60 years after publication). It reads as follows:

> As far as can be determined, no map was made of this area.
>
> Per A. A. Klingebiel
> Roy W. Simonson

The two surveys have been scanned but cannot as yet be posted to the Web because they have no SSAID number.

See the next four pages for the survey of the Cache a la Poudre Valley in Colorado.

Following is an 1899 letter from Thomas H. Means to Milton Whitney, Chief of the Division of Soils:



Hotel Roberts,
Provo, Utah.
W. D. ROBERTS, JR., Proprietor.

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DEPARTMENT OF AGRICULTURE, U.S. RECEIVED JUL 26 1899 Division of Soils.

July 22. 1899

Prof. Milton Whitney:
Chief of Division of Soils.

Dear Prof. Whitney:

Your letter of July 14 was just received forwarded from Salt Lake City. I am pleased to hear about the California work. California is the Mecca of all alkalians and I particularly desire to see and study the country. My only reason for talking about going was the wording of your first letter. You said I was to advise in the declamation of 2500 acres of orange trees. That struck me as a little funny for I have never seen an orange orchard in bearing. Your second and last said letter put the matter in rather a different light. I fully believe I can carry out the instructions in your letter of the 14th. I am likely to strike black alkali so all the help you can give me will be very valuable. I have just received your telegram in answer to my message of last night. My letter is on the way. I think that contains all the information you desire. I will hasten the report as soon as possible.

I will leave Tomorrow (Sunday) for Gunnison and stay there until Wednesday or Thursday morning and then go on to the Cache Valley.

The check came this morning and once more I am happy.

Respectfully
Thos. H. Means

A RECONNOISSANCE IN THE CACHE A LA POUDRE VALLEY, COLORADO.

By THOS. H. MEANS.

SOILS AND ALKALI.

The Cache a la Poudre Valley, or the Greeley country, as it is sometimes called, is one of the oldest as it is one of the most prosperous irrigation districts of the West.

One month was spent in a reconnoissance of this valley in the summer of 1899, and as the conditions there are unique in a way the results of the investigations may be of more than mere local interest.

The Cache a la Poudre Valley, or at least that part of it which lies east of the foothills of the Rocky Mountains, is cut from a series of nearly horizontal strata of cretaceous rocks. That portion of these strata which is exposed in the irrigated parts of the valley is largely sandstone or sandy shale, though at some places a bed of heavy blue shale is exposed. From these shales and sandstones the soils of the valley are formed, modified in a measure by the mixture of materials brought down from the mountains by the streams. The farming lands are situated on a more or less perfect system of terraces extending back from the stream and merging indefinitely into the upland, which consists of hills rounded by erosion. The lateral valleys, which extend back from the main Poudre Valley, are the result of flood erosion, no water flowing through any of them before irrigation was practiced except during times of heavy rains.

The soils of the bottom lands are generally sandy or gravelly, with coarse, gravelly subsoils. Such soils, where well drained, furnish excellent truck lands; but the greater part of this low land is wet from the seepage from the upper irrigated lands, and at present is used for pasturage and hay crops.

The second and third bottoms consist of heavier soils, becoming in some places a heavy clay. This clay land, on account of its impervious nature, acts as an obstruction to the flow of seepage waters from the uplands, and is in consequence often wet or alkaline. This type of land abuts directly against the upland soils, and extends around the mouths of the draws and lateral valleys. The same type

of heavy soil is found in the bottoms of the draws, where the natural moisture has collected the fine particles of soil from the hillsides and promoted the disintegration of the large grains.

The greater part of the farming lands of the valley lies upon the rounded hills of the uplands. The soil on these hills is a sandy loam in nearly all cases, varying slightly in texture. Immediately north of Greeley it contains about 7 per cent of clay, while north of New Windsor it contains 12 per cent, and around Fort Collins the soils are as a rule still heavier.

Many inclosed basins are found throughout the country, in the bottoms of which the soil is heavy and impervious. In these natural basins the water collects after each rain, and when they are irrigated the waste water collects in the lowest parts, forming swamps. The bottom lands were the first to be irrigated, and as the country became more thickly settled new canals were built covering the higher lands. In this way the irrigated land has extended back from the river to a distance in some places of more than 10 miles. The construction of one canal above another in this way has opened a wide field for inquiry into the possibilities of damage from seepage water, and in the present investigation special attention was given to the damage already done and to the possible remedies for this damage.

Since the time allotted to the field work was too short to warrant a complete study of the district, two townships were selected, comprising a strip of land from the Poudre to the desert land above the uppermost canal, the Larimer County Canal. This section was studied in detail, and the areas of wet or alkali soil were outlined in the field on a map. In this way a definite idea was obtained of the amount of wet land which at present exists, and the best means for removing this excess of water were considered.

It was found that the amount of wet land under the Larimer County Canal is small and confined to the bottoms of draws and land immediately adjoining the canal. The whole of the area under the Larimer County Canal is not farmed at present, but when all the land is farmed this area of wet land will be likely to increase. The seepage water, however, seems to originate in the losses from the canals and constantly running laterals rather than in seepage from the irrigated fields.

Professor Carpenter, of the Colorado Experiment Station, has investigated the question of the origin of the seepage waters, and, in his opinion, the greater part comes from the canals and laterals.

The material through which the canals run is largely loose in character, and the water is clear, carrying very little material which would clog the interstitial spaces of the soil. There can be no question, however, but that over irrigation, through ignorance or neglect, is also the cause of much seepage. The effect of over irrigation is very noticeable in some districts, and the careless use of water can not be too strongly condemned. It not only injures the land to which it is applied, but it

also largely increases the seepage water to the destruction of lower lands.

Under the Larimer and Weld Canal the amount of actual damage is greater than under the Larimer County Canal. The lands have been under irrigation longer and the subsoil has had more opportunity to fill up; besides, the amount of land irrigated is larger. This land also receives the seepage from the lands under the Larimer County Canal.

Under No. 2 canal the amount of wet land is still larger than under either of the canals above mentioned. It receives the seepage from all the land above, as well as the seepage from several reservoirs situated at a higher elevation. The soils under No. 2 canal are heavier than the upland soils, the land is more level, and the natural drainage is poorer. In the district mapped several large areas of wet land under this canal are shown. This area receives the direct seepage from all the upland, and since the underlying beds of gravel are not contiguous to give adequate drainage, the water tends to rise to the surface in places and swamps are formed.

One of the first questions which should be considered in the opening of new farming lands is the drainage. If the natural drainage is good—that is, if the excess of water is quickly removed from the subsoil—the installation of drains is not necessary, but if the water at any time stands within the subsoil or if the excess of water, applied through irrigation or falling as rain, does not quickly pass away through the underground drainage the crops grown upon the land will suffer and the farmer will not obtain the best results from his efforts. The wet land of an irrigated country should be immediately drained when the level of water rises closer than within 3 feet of the surface of the ground. It may be that the water rises near the surface only during a limited period of the year, but this may be long enough to injure a crop.

The underground waters of an irrigated district situated within the arid regions of the West are never free from salts in solution. When this water is allowed to approach the surface of the ground it evaporates, leaving its burden of salt on or near the surface. The salt continues to accumulate in this manner unless the surface water is drained away. Usually such a quantity of salt accumulates that nothing useful will grow upon the land. When reclamation is attempted both the water and salt have to be removed, thus making the work of reclamation very difficult and costly. From the standpoint of economy, therefore, it is much better to install drains before or at least as soon as the ground becomes wet. This will not only remove the excess of water, but will insure the land against ever becoming alkaline.

In the Greeley district the process has as yet gone in most places only far enough to damage the ground from water. If the water is not removed much more damage is probable from alkali. A wet piece of ground is valuable in some cases as pasture, but a piece of badly alkaline land is practically worthless. The underground waters are not

highly charged with salts and the evolution of an alkali flat is slow, but none the less sure. In the shales of the underlying rocks quantities of alkali are stored, and where the seepage water passes through this shale and appears again the accumulation of alkali at the surface is much more rapid.

Repeated tests were made for sodium carbonate, but none was found. This was to be expected, since all of the soils contain small quantities of gypsum, which is the chemical antidote for black alkali.

There is no chemical preparation known which would render the alkali of the Poudre Valley harmless, consequently in order to redeem the lands already damaged these salts must be removed from the soils and removed so far that there can be no possibility of their ever coming back again. There is but one known way of effectively removing these alkali salts, and that is by underdrainage. In the Poudre Valley at present only the lower lands are in need of drainage. The lower lands along the Poudre River and the immediate bottoms of the draws extending back into the hills should be drained at once. In some cases a simple line of drains up the center of the draw would suffice for the present and would insure much of the bottom land from damage. By drawing off the water from the hill land through proper drains in the bottom of the draws, much less water would reach the Poudre bottoms as seepage. The larger tracts of land in the draws and Poudre bottoms should be thoroughly tiled. The shallow basins and sinks offer the most serious difficulties in the construction of drains. Where the basin has a shallow depth the expense of cutting an outlet for the water may be slight, but where the basin is deep the expense of cutting an outlet is liable to be great.

SUMMARY.

Considerable damage has been felt in parts of the Poudre Valley from wet or alkali soils. Such wet or alkali tracts are the natural result of poor drainage. Tile drains should be installed in all the lower lands both to remove the excess of water and to prevent the accumulation of alkali. With continued irrigation of the uplands the amount of possible damage to the lower lands is very great and to insure against this damage the drainage should be commenced at once.