Detailed Soil/Site Evaluation and Ksat Testing

County Line Plaza

Chatham County, NC
September 2006

Prepared for:

Lee-Moore Oil Company
Attn: Kirk J. Bradley
PO Drawer 9
Sanford, NC 27331

Prepared by:

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S&EC Job Number 4-1677.S2

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September 13, 2006
Project #4-1677.S2

Mr. Kirk J. Bradley
Lee-Moore Oil Company
PO Drawer 9
Sanford, NC 27331

Re: **Detailed Soil/Site Evaluation and Ksat testing** for Reuse Wastewater Applications on 62acres N 15-501 Project, +/-62acres bordering the Orange County Line - Chatham County, NC

Soil & Environmental Consultants, PA (S&EC) performed a detailed soil/site evaluation on the above referenced tract. This was performed at your request as part of the preliminary planning process in order to delineate dominant soil types within the proposed wetted areas. Proposed wetted areas provided to us and evaluated total +/-16acres. Initial fieldwork was completed August 10, 2006 after receiving changes to the wetted areas, we went back to the field and confirmed the soils in those areas as well as conducted Ksat measurements on the soils in the wetted areas which now total approximately 13.4 acres. The type of septic system that was proposed at the time of the initial evaluation was a spray irrigation system with reuse quality effluent. The new proposed system is a surface drip irrigation type of septic system with pretreatment per the CE Group, PA. This type of system is still a surface discharge type of system and will require permitting by the DWQ at NCDNR.

DETAILED SOIL/SITE EVALUATION FOR REUSE SPRAY APPLICATIONS

S&EC traversed the property and mapped the soils to the Natural Resource Conservation Service (NRCS) Soil Series level. The accompanying AutoCAD map depicts the dominant soil series' present on the project. The majority of soils on this site have a bouldery surface. Areas outside of proposed wetted areas were not evaluated. A well was observed and GPS-located on the site, and is shown on the attached map. After mapping the soils and performing the Ksat measurements, it may be possible, that a subsurface drip irrigation system may fit in the Wedowee soil area on the site. This type of system would go through the Local Health Department and the State. An issue with this type of system on this site in the Wedowee unit with regards to subsurface is boulders. This area is quite bouldery and may present both an installation problem and may be a concern with the local Health Department regarding subsurface. The other soil areas on the site are not likely to be permitted for subsurface application of wastewater even with drip irrigation distribution due to depth of SHWT in the Helena and Santuc soils and depth to saprolite in the Louisburg soil series. The following is a list of soil series noted most similar to the soils encountered on the project:

Wedowee – These soils are very deep, well-drained, moderately permeable soils with kaolinitic clay mineralogy. Depth to Seasonally High Water Table (SHWT) and Rock/Cr is greater than 60 inches. Generally usable for subsurface wastewater disposal.

Louisburg – These soils are very deep, well-drained, rapidly permeable soils. Depth to SHWT and Rock/Cr is greater than 60 inches. Marginal usage with respect to subsurface wastewater disposal due to depth to hard saprolite and flow being higher than 1000 gpd with respect to saprolite (15 A NCAC 18A .1900 "Laws and Rules for Sewage Treatment and Disposal Systems" rule .1956(6).)

Santuc – These soils are very deep, moderately well drained, and moderately slowly permeable. Depth to Cr is greater than 60 inches. These soils have a SHWT at 30 to 60 inches. There was very little of this series noted in the wetted areas evaluated. Generally unsuitable for subsurface wastewater disposal due to depth to hard saprolite, mixed mineralogy, and SHWT.

Helena – These soils are very deep, moderately well drained, slowly permeable soils with mixed clay mineralogy. Depth to SHWT is 12 inches or more. Depth to Rock/Cr is greater than 60 inches. Unsuitable for subsurface wastewater disposal due to depth to SHWT and expansive clay mineralogy.

Note the soil series Hard Labor was noted on the initial field visit and report, there was such a small amount of this soil series noted that we have decided to exclude it from the report and testing.

Please refer to the attached NRCS Official Soil Series Descriptions for more in depth information on typical soil pedons for these soil series.

Please keep in mind that the included descriptions in these inclusions are NOT the descriptions for your specific site but rather the typifying pedon description provided by NRCS for that series.

The boundary between these soil types has been shown on the enclosed map. These boundaries were established with the assistance of Global Positioning Systems in order to more accurately depict the soil boundaries.

Hydraulic Conductivity

Once the areas were mapped, we began the next phase of the project, which was to collect hydrology data from the soil horizons and to make detailed profile descriptions of the different types of areas. Ten sites selected were chosen because they were representative of the areas we found on the Site. We have included a detailed profile description of the Site and its hydraulic conductivity values with this report.

4-1677.S2 County Line Plaza Chatham County, NC
Profile/Deep Boring Descriptions (in inches)
August 29 & 30, September 8 2006

Site 1 – Profile & Deep Boring (Wedowee Bouldery)

0-8	A	10 YR 4/2 Sandy Loam, very friable, granular, ns, np
8-50	Bt	7.5 YR 5/6 Sandy Clay, mod, med, sbky, f, ss, sp
50-60	BC	5 YR 5/6 Sandy Clay Loam, wk, med, sbky, ss, np Common white minerals.
60-120	C1	5 YR 6/6 Sandy Loam, friable, massive, ns, np
120-252	C2	5 YR 8/4 Sandy Loam, very friable, massive, ns, np

Site 2 – Profile (Wedowee Bouldery)

0-8	A	10 YR 4/3 Sandy Loam, very friable, granular, ns, np
8-38	Bt	7.5 YR 5/6 Sandy Clay, mod, med, sbky, f, ss, sp
38-46	BC	5 YR 5/6 Sandy Clay Loam, wk, med, sbky, ss, np Common white minerals.
46-84	C1	5 YR 6/6 Sandy Loam, friable, massive, ns, np

Site 3 – Profile & Deep Boring (Wedowee Bouldery)

0-10	A	10 YR 4/2 Sandy Loam, very friable, granular, ns, np
10-30	Bt	7.5 YR 5/6 Sandy Clay, mod, med, sbky, f, ss, sp
30-40	BC	5 YR 5/6 Sandy Clay Loam, wk, med, sbky, ss. sp Few white minerals.
40-252	C	5 YR 6/6 Sandy Loam, friable, massive, ns, np

Site 4 – Profile (Helena)

0-10	A	10 YR 6/3 Sandy Loam, friable, granular, ns, np
10-16	Bt1	10 YR 5/8 Sandy Clay, mod, med, abky, f, s, p
16-28	Bt2	10 YR 5/8 Sandy Clay, mod, med, sbky, f, s, p Few to common 10 YR 6/2 mottles
28-50	C1	10 YR 5/6 Sandy Clay Loam, massive, firm, s, p Common 10 YR 7/2 mottles
50-54	C2	10 YR 5/6 Sandy Loam, friable, massive, ns, np Common 10 YR 6/2 mottles

54 inches Auger Refusal – Extremely dry conditions

Site 5 – Profile (Santuc)

0-12	A	10 YR 4/3 Sandy Loam, friable, granular, ns, np
12-24	Bt1	7.5 YR 5/6 Sandy Clay Loam, mod, med, sbky, friable, ss, sp
24-40	Bt2	7.5 YR 5/6 Sandy Clay Loam, s, mod, abky, f, s, p Common 10 YR 7/2 mottles
40-54	C1	10 YR 8/4 Sandy Loam, friable, massive Common 10 YR 7/1 clay flows

54 inches Auger Refusal – Extremely dry conditions

Site 6 – Profile (Helena)

0-13	A	10 YR 4/3 Sandy Loam, friable, granular, ns, np
13-36	Bt1	10 YR 6/6 Clay, mod, med, sbky, f, s, p Few 7.5 YR 5/8 mottles
36-62	Bt2	10 YR 6/6 Clay, mod, med, sbky, f. s, p Many 10 YR 7/2 mottles
62-102	BC	10 YR 6/6 Sandy Clay Loam, massive, firm, s, p Many 10 YR 7/2 mottles
102-174	C1	7.5 YR 5/8 Loam, massive, friable, ss, sp Many 10 YR 7/2 mottles
174-252	C2	10 YR 6/4 Sandy Loam, friable, massive Few to common 10 YR 8/1 mottles and few 10 YR 7/2 clay flows

Site 7 – Profile (Louisburg)

0-10	A	10 YR 3/3 Sandy Loam, , friable, granular, ns, np
10-16	Bt1	7.5 YR 5/4 Sandy Loam, wk, med, sbky, friable, ns, np
16-28	Bt2	7.5 YR 4/4 Sandy Clay Loam, wk, med, sbky, friable, ss, sp Few faint 10 YR 7/2 relic mottles
28-42	C1	7.5 YR 6/4 Sandy Loam, friable, massive Common 10 YR 8/1 relic mottles and few 10 YR 7/1 relic mottles
42-70	C2	7.5 YR 6/4 Sandy Loam, friable, massive Common 10 YR 8/1 mottles

70 inches Auger Refusal – Extremely dry conditions

Site 8 – Profile (Louisburg)

0-10	A	10 YR 3/3 Sandy Loam, mod, med, granular, very friable
10-18	Bt1	7.5 YR 5/4 Sandy Loam, wk, med, sbky, friable, ns, np
18-30	Bt2	7.5 YR 4/4 Sandy Clay Loam, mod, med, sbky, friable, ss, sp
30-44	BC	7.5 YR 4/6 Sandy Loam, wk, med, sbky, friable, ns, np Common 10 YR 8/1 mottles
44-84	C	7.5 YR 6/4 Sandy Loam, friable, massive Common 10 YR 8/1 mottles

Site 9 – Profile (Helena)

0-14	A	10 YR 5/3 Sandy Loam, friable, granular, ns, np
14-30	Bt	10 YR 4/6 Clay, mod, med, sbky, vf, s, vp Many 10 YR 7/2 mottles
30-36	C1	10 YR 4/8 Sandy Clay Loam, friable, massive Many 10 YR 7/2 mottles
36-58	C2	10 YR 4/8 Sandy Loam, friable massive Few to common 10 YR 8/1 mottles

58 inches Auger Refusal – Extremely dry conditions

Site 10 – Profile (Louisburg)

0-8	A	2.5 Y 5/4 Sandy Loam, mod, med, granular, very friable
8-22	Bt1	10 YR 5/6 Sandy Clay, mod, med, sbky, friable, ss, sp
22-28	Bt2	10 YR 5/6 Sandy Clay Loam, mod, med, sbky, friable, ss, sp
28-32	BC	7.5 YR 5/8 Sandy Clay Loam, wk, med, sbky, friable, ss, sp
32-252	C	10 YR 6/6 Coarse Sandy Loam, friable, massive Few to common white minerals

With the wetted area mapped, the detailed soil descriptions noted, we next looked at the hydraulic characteristics associated with the various soil type units. This was completed using constant head permeameters. Multiple tests were completed on each horizon for each unit that was accepting wastewater. The tests introduce water into test holes and the level of ponded water in the hole is maintained. This results in a constant head pressure being exerted on the water column in the test hole. The rate of water is the fastest at the beginning of the test. The rate drops during the test until it reaches a steady state. This steady, diminished rate is the rate used to convey the hydraulic characteristics of the site.

Hydraulic Conductivity Data

County Line Plaza Ksat Summary August/September 2006

Location	Series Name	Horizon	Ksat ft/day	frm data Ksat gpd/ft^2	Ksat in/day	Ksat in/week	Ksat in/yr
SITE 1	Wedowee	Bt	3.050802	22.82	36.60963	256.2674	13362.51
SITE 1	Wedowee	C	0.631016	4.72	7.572193	53.00535	2763.85
SITE 2	Wedowee	Bt	2.823529	21.12	33.88235	237.1765	12367.06
SITE 2	Wedowee	C	0.529412	3.96	6.352941	44.47059	2318.824
SITE 3	Wedowee	Bt	0.947861	7.09	11.37433	79.62032	4151.631
SITE 3	Wedowee	C	0.608289	4.55	7.299465	51.09626	2664.305
SITE 4	Helena	Bt	0.466578	3.49	5.59893	39.19251	2043.61
SITE 4	Helena	C	0.34492	2.58	4.139037	28.97326	1510.749
SITE 5	Santuc	Bt	0.580214	4.34	6.962567	48.73797	2541.337
SITE 5	Santuc	C	2.585561	19.34	31.02674	217.1872	11324.76
SITE 6	Helena	Bt	1.574866	11.78	18.8984	132.2888	6897.914
SITE 6	Helena	C	0.084225	0.63	1.010695	7.074866	368.9037
SITE 7	Louisburg	Bt	0.637701	4.77	7.652406	53.56684	2793.128
SITE 7	Louisburg	C	0.57754	4.32	6.930481	48.51337	2529.626
SITE 8	Louisburg	Bt	0.447861	3.35	5.374332	37.62032	1961.631
SITE 8	Louisburg	C	0.898396	6.72	10.78075	75.46524	3934.973
SITE 9	Helena	Bt	0.086898	0.65	1.042781	7.299465	380.615
SITE 9	Helena	C	0.104278	0.78	1.251337	8.759358	456.738
SITE 10	Louisburg	Bt	0.382353	2.86	4.588235	32.11765	1674.706
SITE 10	Louisburg	C	0.144385	1.08	1.73262	12.12834	632.4064

Average Ksat Values						
		gpd/sq. ft.	ft/day	in/day	in/hr
Wedowee	Bt	17.01	2.274064	27.28877	1.137032
	C	4.41	0.589572	7.074866	0.294786
Helena	Bt	5.31	0.709447	8.513369	0.354724
	C	1.33	0.177807	2.13369	0.088904
Louisburg	Bt	3.66	0.489305	5.871658	0.244652
	C	4.04	0.540107	6.481283	0.270053
Santuc	Bt	4.34	0.580214	6.962567	0.290107
	C	19.34	2.585561	31.02674	1.292781

In reviewing the soil hydraulic characteristics the averages for the type units is reported at the end of the Ksat data sheet. The layers noted are the B or Bt layer, which is normally the clayey layer. The C layer, which is the parent material or saprolite layer, is the material between the bedrock and the soil profile.

General Wastewater Considerations

The flow proposed by the CE Group is 14,000 gallons per day. Mr. Ashness, PE of the CE Group requested a feasibility study on the proposed wetted areas to determine if a 14,000-gpd flow was possible given the soils discovered on the site.

For the purpose of this request, after the Ksats were calculated, S&EC, PA created a preliminary water balance in order to determine if the site could be reasonably expected to assimilate the 14,000-gpd wastewater flow. It is my understanding that a hydrogeologist will conduct a final water balance if this system is to be irrigated to the surface. This water balance was conducted for feasibility of disposal of the wastewater.

The water balance calculations used were based on the NCDWQ Version 5 Water Balance Calculator December 2004. Precipitation data was obtained from NRCS County Soil Survey for Randolph County for a period of 60 years. PET or potential evapo-transpiration was calculated from the NCDWQ water balance calculator using the Thornthwaite PET Calculation based on average monthly temperature data from NRCS County Soil Survey for Randolph County for a period of 60 years, and Pan Evaporation Data from the Chapel Hill Station in Orange County. The average Ksat of the most limiting horizon of each soil series was used for the water balance calculation. Based on these assumptions and the soils mapped on the site, three "zones" were determined.

Zone 1	Wedowee Soil series	ave Ksat .29in/hr	3.27 acres
Zone 2	Helena/Santuc Series	ave Ksat .09in/hr	7.11 acres
Zone 3	Louisburg Soil Series	ave Ksat .24in/hr	3.02 acres

Based on these field measurements, the 14,000-gpd flow could be spray or drip irrigated into these three zones with a design irrigation rate of 28.8 inches per year in Wedowee, 5.67 inches per year in the Helena and 17.81 inches per year in the Louisburg zones. For this example, we used 10 % of the Ksat value. We used this because the soils were coarse textured and the Ksats were good even for the Helena soil series. If 6% of the Ksat is used which is more conservative, for the months of January, February, and March, enough storage would be required for 10.2 days at 143,106 gallons. After performing the water balance using 10% of the Ksat, no seasonal restriction was needed and no additional storage at these rates. At 6% seasonal restrictions would be required on the Helena soil series. Again, the final water balance is to be determined by a hydrogeologist. Even if no seasonal restriction was needed in the Helena/Santuc zone, these areas should not be irrigated when soil conditions present a SHWT within 12 inches of the soils surface. A copy of the preliminary water balance is attached for both a 6% calculation and a 10% calculation.

If the 3.27 acres is to be used for subsurface disposal pending approval of the area by the Local Health Department and the State Regional Soils Specialist, this area will have to be fully evaluated with a backhoe to investigate the bouldery surface that we have encountered in the area, which is a limiting factor for subsurface disposal. Based on the Ksat value of the Bt horizon of the Wedowee soil series, which is 17.01-gpd/square foot, the State will typically allow you to use 10% of the ksat if not pretreated or 20% of the Ksat if pretreated on conventional septic systems. A conventional septic system for 14,000 gpd will not fit in the 3.27-acre area, however a drip irrigation septic system may fit in this area if we can increase the LTAR. The Wedowee soil series is a Group IV soil with a maximum LTAR for clayey soils and drip irrigation of .15-gpd/square foot. Using pretreatment, and the measured Ksat, I would propose an LTAR of .3 gpd/square foot which is less than .2 % of the measured Ksat of the Bt horizon which is the horizon where a subsurface trench could be installed.

Using the following formula, Flow in gal/LTAR gpd/sq.ft. /2ft (trench spacing) = 14000gpd / (.3 gpd/sq.ft.) / 2 ft. = 23,333 ft of drip line on two foot centers and 46,666 sq. feet of area. Because this would be a subsurface system, a repair area of equal size would be required for a total of approximately 93,333 square feet or 2.14 acres.

After this investigation, there appears to be a couple of options available to handle the wastewater, subsurface drip has potential with the noted exceptions, surface drip irrigation, or surface spray irrigation of reuse quality. Other types of systems may be possible if the flow for this project were to be reduced.

This report discusses the general location of potentially useable soils for on-site surface wastewater disposal and, of course, does not constitute or imply any approval or permit as needed by the client from the State. S&EC is a professional consulting firm that specializes in the delineation of soil areas for wastewater disposal. As a professional consulting firm, S&EC is hired for its professional opinion in these matters. The rules governing wastewater treatment (interpreted and governed by local and state agencies) are evolving constantly, and in many cases, affected by the opinions of individuals employed by these governing agencies. Because of this, S&EC cannot guarantee that areas delineated and/or systems designed will be permitted by the governing agencies. As always, S&EC recommends that anyone making financial commitments on a tract be fully aware of individual permit requirements on that tract prior to final action. Following field review with NCDWQ, and any site plan changes, modifications to the soil map may be required.

Soil & Environmental Consultants, PA. is pleased to be of service in this matter and we look forward to assisting in any site analysis needs you may have in the future. Please feel free to call with any questions or comments.

The locations for the Ksats and the deep borings are also included on map titled Detailed Soil/Site Evaluation for Reuse Spray and are provided with this report.

S&EC, PA is pleased to be of service with this project and should you need any additional information, please do not hesitate to call.

Sincerely,

Robert Edwin Stott, RS, LSS
Branch Manager
S&EC, PA Greensboro

Encl:

- NRCS Official Soil Series Descriptions
- Copy of NCDWQ Water Balance (Preliminary) @6% and 10%
- Detailed Soil/Site Evaluation for Reuse Spray

LOCATION HELENA NC+AL GA SC VA
Established Series
Rev. AG
05/2000

HELENA SERIES

The Helena series consists of very deep, moderately well drained, slowly permeable soils that formed in residuum weathered from a mixture of felsic, intermediate, or mafic igneous or high-grade metamorphic rocks such as aplitic granite or granite gneiss that is cut by dykes of gabbro and diorite, or mixed with hornblende schist or hornblende gneiss. These soils are on broad ridges and toeslopes of the Piedmont uplands. Slope is dominantly between 2 to 10 percent but ranges from 0 to 15 percent. Mean annual precipitation is 46 inches, and mean annual temperature is 61 degrees F, near the type location.

TAXONOMIC CLASS: Fine, mixed, semiactive, thermic Aquic Hapludults

TYPICAL PEDON: Helena sandy loam - in a cultivated field on a 4 percent slope. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 8 inches; grayish brown (10YR 5/2) sandy loam; weak, medium, and coarse granular structure; very friable; many fine roots; moderately acid; abrupt smooth boundary. (4 to 10 inches thick)

E--8 to 12 inches; light yellowish brown (10YR 6/4) sandy loam; weak medium granular structure; very friable; few fine roots; few fine black concretions; strongly acid; clear wavy boundary. (0 to 10 inches thick)

BE--12 to 19 inches; brownish yellow (10YR 6/6) sandy clay loam; moderate medium prismatic structure that parts to moderate medium angular blocky; friable; sticky, plastic; few fine roots; few fine pores; few faint clay films on faces of peds; few medium quartz gravel; common fine faint pale brown (10YR 6/3) iron depletions; very strongly acid; clear wavy boundary. (0 to 7 inches thick)

Bt1--19 to 24 inches; yellowish brown (10YR 5/8) clay; weak coarse angular blocky structure; firm; sticky, plastic; few fine roots; few fine pores; few faint clay films on faces of peds; few fine prominent light brownish gray (10YR 6/2) iron depletions; very strongly acid; clear wavy boundary.

Bt2--24 to 39 inches; yellowish brown (10YR 5/8) clay; weak coarse subangular blocky and angular blocky structure; very firm, sticky, very plastic; few fine roots; few fine pores; common distinct clay films on faces of peds; many medium prominent gray (10YR 6/1) iron depletions; very strongly acid; clear wavy boundary.

Bt3--39 to 43 inches; light yellowish brown (10YR 6/4) clay loam; weak medium subangular blocky structure; extremely firm, sticky, very plastic; common distinct clay films on faces of peds; few brown concretions; common medium distinct light gray (10YR 7/1) iron depletions; very strongly acid; clear wavy boundary. (Combined thickness of the Bt horizon is 17 to 42 inches.)

BCg--43 to 46 inches; light gray (10YR 7/1) clay loam; weak coarse subangular blocky structure; friable, sticky, plastic; many coarse prominent strong brown (7.5YR 5/6) soft masses of iron accumulation; very strongly acid; clear wavy boundary. (0 to 14 inches thick)

C--46 to 60 inches; strong brown (7.5YR 5/8) sandy loam saprolite; many coarse prominent light gray (10YR 7/1) streaks; massive; friable; few coarse veins of gray clay; common fragments of granitic rock; very strongly acid.

TYPE LOCATION: Durham County, North Carolina; 0.4 mile west of Mangum Store on SR 1603; 400 feet north on a farm road and 400 feet east in a cultivated field.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 40 to more than 60 inches. Depth to bedrock is greater than 5 feet. The soil is extremely acid to strongly acid except where the surface has been limed. Limed soils are typically moderately acid or slightly acid in the upper part. Gravel fragments range from 0 to 35 percent, by volume, throughout the profile. Some pedons may have few to common dark concretions in the upper part of the profile.

The A or Ap horizon has hue of 10YR or 2.5Y, value of 3 to 6, and chroma of 1 to 4. It is loamy sand, loamy coarse sand, coarse sandy loam, fine sandy loam, sandy loam, or loam in the fine-earth fraction. In eroded phases the Ap horizon is clay loam or sandy clay loam in the fine-earth fraction.

The E horizon, where present, has hue of 10YR to 5Y, value of 5 to 8, and chroma of 2 to 4. Texture is loamy sand, loamy coarse sand, coarse sandy loam, fine sandy loam, sandy loam, or loam in the fine-earth fraction.

The BE or BA horizon, where present, has hue of 7.5YR to 5Y, value of 5 to 8, and chroma of 3 to 8. It is sandy clay loam or clay loam in the fine-earth fraction.

The Bt horizon has hue of 7.5YR to 5Y, value of 5 to 8, and chroma of 3 to 8. In some pedons, the lower Bt horizon has 5YR hues or is multicolored in shades of yellow, brown, gray, or red. Iron depletions with chroma of 2 or less occur within 24 inches of the upper boundary of the Bt horizon. Soft masses of iron accumulation in shades of yellow, brown, or red may also be present. Texture is dominantly clay loam, sandy clay, or clay in the fine-earth fraction, but some pedons have thin subhorizons of sandy clay loam.

The Btg horizon, where present, has hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 1 or 2. Soft masses of iron accumulation in shades of yellow, brown, or red commonly are present. Texture is clay loam, sandy clay, or clay in the fine-earth fraction. Some pedons have thin subhorizons of sandy clay loam.

The BC and BCg horizons, where present, have colors similar to the Bt horizon or the Btg horizon, respectively. Texture is clay loam, sandy clay loam, loam, fine sandy loam, or sandy loam in the fine-earth fraction.

The C horizon has hue of 5YR to 5Y, value of 5 to 8, and chroma of 3 to 8, or is multicolored in shades of gray, yellow, brown, red or white. The Cg horizon, where present, has hue of 10YR to 5Y, value of 5 to 7, and chroma of 1 or 2 and is typically multicolored in shades of yellow or brown. The C and Cg horizons are saprolite that has a texture of sandy loam, fine sandy loam, sandy clay loam, or loam in the fine-earth fraction. Bodies or seams of clay loam or clay are in some pedons.

COMPETING SERIES: These are the Annemaine, Beason, Cid, Craven, Creedmoor, Dogue, Eulonia, Gritney, Lignum, Maubila, Nemours, Nevarc, Peawick, Sacul, and Telfair series. Annemaine, Benson, Craven, Dogue, Eulonia, Gritney, Maubila, Nemours, Nevarc, Peawick, Sacul, and Wolftever soils lack a C horizon of saprolite. In addition, Annemaine, Eulonia, Nemours, Newco, and Sacul soils have redder hue, and Beason, Craven and Dogue soils contain more silt. Also, Peawick soils commonly have aluminum saturation greater than 50 percent. Cid soils have a lithic contact between depths of 20 and 40 inches. Creedmoor soils have a higher coefficient of linear extensibility, more exchangeable aluminum than Helena, and the C horizon is weathered Triassic saprolite. Lignum and Prosperity soils have paralithic contact within 40 to 60 inches.

GEOGRAPHIC SETTING: The Helena soils are on broad ridges, toe slopes and heads of drains in the Piedmont uplands. Slopes are mostly between 2 and 10 percent and range from 0 to 15 percent. The soil formed in residuum weathered from a mixture of felsic, intermediate, or mafic igneous or high-grade metamorphic rocks such as aplitic granite or granite gneiss that is cut by dykes of gabbro and diorite, or mixed with hornblende schist or hornblende gneiss. Mean annual precipitation ranges from 37 to 69 inches, and mean annual temperature ranges from 58 to 65 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: These are Appling, Cecil, Cullen, Durham, Enon, Hard Labor, Iredell, Louisburg, Mecklenburg, Pacolet, Prosperity, Rion, Santuc, Sedgefield, Vance, Wedowee, Wilkes, and Worsham series. Appling, Cecil, Hard Labor, Pacolet, and Wedowee soils have kaolinitic mineralogy. Cullen and Vance soils are well drained. Durham and Rion soils have less than 35 percent clay in the Bt horizon. Enon, Iredell, Mecklenburg, Sedgefield, and Wilkes soils have base saturation of more than 35 percent. In addition, Wilkes soils are loamy and shallow. All of these except for Iredell, Sedgefield, and Worsham soils are on landscape positions that have better surface drainage. Iredell, Prosperity, Santuc, and Sedgefield soils are in similar landscape positions to Helena. Worsham soils are in heads of drains and upland drainageways. Santuc soils have a fine-loamy particle size class

DRAINAGE AND PERMEABILITY: Moderately well drained: medium to rapid runoff; slow permeability. There is a perched water table in late winter and early spring.

USE AND VEGETATION: About two-thirds of this soil is used for crops and pasture. Common crops are tobacco, corn, soybeans, small grain, and vegetables. Less common are cotton and hay. The remaining acreage is in forests of mixed hardwood and pine. Native species include loblolly pine, shortleaf pine, Virginia pine, sweetgum, willow oak, red oak, white oak, yellow-poplar, and American elm. Understory species include sourwood, flowering dogwood, winged elm, eastern cedar, hophornbean, eastern redbud, and sassafras.

DISTRIBUTION AND EXTENT: Piedmont of Alabama, Georgia, North Carolina, South Carolina, and Virginia. The series is of large extent; the area is more than 300,000 acres.

MLRA OFFICE RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: Person County, North Carolina, 1928.

REMARKS: The August 1991 revision changed depth to bedrock from "more than 48 inches to more than 60 inches" to be consistent with one depth to bedrock class as shown on the Soil Interpretation Records for Helena.

Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon - the zone from the surface of the soil to 12 inches (Ap and E horizons)
Argillic horizon - the zone between depths of 12 and 46 inches below the surface (BE, Bt1, Bt2, Bt3 and BCg horizons)
Aquic conditions - periodic episaturation and redox depletions within 24 inches of the upper boundary of the argillic horizon (beginning in the Bt1 horizon)

Revised: RLV 8/14/98

MLRA = 136

ADDITIONAL DATA:

TABULAR SERIES DATA:
SOI-5 Soil Name Slope Airtemp FrFr/Seas Precip Elevation
NC0058 HELENA 0- 15 58- 65 85-240 37- 69 350- 900
NC0176 HELENA 0- 15 58- 65 185-240 37- 69 350- 900
NC0266 HELENA 0- 15 58- 65 185-240 37- 69 350- 900

SOI-5	FloodL	FloodH	Watertable	Kind	Months	Bedrock	Hardness
NC0058	NONE		1.5-2.5	PERCHED	JAN-APR	60-60	
NC0176	NONE		1.5-2.5	PERCHED	JAN-APR	60-60	
NC0266	NONE		1.5-2.5	PERCHED	JAN-APR	60-60	

SOI-5	Depth	Texture	3-Inch	No-10	Clay%	-CEC-
NC0058	0-12	SL FSL L	0- 5	90-100	5-20	1- 6
NC0058	0-12	SCL CL	0- 5	95-100	20-35	4- 8
NC0058	12-19	SCL CL	0- 5	95-100	20-35	4- 7
NC0058	19-43	CL SC C	0- 5	95-100	35-60	7- 13
NC0058	43-60	VAR	-	-	-	-
NC0176	0-12	GR-FSL GR-L GR-COSL	0- 5	50- 75	5-20	1- 6
NC0176	0-12	GR-LCOS GR-LS GR-S	0- 5	50- 75	3-12	1- 4
NC0176	0-12	GR-CL GR-SCL	0- 5	50- 75	20-35	4- 8
NC0176	12-19	SCL CL SL	0- 5	95-100	20-35	4- 7
NC0176	19-43	CL SC C	0- 5	95-100	35-60	7- 13
NC0176	43-60	VAR	-	-	-	-
NC0266	0-12	LS LCOS	0- 5	90-100	3-12	1- 4
NC0266	12-19	SCL CL	0- 5	95-100	20-35	4- 7
NC0266	19-43	CL SC C	0- 5	95-100	35-60	7- 13
NC0266	43-60	VAR	-	-	-	-

SOI-5	Depth	-pH-	O.M.	Salin	Permeab	Shnk-Swll
NC0058	0-12	3.5- 6.5	.5-2.	0- 0	2.0- 6.0	LOW
NC0058	0-12	3.5- 6.5	.5-1.	0- 0	0.2- 0.6	LOW
NC0058	12-19	3.5- 5.5	0.-.5	0- 0	0.2- 0.6	MODERATE
NC0058	19-43	3.5- 5.5	0.-.5	0- 0	0.06- 0.2	HIGH
NC0058	43-60	-	-	-	-	
NC0176	0-12	4.5- 6.5	.5-2.	0- 0	2.0- 6.0	LOW
NC0176	0-12	4.5- 6.5	.5-2.	0- 0	6.0- 20	LOW
NC0176	0-12	4.5- 6.5	.5-1.	0- 0	0.2- 0.6	LOW
NC0176	12-19	4.5- 5.5	0.-.5	0- 0	0.2- 0.6	MODERATE
NC0176	19-43	4.5- 5.5	0.-.5	0- 0	0.06- 0.2	HIGH
NC0176	43-60	-	-	-	-	
NC0266	0-12	3.5- 6.5	.5-2.	0- 0	6.0- 20	LOW
NC0266	12-19	3.5- 5.5	0.-.5	0- 0	0.2- 0.6	MODERATE
NC0266	19-43	3.5- 5.5	0.-.5	0- 0	0.06- 0.2	HIGH
NC0266	43-60	-	-	-	-	

LOCATION LOUISBURG GA+AL NC SC VA
Established Series
Rev. RLV
09/2003

LOUISBURG SERIES

The Louisburg Series consists of very deep, well drained, rapidly permeable soils that formed in material weathered from felsic igneous and metamorphic rock, primarily granite and granite gneiss. The Louisburg soils are on summits and side slopes of the Piedmont uplands. Slope ranges from 6 to 45 percent. Near the type location, the mean annual temperature is 60 degrees F, and the mean annual precipitation is 45 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, semiactive, thermic Typic Hapludults

TYPICAL PEDON: Louisburg gravelly sandy loam in an area of Rawlings-Louisburg-Buckhead complex, 15 to 45 percent slopes, very stony--forested.
(Colors are for moist soil unless otherwise stated.)

A--0 to 4 inches; dark brown (10YR 3/3) gravelly sandy loam; moderate medium granular structure; very friable; many very fine, fine, and medium and common coarse roots; few fine flakes of mica; 12 percent gravel, 5 percent cobbles, and 3 percent stones; moderately acid; abrupt smooth boundary. (2 to 9 inches thick)

E--4 to 7 inches; light yellowish brown (10YR 6/4) gravelly sandy loam; weak fine subangular blocky structure; very friable; common very fine, fine, and medium and few coarse roots; few fine flakes of mica; 12 percent gravel and 5 percent cobbles; moderately acid; clear smooth boundary. (0 to 8 inches thick)

Bt1--7 to 14 inches; brown (7.5YR 5/4) sandy loam; weak medium subangular blocky structure; friable, common very fine, fine, and medium and few coarse roots; few faint brown (7.5YR 4/3) clay films on faces of peds; few fine flakes of mica; 10 percent gravel and 2 percent cobbles; moderately acid; clear wavy boundary.

Bt2--14 to 26 inches; brown (7.5YR 4/4) loam; weak medium subangular blocky structure; friable; common very fine, fine, and medium, and few coarse roots; few distinct brown (7.5YR 4/3) clay films on faces of peds; few fine flakes of mica; 8 percent gravel, 2 percent cobbles; moderately acid; clear wavy boundary.
(Combined thickness of the Bt horizon is 15 to 30 inches)

BC--26 to 36 inches; strong brown (7.5YR 4/6) sandy loam; weak medium subangular blocky structure; friable; few very fine, fine, medium, and coarse roots; common fine flakes of mica; 10 percent gravel, 2 percent cobbles; moderately acid; clear irregular boundary. (0 to 20 inches thick)

C--36 to 60 inches: 50 percent light brown (7.5YR 6/4), 40 percent red (2.5YR 4/6), and 10 percent very pale brown (10YR 8/3) saprolite that crushes to gravelly sandy loam; massive; friable; few very fine, fine, medium, and coarse roots in fractures; common fine flakes of mica; 10 percent gravel, 5 percent cobbles, and 2 percent highly weathered stones; strongly acid.

TYPE LOCATION: Morgan County, Georgia; 800 feet east of Rutledge Road and 4,600 feet north of the Fambaugh Bridge Road bridge over Hard Labor Creek; (USGS Quadrangle, Rutledge North, GA (1971), lat. 33 degrees 38 minutes 59 seconds N., long. 83 degrees 34 minutes 37 seconds W.):

RANGE IN CHARACTERISTICS: Solum thickness ranges from 20 to 40 inches. The solum is underlain by saprolite. Depth to bedrock, both hard and weathered, is more than 5 feet. Content of rock fragments ranges from 0 to 35 percent throughout, but individual subhorizons range up to 60 percent. Rock fragments consist of gravel, cobbles, stones and boulders. Reaction ranges from very strongly acid to moderately acid. Flakes of mica range from none to common in all horizons.

The A horizon is has hue of 7.5YR to 2.5Y, value of 3 to 6, and chroma of 2 to 4. It is fine sandy loam, sandy loam, loamy sand, or loamy coarse sand in the fine-earth fraction.

The E horizon, where present, has hue of 7.5YR to 2.5Y, value of 3 to 6, and chroma of 2 to 4. It is fine sandy loam, sandy loam, loamy sand, or loamy coarse sand in the fine-earth fraction.

The Bt horizon has hue of 2.5YR to 10YR, value of 4 to 7, and chroma of 4 to 8. Mottles range from none to common and are in shades of red, brown, and yellow. Texture is dominantly sandy loam, coarse sandy loam, or loam in the fine-earth fraction. Some pedons may have thin subhorizons of sandy clay loam.

The C horizon is highly weathered saprolite from felsic igneous and metamorphic rock, primarily granite and granite gneiss.

The Cr horizon, where present, is weathered felsic igneous and metamorphic rock, primarily granite and granite gneiss.

The R horizon, where present, is hard felsic igneous and metamorphic rock, primarily granite and granite gneiss.

COMPETING SERIES: The Bojac series is the only competitor. Bojac soils formed in loamy and sandy stratified fluvial sediments and are flood plains and stream terraces.

GEOGRAPHIC SETTING: Louisburg soils are on sloping ridgetops and sideslopes of the Piedmont uplands. Slopes range from 6 to about 45 percent. The soil formed in material weathered from felsic igneous and metamorphic rock, primarily granite and granite gneiss. The mean annual temperature ranges from 59 to 65 degrees F, and the mean annual precipitation ranges from 45 to 52 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the Appling, Ashlar, Buckhead, Cecil, Hard Labor, Madison, Pacolet, Rawlings, Rion, Saw, Wateree, Wedowee, and Wilkes series. Appling, Cecil, Hard Labor, Madison, Pacolet. Saw and Wedowee soils are in a fine family. In addition, Saw soils have bedrock at a depth of 20 to 40 inches. Buckhead, Rawlings and Rion soils are in a fine-loamy family. In addition, Rawlings soils have bedrock at a depth of 20 to 40 inches. Ashlar and Wateree soils have bedrock at a depth of 20 to 40 inches. Wilkes soils are in a shallow family.

DRAINAGE AND PERMEABILITY: Well drained to excessively drained; runoff is medium to rapid; permeability is moderately rapid.

USE AND VEGETATION: Mostly forested with post oak, white oak, and red oaks but there are some hickories, dogwoods, and shortleaf and loblolly pines. Cultivated areas are used for corn, oats, vegetables, and pasture.

DISTRIBUTION AND EXTENT: The Southern Piedmont MLRA 136 of Georgia, Alabama, South Carolina, North Carolina, and Virginia. The series is not extensive.

MLRA OFFICE RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: DeKalb County, Georgia; 1938.

REMARKS: Louisburg soils were formerly classified in the Lithosol great soil group. The July 1975 revision changed the series from a moderately deep Typic Dystrochrept to a very deep Ruptic Ultic Dystrochrept with variable depth to lithic or paralithic contact. The purpose was to describe a complex of Dytrochrepts and Hapludults. The series was little used after the 1975 revision as the Ashlar, Wateree and Rion soils were used for these complexes. This revision restores part of the concept of the Louisburg series for the very deep component that occurs in many or most of these map units.

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - the zone from the surface of the soil to a depth of 4 inches (A and E horizons)

Argillic horizon - the zone from 7 to 26 inches below the surface (Bt1 and Bt2 horizons).

MLRA=136

ADDITIONAL DATA:

SOI-5 Soil Name Slope Airtemp FrFr/Seas Precip Elevation
GA0038 LOUISBURG 2- 50 60- 65 210-240 45- 52 500- 800
GA0059 LOUISBURG 6- 50 60- 65 210-240 45- 52 500- 800
GA0086 LOUISBURG 2- 50 60- 65 210-240 45- 52 500- 800

SOI-5 FloodL FloodH Watertable Kind Months Bedrock Hardness
GA0038 NONE 6.0-6.0 - 40-40 HARD
GA0059 NONE 6.0-6.0 - 40-40 HARD
GA0086 NONE 6.0-6.0 - 40-40 HARD

SOI-5 Depth Texture 3-Inch No-10 Clay% -CEC-
GA0038 0- 7 LS LCOS 0- 15 70- 98 2-12 -
GA0038 0- 7 SL FSL 0- 15 75- 95 5-15 -
GA0038 7-24 SL 0- 15 75- 98 7-18 -
GA0038 24-60 WB - - - -
GA0059 0- 7 ST-SL ST-LS ST-LCOS 25- 38 70- 83 2-15 -
GA0059 0- 7 STV-SL 35- 50 70- 83 2-15 -
GA0059 7-24 ST-SL 25- 38 75- 83 7-18 -
GA0059 24-60 WB - - - -
GA0086 0- 7 GR-LS GR-LCOS 0- 15 50- 75 2-12 -
GA0086 0- 7 GR-SL GR-FSL GR-COSL 0- 15 50- 75 5-15 -
GA0086 7-24 SL GR-SL GR-COSL 0- 15 60- 90 7-18 -
GA0086 24-60 WB - - - -

SOI-5 Depth -pH- O.M. Salin Permeab Shnk-Swll
GA0038 0- 7 4.5- 6.0 .5-2. 0- 0 6.0- 20 LOW
GA0038 0- 7 4.5- 6.0 .5-2. 0- 0 6.0- 20 LOW
GA0038 7-24 4.5- 6.0 - 0- 0 6.0- 20 LOW
GA0038 24-60 - - - -
GA0059 0- 7 4.5- 6.0 .5-2. 0- 0 6.0- 20 LOW
GA0059 0- 7 4.5- 6.0 .5-2. 0- 0 6.0- 20 LOW
GA0059 7-24 4.5- 6.0 - 0- 0 6.0- 20 LOW
GA0059 24-60 - - - -
GA0086 0- 7 4.5- 6.0 .5-2. 0- 0 6.0- 20 LOW
GA0086 0- 7 4.5- 6.0 .5-2. 0- 0 6.0- 20 LOW
GA0086 7-24 4.5- 6.0 - 0- 0 6.0- 20 LOW
GA0086 24-60 - - - -

LOCATION SANTUC SC
Established Series
Rev. ECH-RLV
04/2006

SANTUC SERIES

The Santuc series consists of very deep, moderately well drained, moderately slowly permeable soils that formed in residuum weathered from mixed acid crystalline rocks. These soils are on broad ridges, side slopes, toe slopes and at the heads of small drainageways of the Piedmont uplands. There is a perched water table in late winter and early spring. Slope ranges from 2 to 15 percent.

TAXONOMIC CLASS: Fine-loamy, mixed, semiactive, thermic Aquic Hapludults

TYPICAL PEDON: Santuc sandy loam - on a 2 percent slope in a wooded area. (Colors are for moist soil.)

A--0 to 3 inches; dark grayish brown (10YR 4/2) loamy coarse sand; weak fine granular structure; very friable; many fine and medium roots, and few coarse roots; extremely acid; clear smooth boundary. (2 to 8 inches thick)

E--3 to 9 inches; brown (10YR 5/3) sandy loam; weak fine granular structure; very friable; common fine and few medium roots; very strongly acid; clear smooth boundary. (0 to 8 inches thick)

Bt1--9 to 14 inches; yellowish brown (10YR 5/4) sandy loam; weak medium angular blocky structure; friable; few fine and medium roots; few faint clay films on faces of peds; extremely acid; gradual smooth boundary.

Bt2--14 to 26 inches; yellowish brown (10YR 5/4) sandy clay loam; moderate coarse subangular and angular blocky structure; firm; few fine and medium roots; many distinct clay films on faces of peds; 2 percent quartz gravel; common medium distinct reddish yellow (7.5YR 6/8) and few medium prominent yellowish red (5YR 5/8) masses of oxidized iron; extremely acid; clear smooth boundary.

Bt3--26 to 41 inches; brownish yellow (10YR 6/6) clay loam; weak coarse prismatic parting to strong coarse angular blocky structure; very firm; few fine and medium roots; many prominent clay films on faces of peds; common coarse distinct yellow (10YR 7/8) masses of oxidized iron and common coarse prominent light brownish gray (10YR 6/2) iron depletions; extremely acid; clear smooth boundary. (Combined thickness of the Bt horizon is 21 to 40 inches.)

BC--41 to 51 inches; yellow (10YR 7/8) loam; weak medium subangular blocky structure: firm; few fine roots; few distinct clay films on faces of peds; many coarse distinct very pale brown (10YR 8/3) and common medium distinct light brownish gray (10YR 6/2) and light gray (10YR 7/1) iron depletions: extremely acid: clear wavy boundary. (0 to 15 inches thick)

C--51 to 60 inches; very pale brown (10YR 8/4) sandy loam saprolite; massive; friable; many medium distinct yellow (10YR 7/8), and few coarse prominent reddish yellow (7.5YR 6/8) masses of oxidized iron and common medium distinct light brownish gray (10YR 6/2) iron depletions; extremely acid.

TYPE LOCATION: Union County, South Carolina; 9 miles north of Whitmire, 1.24 miles southwest of the intersection of S.C. Highway 24 and S.C. Highway 132 on S.C. Highway 132; 50 feet east of road.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 40 to 60 inches or more. Depth to bedrock is more than 60 inches. The soil is extremely acid to strongly acid. Content of quartz gravel ranges from 0 to 10 percent by volume in the A and E horizons and from 0 to 5 percent in the B and C horizons. Flakes of mica range from none to a few in the Bt and C horizons.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 4. It is loamy coarse sand, loamy sand, coarse sandy loam, or sandy loam.

The E horizon, where present, has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 to 6. It is loamy coarse sand, loamy sand, coarse sandy loam, or sandy loam.

The Bt horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 4 to 8. In some pedons, the lower Bt horizon has masses of oxidized iron in shades of yellow, brown, or red. Iron depletions with chroma of 2 or less are in the upper 24 inches of the Bt horizon. The texture is sandy loam, sandy clay loam, or clay loam, and includes clay in the lower part.

The C horizon has hue of 7.5YR to 2.5Y, value of 5 to 7, and chroma of 3 to 6. It is typically mottled in shades of gray, yellow, or brown. The C horizon is sandy loam, loam, or sandy clay loam saprolite.

COMPETING SERIES: These are the Abell, Altavista, Bertie, Tetotum, and Winton series in the same family, and the Bush River, Helena, and Prosperity series in similar families. Abell soils have a lithologic discontinuity within a depth of 48 inches. Altavista soils are on stream terraces, formed in fluvial sediment, and have an apparent water table. Bertie soils are on the lower coastal plain, formed in marine sediment, and have an apparent water table. Winton soils are on steep bluffs of terraces and formed in fluvial or marine sediment. Bush River, Helena, and Prosperity soils have a clayey particle-size control section. In addition, Bush River and Prosperity soils have a paralithic contact within 60 inches.

GEOGRAPHIC SETTING: Santuc soils are on broad ridges, side slopes, toe slopes and at the heads of small drainageways of the Piedmont uplands. There is a perched water table in late winter and early spring. Slope ranges from 2 to 15 percent. The soil formed in residuum weathered from mixed acid crystalline rocks such as granite or granite gneiss. The mean annual precipitation ranges from 44 to 48 inches, mean annual temperature ranges from 60 to 62 degrees F, and the frost-free season ranges from 210 to 230 days.

GEOGRAPHICALLY ASSOCIATED SOILS: In addition to the similar Bush River, Helena, and Prosperity soils, these include the Appling, Cecil, Durham, Pacolet, Rion, Wateree and Wedowee soils. Appling, Cecil, Pacolet, and Wedowee soils have a clayey particle-size control section and do not have redoximorphic depletions with chroma of 2 or less. Durham and Rion soils do not have redoximorphic depletions with chroma of 2 or less. Wateree soils have a coarse-loamy particle-size control section and do not have redoximorphic depletions with chroma of 2 or less.

DRAINAGE AND PERMEABILITY: Moderately well drained; medium to rapid runoff; moderately slow permeability.

USE AND VEGETATION: Most areas of this soils are forested. Native species include loblolly pine, shortleaf pine, Virginia pine, sweetgum, willow oak, red oak, white oak, yellow-poplar, and American elm. Cleared areas of this soil are used for crops and pasture. Common crops are corn, soybeans, small grain, and vegetables.

DISTRIBUTION AND EXTENT: The Piedmont of South Carolina and possibly Georgia, North Carolina and Virginia. The series is of small extent.

MLRA OFFICE RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: Newberry County, South Carolina, 2005.

REMARKS: These soils were included with the Helena series in several surveys. The name Santuc is from a small community in Union County, South Carolina. The April 2006 revision changed the series status from tentative to established.
Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon - the zone from the surface of the soil to 9 inches (A and E horizons)
Argillic horizon - the zone from 9 to 41 inches (Bt1, Bt2 and Bt3 horizons)

MLRA = 136

SIR = SC0143

ADDITIONAL DATA:

TABULAR SERIES DATA:

SOI-5	Soil Name	Slope	Airtemp	FrFr/Seas	Precip	Elevation
SC0143	SANTUC	2- 15	60- 62	180-230	44- 48	350- 500

SOI-5	FloodL	FloodH	Watertable	Kind	Months	Bedrock	Hardness
SC0143	NONE		1.5-3.0	PERCHED	DEC-MAR	60-60	

SOI-5	Depth	Texture	3-Inch	No-10	Clay%	-CEC-
SC0143	0- 3	SL COSL	0- 5	85-100	5-18	1- 5
SC0143	0- 3	LS LCOS	0- 5	85-100	2-10	1- 3
SC0143	3- 9	LS COSL SL	0- 5	85-100	2-18	1- 3
SC0143	9-26	SL SCL CL	0- 2	90-100	10-35	1- 6
SC0143	26-41	SCL CL C	0- 2	90- 95	20-45	4- 10
SC0143	41-60	L SL SCL	0- 2	90-100	10-27	2- 7

SOI-5	Depth	-pH-	O.M.	Salin	Permeab	Shnk-Swll
SC0143	0- 3	3.6- 5.5	.5-2.	0- 0	0.6- 6.0	LOW
SC0143	0- 3	3.6- 5.5	.5-2.	0- 0	2.0- 6.0	LOW
SC0143	3- 9	3.6- 5.5	.5-1.	0- 0	0.6- 6.0	LOW
SC0143	9-26	3.6- 5.5	0.-.5	0- 0	0.6- 2.0	LOW
SC0143	26-41	3.6- 5.5	0.-.5	0- 0	0.2- 0.6	MODERATE
SC0143	41-60	3.6- 5.5	0.-.5	0- 0	0.6- 2.0	LOW

National Cooperative Soil Survey
U.S.A.

LOCATION WEDOWEE AL+GA NC SC VA
Established Series
Rev. WBP:PGM:DTA:RHB
05/2006

WEDOWEE SERIES

The Wedowee series consists of very deep, well drained, moderately permeable soils that formed in residuum weathered from felsic igneous and metamorphic rocks of the Piedmont uplands. These soils are on narrow ridges and on side slopes of uplands. Slope is dominantly between 6 and 25 percent but ranges from 0 to 60 percent. Near the type location, the average annual temperature is about 63 degrees F. and average annual precipitation is about 53 inches.

TAXONOMIC CLASS: Fine, kaolinitic, thermic Typic Kanhapludults

TYPICAL PEDON: Wedowee sandy loam, in a field. (Colors are for moist soil.)

A--0 to 4 inches; dark grayish brown (10YR 4/2) sandy loam; moderate fine granular structure; very friable; strongly acid; abrupt smooth boundary. (1 to 8 inches thick)

E--4 to 7 inches; brownish yellow (10YR 6/6) coarse sandy loam; weak fine granular structure; very friable; very strongly acid; clear smooth boundary. (0 to 6 inches thick)

Bt--7 to 23 inches; strong brown (7.5YR 5/6) clay; few fine distinct brownish yellow (10YR 6/6) and red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; firm; slightly sticky, slightly plastic; few faint clay films on faces of peds; very strongly acid; gradual wavy boundary. (10 to 24 inches thick)

BC--23 to 35 inches; strong brown (7.5YR 5/6) clay loam; many fine distinct red (2.5YR 4/6) and common fine distinct brownish yellow (10YR 6/6) mottles; weak medium subangular blocky structure; friable; slightly sticky, nonplastic; very strongly acid; gradual wavy boundary. (0 to 12 inches thick)

C--35 to 80 inches; mottled strong brown (7.5YR 5/6), brownish yellow (10YR 6/6), yellowish red (5YR 5/8), and white (10YR 8/1) sandy clay loam saprolite; massive; very friable; very strongly acid.

TYPE LOCATION: Granville County, North Carolina; about 2.5 miles east of Wilton on North Carolina Highway 56, about 1.5 miles northeast on Secondary Road 1625, about 1,000 feet north of the intersection with Secondary Road 1628, in a field; Wilton USGS topographic quadrangle: lat. 36 degrees 08 minutes 33 seconds N. and long. 78 degrees 31 minutes 18 secinds W.

RANGE IN CHARACTERISTICS: The Bt horixon is at least 10 to 24 inches thick and extends to a depth of 18 to 30 inches. Depth to rock is more than 60 inches. Reaction ranges from extremely acid to moderately acid throughout except where lime has been added. Flakes of mica range from none to few in the A horizon and the upper part of the B horizon and from none to common in the lower part of the B and C horizon.

The A horizon has hue of 7.5YR to 2.5Y, value of 3 to 6 and chroma of 2 to 8. It is coarse loamy sand, coarse sandy loam, sandy loam, fine sandy loam, loam or their gravelly analogues. In eroded areas, the A horizon is sandy clay loam or clay loam ,or their gravelly analogues. Content of coarse fragments, dominantly gravel size, range from 0 to 60 percent by volume.

The E horizon has hue of 7.5YR to 2.5Y, value of 4 to 7, and chroma of 3 to 8. It is coarse loamy sand, coarse sandy loam, sandy loam, fine sandy loam, loam; or their gravelly analogues.

The BE horizon, where present, has hue of 5YR to 10YR, value of 4 to 7 and chroma of 3 to 8. It is loam, fine sandy loam, sandy loam, sandy clay loam or clay loam.

The Bt horizon has hue of 5YR or 10YR, value of 4 to 6 and chroma of 6 to 8. Mottles in shades of brown, yellow, and red may be in some pedons. Texture of the Bt horizon is sandy clay loam, clay loam, sandy clay, or clay. Clay content of the particle-size control section averages 35 to 60 percent.

The BC horizon has hue of 2.5YR to 10YR, value of 5 to 7 and chroma of 4 to 8. Mottles in shades of red, brown, and yellow range from none to common. It is sandy clay loam, clay loam, loam, or fine sandy loam.

The C horizon is multicolored loamy saprolite.

COMPETING SERIES: These include the Appling, Bethlehem, Cecil, Georgeville, Herndon, Madison, Nanford, Nankin, Pacolet, Saw, and Tarrus series in the same family. Appling and Cecil soils have thicker Bt horizons. Additionally, Cecil soils have dominant hue of 5YR or redder throughout the Bt horizon. Bethlehem soils have a paralithic contact within 20 to 40 inches of the surface. Georgeville, Herndon, Nanford, and Tarrus soils formed from Carolina slate and have more than 30 percent silt. Madison soils have dominant hue of 5YR or redder in the Bt horizon and contain more mica. Nankin soils formed from marine sediments. Pacolet soils have Bt horizons with hue of 2.5YR or redder. Saw soils have a lithic contact within 20 to 40 inches of the surface.

GEOGRAPHIC SETTING: Wedowee soils are on sloping to steep uplands of the Southern Piedmont MLRA. Slopes are mainly 6 to 25 percent, but range from 2 to 60 percent. The soils have formed in residuum from weathered felsic igneous and metamorphic rocks. Near the type location, the mean annual precipitation ranges from 42 to 56 inches and the mean annual temperature ranges from 58 to 65 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: In addition to the competing Appling, Bethlehem, Cecil, Madison, Pacolet, and Saw series, these are the Ashlar, Durham, Hard Labor, Helena, Lockhart, Louisburg, Rion, Rolesville, Vance, Wake, Wateree, and Worsham series. Ashlar soils are coarse-loamy and have a lithic contact within 20 to 40 inches. Durham soils are fine-loamy. Hard Labor soils have a perched water table at 2.5 to 5 feet. Helena and Vance soils have a mixed mineralogy and, in addition, Helena soils have a perched water table 1.5 to 2.5 feet. Lockhart soils have more than 35 percent rock fragments in the particle-size control section. Louisburg soils are coarse-loamy. Rion soils are fine-loamy. Rolesville soils are sandy throughout and have a lithic contact within 20 to 40 inches. Wake soils are sandy throughout and have a lithic contact within 20 inches. Wateree soils are coarse-loamy and have a paralthic contact within 20 to 40 inches. Worsham soils are poorly drained and are around the heads of drains.

DRAINAGE AND PERMEABILITY: Well drained. Runoff is medium to rapid and internal drainage is medium. Permeability is moderate.

USE AND VEGETATION: Most areas are wooded. Common trees include loblolly pine, Virginia pine, red oak, white oak, post oak, hickory, blackgum, maple, and dogwood. Cleared areas are used for cotton, corn, tobacco, small grain, hay, and pasture.

DISTRIBUTION AND EXTENT: The Piedmont of Alabama, Georgia, North Carolina, South Carolina and Virginia. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: Randolph County, Alabama; 1969.

REMARKS:
Wedowee soils were formerly mapped as thin solum phases of the Appling series. The 5/90 revision changed the classification to Typic Kanhapludults in recognition of the low activity clay content of the argillic horizon. The December 2005 revision moved the type location from Randolph County, Alabama to a more representative site. The 2006 revision was to clean up text.
Revised: RLV 11/24/97; DTA 12/30/2005; RHB 05/12/2006
Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon - the zone from the surface of the soil to a depth of 7 inches (A and E horizons)
Argillic and kandic horizon - the zone from 7 to 23 inches (Bt horizon)

ADDITIONAL DATA:

TABULAR SERIES DATA:

SOI-5	Soil Name	Slope	Airtemp	FrFr/Seas	Precip	Elevation
AL0046	WEDOWEE	0-60	58-65	175-225	42-56	200-800
AL0138	WEDOWEE	0-60	58-65	175-225	42-56	200-800
AL0146	WEDOWEE	0-60	58-65	175-225	42-56	200-800

SOI-5	FloodL	FloodH	Watertable	Kind	Months	Bedrock	Hardness
AL0046	NONE		>6.0		-	>60	
AL0138	NONE		>6.0		-	>60	
AL0146	NONE		>6.0		-	>60	

SOI-5	Depth	Texture	3-Inch	No-10	Clay%	-CEC-
AL0046	0-10	SL FSL L	0-0	80-100	5-20	2-8
AL0046	0-10	SCL CL	0-0	90-100	20-30	2-8
AL0046	10-14	L SCL	0-0	90-100	14-30	3-10
AL0046	14-32	SC CL C	0-0	95-100	35-60	3-10
AL0046	32-60	SCL CL SL	0-0	70-100	15-30	3-8
AL0138	0-10	BY-SL BY-L	10-20	70-90	5-20	2-8
AL0138	10-14	L SCL	0-5	90-100	14-30	3-10
AL0138	14-32	SC CL C	0-0	95-100	35-60	3-10
AL0138	32-60	SCL CL SL	0-0	70-100	15-30	3-8
AL0146	0-10	GR-SL GR-FSL GR-L	0-5	50-80	6-20	2-8
AL0146	0-10	GR-SCL GR-CL	0-5	50-80	20-30	2-8
AL0146	10-14	L SCL	0-0	90-100	14-30	3-10
AL0146	14-32	SC CL C	0-0	95-100	35-60	3-10
AL0146	32-60	SCL CL SL	0-0	70-100	15-30	3-8

SOI-5	Depth	-pH-	O.M.	Salin	Permeab	Shnk-Swll
AL0046	0-10	3.6- 5.5	.5-3.	0-0	2.0-6.0	LOW
AL0046	0-10	3.6- 5.5	.5-3.	0-0	0.6-2.0	LOW
AL0046	10-14	3.6- 5.5	0.-.5	0-0	0.6-2.0	LOW
AL0046	14-32	3.6- 5.5	0.-.5	0-0	0.6-2.0	LOW
AL0046	32-60	3.6- 5.5	0.-.5	0-0	0.6-2.0	LOW
AL0138	0-10	3.6- 5.5	0.-1.	0-0	2.0-6.0	LOW
AL0138	10-14	3.6- 5.5	0.-.5	0-0	0.6-2.0	LOW
AL0138	14-32	3.6- 5.5	0.-.5	0-0	0.6-2.0	LOW
AL0138	32-60	3.6- 5.5	0.-.5	0-0	0.6-2.0	LOW
AL0146	0-10	3.6- 5.5	.5-3.	0-0	2.0-6.0	LOW
AL0146	0-10	3.6- 5.5	.5-3.	0-0	0.6-2.0	LOW
AL0146	10-14	3.6- 5.5	0.-.5	0-0	0.6-2.0	LOW
AL0146	14-32	3.6- 5.5	0.-.5	0-0	0.6-2.0	LOW
AL0146	32-60	3.6- 5.5	0.-.5	0-0	0.6-2.0	LOW

A Spray Irrigation Water Balance for

Permit No: 10%

Permittee Name:

Contact Name:

Address:

Facility Orange Chatham Line 15-501

Address: 15-501

Water Budget Prepared By:

Edwin Stott, L.S.S., S&EC, PA
3817 E Lawndale Drive,
Greensboro, NC 27455

Enter Data ===>

Precipitation Worksheet

FYI

Calculate the precipitation for an 80th percentile "wet" year, based on long term data (approx. 30 years or greater).

Click on each step box

Precipitation Data

	Step 1		Step 2
Month	Mean Monthly Precipitation	Percent of Mean Annual Precipitation	80th Percentile Monthly Precipitation
	inches	percent	inches
January	3.68	8.08	4.15
February	3.70	8.13	4.17
March	4.08	8.96	4.60
April	3.47	7.62	3.91
May	3.91	8.59	4.41
June	3.92	8.61	4.42
July	5.00	10.98	5.63
August	4.87	10.70	5.49
September	3.64	7.99	4.10
October	3.20	7.03	3.61
November	2.87	6.30	3.23
December	3.19	7.01	3.59
TOTALS =	45.53	100.00	51.30
		Calculations	Calculations

Values shown in yellow cells are linked to other locations within the Water Balance Program

Step 3 - Precipitation Data Soucre

Location of Precipitation Data:	Asheboro, NC
Staring Year of Data Record:	1933
Ending Year of Data Record:	1993
Period of Record (Years) =	60

Step 4

Source of Data:

USDA-NRCS County Soil Surveys (contact local NRCS office)

Important Note: Period of record for precipitation data should match period of record for temperature data

Enter Data ==>

Potential Evapo-Transpiration (PET) Worksheet

Choose PET Method: ☑ Thornthwaite Method ← Click on CheckBox → ☐ Manually Entered PET

Click on each step box

Thornthwaite PET Calculation

Step 1 | Step 2

Month	Mean monthly temp.	Daylight hours / 12	Heat index	Calculated PET	PET Data used in Water Balance
	(degrees F)			inches	
January	41.3	0.87	1.05	0.30	0.30
February	43.8	0.85	1.51	0.44	0.44
March	51.6	1.03	3.25	1.25	1.25
April	60.6	1.09	5.76	2.47	2.47
May	68.1	1.21	8.19	4.05	4.05
June	75.0	1.21	10.67	5.42	5.42
July	78.0	1.23	11.82	6.15	6.15
August	77.0	1.16	11.44	5.59	5.59
September	71.3	1.03	9.32	3.96	3.96
October	60.9	0.97	5.85	2.24	2.24
November	51.7	0.86	3.27	1.05	1.05
December	43.1	0.85	1.37	0.40	0.40
		TOTALS =	73.50	33.31	33.31

Site Latitude (degrees): 35.42 — within range

Calculations | Calculations | Calculations

Source of Temperature Data

Step 3

Location of Precipitation Data: Ashboro, NC

Staring Year of Data Record: 1933

Ending Year of Data Record: 1993

Period of Record (Years) = 60

Source of Data:

USDA-NRCS County Soil Surveys (contact local NRCS office)

Note: Period of record for Temperature data should match period of record for Precipitation data

PET Data — Step 4 — Manually Entered PET Data (inches)

Calculations

Source of PET Data

Step 5

FYI 1

FYI 2

Step 6

Values shown in yellow cells are linked to other locations within the Water Balance Program

Influent, Lagoon Storage, and Zone Setup Worksheet

Calculate the adjusted influent loading by including the gains and losses from the Storage Lagoon, and set up the Spray Zones areas and individual Zone flowrates.

Click on each step box

Enter Data ==>

Step 1	Step 2	Step 3		Step 4
Pan Evap. Data / Precip	Area of Lagoon (acres):	Design Daily Flow (Influent) (gals/day): 14,000	Total Flow to be Disposed (Annual Averaged) (gals/day): 14,000	Total Flow to All Zones (gals/day): 14,000
	Lagoon Gains & Losses	Influent	should be equal	

	Zone 1	Zone 2	Zone 3
Daily Flow to Zone (gals/day)	7,000	3,000	4,000
Wetted Acreage (acres)	3.27	7.11	3.02
Irr. Rate (in/wk) =	0.55	0.11	0.34

Month	Days per month	Pan Evaporation Data	Adjusted Pan Data	Precip	Lagoon Gains from Precip.	Lagoon Losses from Evap.	Design Influent Volume per Month	Total: Influent + Lagoon Gains & Losses	Zone 1 Volume to be Disposed	Zone 1 Design Irrigation per month	Zone 2 Volume to be Disposed	Zone 2 Design Irrigation per month	Zone 3 Volume to be Disposed	Zone 3 Design Irrigation per month
		inches	inches	inches	gallons	gallons	gallons	gallons	gallons	inches	gallons	inches	gallons	inches
January	31	1.10	0.77	4.15	0	0	434,000	434,000	217,000	2.45	93,000	0.48	124,000	1.51
February	28	1.09	0.76	4.17	0	0	392,000	392,000	196,000	2.21	84,000	0.44	112,000	1.37
March	31	3.42	2.39	4.60	0	0	434,000	434,000	217,000	2.45	93,000	0.48	124,000	1.51
April	30	5.36	3.75	3.91	0	0	420,000	420,000	210,000	2.37	90,000	0.47	120,000	1.46
May	31	6.21	4.35	4.41	0	0	434,000	434,000	217,000	2.45	93,000	0.48	124,000	1.51
June	30	6.91	4.84	4.42	0	0	420,000	420,000	210,000	2.37	90,000	0.47	120,000	1.46
July	31	7.29	5.10	5.63	0	0	434,000	434,000	217,000	2.45	93,000	0.48	124,000	1.51
August	31	6.44	4.51	5.49	0	0	434,000	434,000	217,000	2.45	93,000	0.48	124,000	1.51
September	30	5.10	3.57	4.10	0	0	420,000	420,000	210,000	2.37	90,000	0.47	120,000	1.46
October	31	3.59	2.51	3.61	0	0	434,000	434,000	217,000	2.45	93,000	0.48	124,000	1.51
November	30	2.23	1.56	3.23	0	0	420,000	420,000	210,000	2.37	90,000	0.47	120,000	1.46
December	31	1.68	1.18	3.59	0	0	434,000	434,000	217,000	2.45	93,000	0.48	124,000	1.51
			Calc.		Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.
Totals	365	50.42	35.29	51.30	0	0	5,110,000	5,110,000	2,555,000	28.80	1,095,000	5.67	1,460,000	17.81

Source of PAN Evap. Data

Step 6

Chapil Hill Station, Orange County

Sources for PAN Evaporation Data
Aurora Station, Beaufort County
Chapil Hill Station, Orange County
Other

Soils and Water Balance for Zone 1

Zone 1 Description: Wedowee

Calculate Soil Drainage

Step 1		Step 2	f x Ksat
In-situ saturated vertical hydraulic conductivity (Ksat)		Drainage factor (f)	Soil Drainage Rate
in/hr	in/day	percent	in/day
0.30	7.08	0.100	0.71

Soils Series Information for Zone 1

Series Name	Drainage class	Water table depth (BLS)	risk of perching	Is bedrock < 60" BLS ?
Wedowee	well	>3.0	low	no

Potential site limitations

BLS = below land surface

Published soil permeability rates by series or textural class are not acceptable. Actual in-situ soils Ksat data is required.

Copied from Influent & Zones Setup Sheet:		
Daily Flow =	7,000	gals/day
Zone 1 Area =	3.27	acres

Click the "CALCULATE" button after making changes.

HELP

Month	Days per month	PET	Zone 1 Soil Drainage	Zone 1 Total Loss	Precip	Calculated Maximum Allowable Irrigation	Manual Override Maximum Allowable Irrigation	Actual Used Maximum Allowable Irrigation	Design Irrigation per Month	Monthly Excess	Zone 1 Cummulative Storage Required for Irrigation	Zone 1 Actual Monthly Irrigation Rate
		inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
January	31	0.30	21.95	22.25	4.15	18.11		18.11	2.45	15.66	0.00	2.45
February	28	0.44	19.82	20.27	4.17	16.10		16.10	2.21	13.89	0.00	2.21
March	31	1.25	21.95	23.19	4.60	18.60		18.60	2.45	16.15	0.00	2.45
April	30	2.47	21.24	23.71	3.91	19.80		19.80	2.37	17.44	0.00	2.37
May	31	4.05	21.95	26.00	4.41	21.59		21.59	2.45	19.14	0.00	2.45
June	30	5.42	21.24	26.66	4.42	22.24		22.24	2.37	19.87	0.00	2.37
July	31	6.15	21.95	28.10	5.63	22.47		22.47	2.45	20.02	0.00	2.45
August	31	5.59	21.95	27.54	5.49	22.05		22.05	2.45	19.61	0.00	2.45
September	30	3.96	21.24	25.20	4.10	21.10		21.10	2.37	18.73	0.00	2.37
October	31	2.24	21.95	24.18	3.61	20.58		20.58	2.45	18.13	0.00	2.45
November	30	1.05	21.24	22.29	3.23	19.05		19.05	2.37	16.69	0.00	2.37
December	31	0.40	21.95	22.35	3.59	18.75		18.75	2.45	16.31	0.00	2.45
			Calcs	Calcs		Calc M.A.I.	Manual M.A.I.	M.A.I. Used		Calcs		
Totals:	365	33.31	258.42	291.73	51.30	240.43		240.43	28.80			28.80

FYI

Maximum Monthly Storage Required for the Irrigation of Zone 1:

inches		acres		gallons
0.00	over	3.27	=	0

Soils and Water Balance for Zone 2

Zone 2 Description: Helena-Santuc

Calculate Soil Drainage

Step 1		Step 2	f x Ksat
In-situ saturated vertical hydraulic conductivity (Ksat)		Drainage factor (f)	Soil Drainage Rate
in/hr	in/day	percent	in/day
0.09	2.16	0.100	0.22

Soils Series Information for Zone 2 / Potential site limitations

Series Name	Drainage class	Water table depth (BLS)	risk of perching	Is bedrock < 60" BLS ?
Helena	mod well	2.0-3.0	high	no

BLS = below land surface

Published soil permeability rates by series or textural class are not acceptable. Actual in-situ soils Ksat data is required.

Copied from Influent & Zones Setup Sheet:		
Daily Flow =	3,000	gals/day
Zone 2 Area =	7.11	acres

Click the "CALCULATE" button after making changes.

HELP

Month	Days per month	PET	Zone 2 Soil Drainage	Zone 2 Total Loss	Precip	Calculated Maximum Allowable Irrigation	Manual Override Maximum Allowable Irrigation	Actual Used Maximum Allowable Irrigation	Design Irrigation per Month	Monthly Excess	Zone 2 Cummulative Storage Required for Irrigation	Zone 2 Actual Monthly Irrigation Rate
		inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
January	31	0.30	6.70	7.00	4.15	2.85		2.85	0.48	2.37	0.00	0.48
February	28	0.44	6.05	6.49	4.17	2.32		2.32	0.44	1.89	0.00	0.44
March	31	1.25	6.70	7.94	4.60	3.35		3.35	0.48	2.86	0.00	0.48
April	30	2.47	6.48	8.95	3.91	5.04		5.04	0.47	4.58	0.00	0.47
May	31	4.05	6.70	10.74	4.41	6.34		6.34	0.48	5.86	0.00	0.48
June	30	5.42	6.48	11.90	4.42	7.48		7.48	0.47	7.01	0.00	0.47
July	31	6.15	6.70	12.85	5.63	7.22		7.22	0.48	6.73	0.00	0.48
August	31	5.59	6.70	12.29	5.49	6.80		6.80	0.48	6.32	0.00	0.48
September	30	3.96	6.48	10.44	4.10	6.34		6.34	0.47	5.87	0.00	0.47
October	31	2.24	6.70	8.93	3.61	5.33		5.33	0.48	4.84	0.00	0.48
November	30	1.05	6.48	7.53	3.23	4.29		4.29	0.47	3.83	0.00	0.47
December	31	0.40	6.70	7.09	3.59	3.50		3.50	0.48	3.02	0.00	0.48
			Calcs	Calcs		Calc M.A.I.	Manual M.A.I.	M.A.I. Used		Calcs		
Totals:	365	33.31	78.84	112.15	51.30	60.85		60.85	5.67			5.67

FYI

Maximum Monthly Storage Required for the Irrigation of Zone 2:

inches		acres		gallons
0.00	over	7.11	=	0

Soils and Water Balance for Zone 3

Zone 3 Description: Louisburg

Soils Series Information for Zone 3		Potential site limitations		
Series Name	Drainage class	Water table depth (BLS)	risk of perching	Is bedrock < 60" BLS ?
Louisburg	excess-well	>3.0->5.0	low	no

BLS = below land surface

Published soil permeability rates by series or textural class are not acceptable. Actual in-situ soils Ksat data is required.

Calculate Soil Drainage

Step 1		Step 2	f x Ksat
In-situ saturated vertical hydraulic conductivity (Ksat)		Drainage factor (f)	Soil Drainage Rate
in/hr	in/day	percent	in/day
0.24	5.76	0.100	0.58

Copied from Influent & Zones Setup Sheet:		
Daily Flow =	4,000	gals/day
Zone 3 Area =	3.02	acres

Click the "CALCULATE" button after making changes.

HELP

Month	Days per month	PET	Zone 3 Soil Drainage	Zone 3 Total Loss	Precip	Calculated Maximum Allowable Irrigation	Manual Override Maximum Allowable Irrigation	Actual Used Maximum Allowable Irrigation	Design Irrigation per Month	Monthly Excess	Zone 3 Cummulative Storage Required for Irrigation	Zone 3 Actual Monthly Irrigation Rate
		inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
January	31	0.30	17.86	18.16	4.15	14.01		14.01	1.51	12.50	0.00	1.51
February	28	0.44	16.13	16.57	4.17	12.40		12.40	1.37	11.04	0.00	1.37
March	31	1.25	17.86	19.10	4.60	14.51		14.51	1.51	12.99	0.00	1.51
April	30	2.47	17.28	19.75	3.91	15.84		15.84	1.46	14.38	0.00	1.46
May	31	4.05	17.86	21.90	4.41	17.50		17.50	1.51	15.99	0.00	1.51
June	30	5.42	17.28	22.70	4.42	18.28		18.28	1.46	16.82	0.00	1.46
July	31	6.15	17.86	24.01	5.63	18.38		18.38	1.51	16.86	0.00	1.51
August	31	5.59	17.86	23.45	5.49	17.96		17.96	1.51	16.45	0.00	1.51
September	30	3.96	17.28	21.24	4.10	17.14		17.14	1.46	15.67	0.00	1.46
October	31	2.24	17.86	20.09	3.61	16.49		16.49	1.51	14.97	0.00	1.51
November	30	1.05	17.28	18.33	3.23	15.09		15.09	1.46	13.63	0.00	1.46
December	31	0.40	17.86	18.25	3.59	14.66		14.66	1.51	13.15	0.00	1.51
			Calcs	Calcs		Calc M.A.I.	Manual M.A.I.	M.A.I. Used		Calcs		
Totals:	365	33.31	210.24	243.55	51.30	192.25		192.25	17.81			17.81

FYI

Maximum Monthly Storage Required for the Irrigation of Zone 3:

Inches		acres		gallons
0.00	over	3.02	=	0

Zonal Storage Summations

OBJECT: To calculate the minimum wet weather storage required for a multiple zoned spray irrigation site.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Zone Description ==>	Wedowee	Helena-Santuc	Louisburg							
Predominant Soils ==>	Wedowee	Helena	Louisburg	Lynchburg						
Daily Flow to Zone ==>	7,000 gpd	3,000 gpd	4,000 gpd	0 gpd	0 gpd	0 gpd	0 gpd	0 gpd	0 gpd	0 gpd
Wetted Acreage ==>	3 acres	7 acres	3 acres	0 acres	0 acres	0 acres	0 acres	0 acres	0 acres	0 acres

Totals	
Design Daily Influent (gpd) =	14,000
Total Flow Disposed (gpd) =	14,000
Total Area (acres) =	13.40

Month	Days per month	Zone 1 Cummulative Storage Required		Zone 2 Cummulative Storage Required		Zone 3 Cummulative Storage Required		Zone 4 Cummulative Storage Required		Zone 5 Cummulative Storage Required	
		inches	gallons	inches	gallons	inches	gallons	inches	gallons	inches	gallons
January	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
February	28	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
March	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
April	30	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
May	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
June	30	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
July	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
August	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
September	30	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
October	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
November	30	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
December	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0

Month	Zone 6 Cummulative Storage Required		Zone 7 Cummulative Storage Required		Zone 8 Cummulative Storage Required		Zone 9 Cummulative Storage Required		Zone 10 Cummulative Storage Required		Totals Cummulative Storage Required
	inches	gallons	inches	gallons	inches	gallons	inches	gallons	inches	gallons	gallons
January	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
February	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
March	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
April	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
May	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
June	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
July	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
August	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
September	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
October	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
November	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
December	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0

Minimum Required Storage (gallons) → 0

Minimum Storage = 0 gallons divided by 14,000 gpd = 0.0 days

FYI

FYI Minimum Required Storage

A Spray Irrigation Water Balance for

Permit No: 6%

Permittee Name:

Contact Name:

Address:

Facility Orange Chatham Line 15-501

Address: 15-501

0.06

Water Budget Prepared By:

Edwin Stott, L.S.S., S&EC, PA
3817 E Lawndale Drive,
Greensboro, NC 27455

Enter Data ===>

Precipitation Worksheet

FYI

Calculate the precipitation for an 80th percentile "wet" year, based on long term data (approx. 30 years or greater).

Click on each step box

Precipitation Data

Month	Step 1 Mean Monthly Precipitation	Percent of Mean Annual Precipitation	Step 2 80th Percentile Monthly Precipitation
	inches	percent	inches
January	3.68	8.08	4.15
February	3.70	8.13	4.17
March	4.08	0.06	0.03
April	3.47	7.62	3.91
May	3.91	8.59	4.41
June	3.92	8.61	4.42
July	5.00	10.98	5.63
August	4.87	10.70	5.49
September	3.64	7.99	4.10
October	3.20	7.03	3.61
November	2.87	6.30	3.23
December	3.19	7.01	3.59
TOTALS =	45.53	91.10	51.30
		Calculations	Calculations

Values shown in yellow cells are linked to other locations within the Water Balance Program

Step 3 - Precipitation Data Soucre

Location of Precipitation Data:	Asheboro, NC
Staring Year of Data Record:	1933
Ending Year of Data Record:	1993
Period of Record (Years) =	60

Step 4

Source of Data:

USDA-NRCS County Soil Surveys (contact local NRCS office)

Important Note: Period of record for precipitation data should match period of record for temperature data

Enter Data ==>

Potential Evapo-Transpiration (PET) Worksheet

Choose PET Method: ☑ Thornthwaite Method ← Click on CheckBox → ☐ Manually Entered PET

Click on each step box

Thornthwaite PET Calculation

Step 1 | Step 2

Month	Mean monthly temp.	Daylight hours / 12	Heat index	Calculated PET
	(degrees F)			inches
January	41.3	0.87	1.05	0.30
February	43.8	0.85	1.51	0.44
March	51.6	0.06	3.25	0.07
April	60.6	1.09	5.76	2.47
May	68.1	1.21	8.19	4.05
June	75.0	1.21	10.67	5.42
July	78.0	1.23	11.82	6.15
August	77.0	1.16	11.44	5.59
September	71.3	1.03	9.32	3.96
October	60.9	0.97	5.85	2.24
November	51.7	0.86	3.27	1.05
December	43.1	0.85	1.37	0.40
		TOTALS =	73.50	32.14
		Calculations	Calculations	Calculations

Site Latitude (degrees): 35.42

within range

Source of Temperature Data

Step 3

Location of Precipitation Data:	Ashboro, NC
Staring Year of Data Record:	1933
Ending Year of Data Record:	1993
Period of Record (Years) =	60

Source of Data:

USDA-NRCS County Soil Surveys (contact local NRCS office)

Note: Period of record for Temperature data should match period of record for Precipitation data

Step 4

Calculations

Source of PET Data

Step 5

PET Data used in Water Balance
0.30
0.44
0.07
2.47
4.05
5.42
6.15
5.59
3.96
2.24
1.05
0.40
32.14

FYI 1

FYI 2

Step 6

Values shown in yellow cells are linked to other locations within the Water Balance Program

Influent, Lagoon Storage, and Zone Setup Worksheet

Calculate the adjusted influent loading by including the gains and losses from the Storage Lagoon, and set up the Spray Zones areas and individual Zone flowrates.

Click on each step box

Enter Data ==> | Pan Evap. Data | Precip

Step 1

Step 2

Area of Lagoon
acres

Lagoon Gains & Losses

Step 3

Design Daily Flow (Influent)
gals/day
14,000

Influent

Total Flow to be Disposed (Annual Averaged)
gals/day
14,000

should be equal

Step 4

Total Flow to All Zones
gals/day
14,000

Month	Days per month	Pan Evaporation Data	Adjusted Pan Data	Precip	Lagoon Gains from Precip.	Lagoon Losses from Evap.	Design Influent Volume per Month	Total: Influent + Lagoon Gains & Losses
		inches	inches	inches	gallons	gallons	gallons	gallons
January	31	1.10	0.77	4.15	0	0	434,000	434,000
February	28	1.09	0.76	4.17	0	0	392,000	392,000
March	31	3.42	2.39	0.03	0	0	434,000	434,000
April	30	5.36	3.75	3.91	0	0	420,000	420,000
May	31	6.21	4.35	4.41	0	0	434,000	434,000
June	30	6.01	4.84	4.42	0	0	420,000	420,000
July	31	7.29	5.10	5.63	0	0	434,000	434,000
August	31	6.44	4.51	5.49	0	0	434,000	434,000
September	30	5.10	3.57	4.10	0	0	420,000	420,000
October	31	3.59	2.51	3.61	0	0	434,000	434,000
November	30	2.23	1.56	3.23	0	0	420,000	420,000
December	31	1.68	1.18	3.59	0	0	434,000	434,000
			Calc		Calc	Calc	Calc	Calc
Totals	365	50.42	35.29	46.73	0	0	5,110,000	5,110,000

	Zone 1		Zone 2		Zone 3	
	Daily Flow to Zone 1	Wetted Acreage	Daily Flow to Zone 2	Wetted Acreage	Daily Flow to Zone 3	Wetted Acreage
	gals/day	acres	gals/day	acres	gals/day	acres
	7,000	3.27	3,000	7.11	4,000	3.02
	Irr. Rate (in/wk) =	0.55	Irr. Rate (in/wk) =	0.11	Irr. Rate (in/wk) =	0.34
Month	Zone 1 Volume to be Disposed	Zone 1 Design Irrigation per month	Zone 2 Volume to be Disposed	Zone 2 Design Irrigation per month	Zone 3 Volume to be Disposed	Zone 3 Design Irrigation per month
	gallons	inches	gallons	inches	gallons	inches
January	217,000	2.45	93,000	0.48	124,000	1.51
February	196,000	2.21	84,000	0.44	112,000	1.37
March	217,000	2.45	93,000	0.48	124,000	1.51
April	210,000	2.37	90,000	0.47	120,000	1.46
May	217,000	2.45	93,000	0.48	124,000	1.51
June	210,000	2.37	90,000	0.47	120,000	1.46
July	217,000	2.45	93,000	0.48	124,000	1.51
August	217,000	2.45	93,000	0.48	124,000	1.51
September	210,000	2.37	90,000	0.47	120,000	1.46
October	217,000	2.45	93,000	0.48	124,000	1.51
November	210,000	2.37	90,000	0.47	120,000	1.46
December	217,000	2.45	93,000	0.48	124,000	1.51
	Calc	Calc	Calc	Calc	Calc	Calc
Totals	2,555,000	28.80	1,095,000	5.67	1,460,000	17.81

Source of PAN Evap. Data

Step 6

Chapel Hill Station, Orange County

Sources for PAN Evaporation Data
Aurora Station, Beaufort County
Chapel Hill Station, Orange County
Other

Soils and Water Balance for Zone 1

Zone 1 Description: Wedowee

Soils Series Information for Zone 1 / Potential site limitations

Series Name	Drainage class	Water table depth (BLS)	risk of perching	Is bedrock < 60" BLS ?
Wedowee	well	>3.0	low	no

BLS = below land surface

Published soil permeability rates by series or textural class are not acceptable. Actual in-situ soils Ksat data is required.

Calculate Soil Drainage

Step 1: In-situ saturated vertical hydraulic conductivity (Ksat)		Step 2: Drainage factor (f)	f x Ksat: Soil Drainage Rate
in/hr	in/day	percent	in/day
0.30	7.08	0.060	0.42

Copied from Influent & Zones Setup Sheet:		
Daily Flow =	7,000	gals/day
Zone 1 Area =	3.27	acres

Click the "CALCULATE" button after making changes.

HELP

Month	Days per month	PET	Zone 1 Soil Drainage	Zone 1 Total Loss	Precip	Calculated Maximum Allowable Irrigation	Manual Override Maximum Allowable Irrigation	Actual Used Maximum Allowable Irrigation	Design Irrigation per Month	Monthly Excess	Zone 1 Cummulative Storage Required for Irrigation	Zone 1 Actual Monthly Irrigation Rate
		inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
January	31	0.30	13.17	13.47	4.15	9.33		9.33	2.45	6.88	0.00	2.45
February	28	0.44	11.89	12.34	4.17	8.17		8.17	2.21	5.96	0.00	2.21
March	31	0.07	13.17	13.24	0.03	13.21		13.21	2.45	10.76	0.00	2.45
April	30	2.47	12.74	15.22	3.91	11.31		11.31	2.37	8.94	0.00	2.37
May	31	4.05	13.17	17.22	4.41	12.81		12.81	2.45	10.36	0.00	2.45
June	30	5.42	12.74	18.16	4.42	13.74		13.74	2.37	11.38	0.00	2.37
July	31	6.15	13.17	19.32	5.63	13.69		13.69	2.45	11.24	0.00	2.45
August	31	5.59	13.17	18.76	5.49	13.27		13.27	2.45	10.83	0.00	2.45
September	30	3.96	12.74	16.70	4.10	12.60		12.60	2.37	10.23	0.00	2.37
October	31	2.24	13.17	15.40	3.61	11.80		11.80	2.45	9.35	0.00	2.45
November	30	1.05	12.74	13.79	3.23	10.56		10.56	2.37	8.19	0.00	2.37
December	31	0.40	13.17	13.57	3.59	9.97		9.97	2.45	7.53	0.00	2.45
			Calcs	Calcs		Calc. M.A.I.	Manual M.A.I.	M.A.I. Used		Calcs		
Totals:	365	32.14	155.05	187.19	46.73	140.46		140.46	28.80			28.80

FYI

Maximum Monthly Storage Required for the Irrigation of Zone 1:

inches		acres		gallons
0.00	over	3.27	=	0

Soils and Water Balance for Zone 2

Zone 2 Description: Helena-Santuc

Soils Series Information for Zone 2		Potential site limitations		
Series Name	Drainage class	Water table depth (BLS)	risk of perching	Is bedrock < 60" BLS ?
Helena	mod well	2.0-3.0	high	no

BLS = below land surface

Published soil permeability rates by series or textural class are not acceptable. Actual in-situ soils Ksat data is required.

Calculate Soil Drainage

Step 1		Step 2	f x Ksat
In-situ saturated vertical hydraulic conductivity (Ksat)		Drainage factor (f)	Soil Drainage Rate
in/hr	in/day	percent	in/day
0.09	2.16	0.060	0.13

Copied from Influent & Zones Setup Sheet:		
Daily Flow =	3,000	gals/day
Zone 2 Area =	7.11	acres

Click the "CALCULATE" button after making changes.

HELP

Month	Days per month	PET	Zone 2 Soil Drainage	Zone 2 Total Loss	Precip	Calculated Maximum Allowable Irrigation	Manual Override Maximum Allowable Irrigation	Actual Used Maximum Allowable Irrigation	Design Irrigation per Month	Monthly Excess	Zone 2 Cummulative Storage Required for Irrigation	Zone 2 Actual Monthly Irrigation Rate
		inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
January	31	0.30	4.02	4.32	4.15	0.18		0.18	0.48	-0.31	0.31	0.18
February	28	0.44	3.63	4.07	4.17	0.00		0.00	0.44	-0.44	0.74	0.00
March	31	0.07	4.02	4.09	0.03	4.06		4.06	0.48	3.58	0.00	1.22
April	30	2.47	3.89	6.36	3.91	2.45		2.45	0.47	1.99	0.00	0.47
May	31	4.05	4.02	8.06	4.41	3.66		3.66	0.48	3.18	0.00	0.48
June	30	5.42	3.89	9.30	4.42	4.89		4.89	0.47	4.42	0.00	0.47
July	31	6.15	4.02	10.17	5.63	4.54		4.54	0.48	4.06	0.00	0.48
August	31	5.59	4.02	9.61	5.49	4.12		4.12	0.48	3.64	0.00	0.48
September	30	3.96	3.89	7.85	4.10	3.75		3.75	0.47	3.28	0.00	0.47
October	31	2.24	4.02	6.25	3.61	2.65		2.65	0.48	2.17	0.00	0.48
November	30	1.05	3.89	4.93	3.23	1.70		1.70	0.47	1.23	0.00	0.47
December	31	0.40	4.02	4.42	3.59	0.82		0.82	0.48	0.34	0.00	0.48
			Calcs	Calcs		Calc M.A.I.	Manual M.A.I.	M.A.I. Used		Calcs		
Totals:	365	32.14	47.30	79.44	46.73	32.81		32.81	5.67			5.67

FYI

Maximum Monthly Storage Required for the Irrigation of Zone 2:

inches		acres		gallons
0.74	over	7.11	=	143,106

Soils and Water Balance for Zone 3

Zone 3 Description: Loulsburg

Soils Series Information for Zone 3		Potential site limitations		
Series Name	Drainage class	Water table depth (BLS)	risk of porching	Is bedrock < 60" BLS ?
Louisburg	excess-well	>3.0->5.0	low	no

BLS = below land surface

Published soil permeability rates by series or textural class are not acceptable. Actual in-situ soils Ksat data is required.

Calculate Soil Drainage

Step 1		Step 2	f x Ksat
In-situ saturated vertical hydraulic conductivity (Ksat)		Drainage factor (f)	Soil Drainage Rate
in/hr	in/day	percent	in/day
0.24	5.76	0.060	0.35

Copied from Influent & Zones Setup Sheet:		
Daily Flow =	4,000	gals/day
Zone 3 Area =	3.02	acres

Click the "CALCULATE" button after making changes.

HELP

Month	Days per month	PET	Zone 3 Soil Drainage	Zone 3 Total Loss	Precip	Calculated Maximum Allowable Irrigation	Manual Override Maximum Allowable Irrigation	Actual Used Maximum Allowable Irrigation	Design Irrigation per Month	Monthly Excess	Zone 3 Cummulative Storage Required for Irrigation	Zone 3 Actual Monthly Irrigation Rate
		inches	inches	inches	inches	inches	inches	inches	Inches	inches	inches	inches
January	31	0.30	10.71	11.02	4.15	6.87		6.87	1.51	5.36	0.00	1.51
February	28	0.44	9.68	10.12	4.17	5.95		5.95	1.37	4.58	0.00	1.37
March	31	0.07	10.71	10.79	0.03	10.76		10.76	1.51	9.24	0.00	1.51
April	30	2.47	10.37	12.84	3.91	8.93		8.93	1.46	7.47	0.00	1.46
May	31	4.05	10.71	14.76	4.41	10.36		10.36	1.51	8.84	0.00	1.51
June	30	5.42	10.37	15.78	4.42	11.37		11.37	1.46	9.90	0.00	1.46
July	31	6.15	10.71	16.87	5.63	11.23		11.23	1.51	9.72	0.00	1.51
August	31	5.59	10.71	16.30	5.49	10.82		10.82	1.51	9.31	0.00	1.51
September	30	3.96	10.37	14.33	4.10	10.23		10.23	1.46	8.76	0.00	1.46
October	31	2.24	10.71	12.95	3.61	9.34		9.34	1.51	7.83	0.00	1.51
November	30	1.05	10.37	11.41	3.23	8.18		8.18	1.46	6.72	0.00	1.46
December	31	0.40	10.71	11.11	3.59	7.52		7.52	1.51	6.01	0.00	1.51
			Calcs	Calcs		Calc. M.A.I.	Manual M.A.I.	M.A.I. Used		Calcs		
Totals:	365	32.14	126.14	158.28	46.73	111.55		111.55	17.81			17.81

FYI

Maximum Monthly Storage Required for the Irrigation of Zone 3:

inches		acres		gallons
0.00	over	3.02	=	0

Zonal Storage Summations

OBJECT: To calculate the minimum wet weather storage required for a multiple zoned spray irrigation site.

		Zone 1		Zone 2		Zone 3		Zone 4		Zone 5	
Zone Description ==>		Wadowes		Helena-Santuc		Louisburg					
Predominant Soils ==>		Wadowes		Helena		Louisburg		Lynchburg			
Daily Flow to Zone ==>		7,000	gpd	3,000	gpd	4,000	gpd	0	gpd	0	gpd
Wetted Acreage ==>		3	acres	7	acres	3	acres	0	acres	0	acres
Month	Days per month	0.06		Cummulative Storage Required		Cummulative Storage Required		Cummulative Storage Required		Cummulative Storage Required	
		inches	gallons	inches	gallons	inches	gallons	inches	gallons	inches	gallons
January	31	0.00	0	0.31	59,106	0.00	0	0.00	0	0.00	0
February	28	0.00	0	0.74	143,106	0.00	0	0.00	0	0.00	0
March	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
April	30	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
May	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
June	30	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
July	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
August	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
September	30	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
October	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
November	30	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
December	31	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0

	Zone 6		Zone 7		Zone 8		Zone 9		Zone 10		Totals
Zone Description ==>											Design Daily Influent (gpd) = 14,000
Predominant Soils ==>											
Daily Flow to Zone ==>	0	gpd	0	gpd	0	gpd	0	gpd	0	gpd	Total Flow Disposed (gpd) = 14,000
Wetted Acreage ==>	0	acres	0	acres	0	acres	0	acres	0	acres	Total Area (acres) = 13.40
Month	Cummulative Storage Required		Cummulative Storage Required		Cummulative Storage Required		Cummulative Storage Required		Cummulative Storage Required		Cummulative Storage Required
	inches	gallons	inches	gallons	inches	gallons	inches	gallons	inches	gallons	gallons
January	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	59,106
February	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	143,106
March	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
April	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
May	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
June	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
July	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
August	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
September	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
October	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
November	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
December	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0

Minimum Required Storage (gallons) → 143,106

Minimum Storage = 143,106 gallons divided by 14,000 gpd = 10.2 days

FYI | FYI Minimum Required Storage

Calculations:

Listed below are all the calculations used in the Spray Irrigation Water Balance Program, excluding the macros.

Note:
(Units are indicated in italics)

Please note, that the actual values stored and used in the water budget calculations are not rounded off to the number of decimal figures actually displayed. Hand computations will vary from those displayed. The net output, in terms of storage requirements, spray field areas, and hydraulic loading rates will not be significantly different, however.

Precipitation Worksheet

0.06

Percent of Mean Annual Precipitation

Percent of Mean Annual Precipitation *(unit-less)* = [Mean Monthly Rainfall *(inches)* divided by Mean Annual Rainfall *(inches)*] times 100

example:
If the mean monthly precipitation for January is 5 *inches*, with a mean annual precipitation of 68 *inches*, then
the Percent of Mean Annual Precipitation for January
= [5 *inches* divided by 68 *inches*] times 100
= .073529 times 100
= 7.35 *percent*

80th Percentile Monthly Precipitation

80th Percentile Monthly Precipitation *(inches)* = [Percent of Mean Annual Precipitation *(unitless)* divided by 100] times 80th Percentile Year Precipitation *(inches)*

example:
if the Percent of Mean Annual Precipitation is 7.35 percent for January (continuing from above), and the 80th Percentile Year Precipitation is 75 *(inches)*, then the 80th Percentile Monthly Precipitation
= [7.3529 divided by 100] times 75 *(inches)*
= .073529 times 75 (inches)
= 5.51 *(inches)*

Potential Evapo-Transpiration Worksheet (Thornthwaite Method)

(note this is an empirically derived set of relationships)

Daylight Hours / 12 (a comparison between the average length of days by month)

Daylight Hours / 12$_{\text{January}}$ = [[[.87-0.9] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 0.9
Daylight Hours/ 12$_{\text{February}}$ = [[[.85-.87] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 0.87
Daylight Hours/12$_{\text{March}}$ = [[[1.03-1.03] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 1.03
Daylight Hours/ 12$_{\text{April}}$ = [[[1.09-1.08] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 1.08
Daylight Hours/ 12$_{\text{May}}$ = [[[1.21-1.18] / [35 *(degrees)* - 30 (degrees)]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 1.18
Daylight Hours/ 12$_{\text{June}}$ = [[[1.21-.1.17] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 1.17
Daylight Hours/ 12$_{\text{July}}$ = [[[1.23-1.2] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 1.2
Daylight Hours/ 12$_{\text{August}}$ = [[[1.16-1.14] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 1.14
Daylight Hours/12$_{\text{September}}$ = [[[1.03-1.03] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 0.9
Daylight Hours/ 12$_{\text{October}}$ = [[[.97-.98] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 0.98
Daylight Hours/ 12$_{\text{November}}$ = [[[.86-.89] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 0.89
Daylight Hours/ 12$_{\text{December}}$ = [[[.85-.88] / [35 *(degrees)* - 30 *(degrees)*]] times [Site Lattitude *(degrees)* - 30 *(degrees)*]] + 0.88
* *(degrees north lattitude)*

example:
If the site to be used is located at 36.5 *degrees (north lattitude)*, then the number of daylight hours / 12 for January
= [[[.87-.9] /[35 *(degrees)* - 30 *(degrees)*]] times [36.5 *(degrees)* - 30 *(degrees)*] +0.9,
= [[-.03 /5 *(degrees)*] times 6.5 *(degrees)*] + 0.9
= [-.006 times 6.5] + 0.9
= .861 *(unit less)*

Heat Index

Heat index *(degrees F)* = [Mean Monthly Temperature *(degrees F)* -32 *(degrees F)* / 9] raised to the power of 1.514

example:
The heat index for January (location near 36 degrees lattitude)
=[43.5 *(degrees F)* - 32 *(degrees F)*/ 9]1.514
=[11.5 *(degrees F)*/ 9]1.514
=[1.2778 *(degrees F)*]1.514
=1.4494 *(degrees F)*

Calculated PET

PET *(inches)*=[[0.63 times Daylight Hours / 12 *(hours)*] times [[[50 times [Mean Monthly Temperature *(degrees F)*-32 *(degrees F)*]] divided by [9 times TOTAL Heat Index *(degrees F)*]] raised to [0.000000675 times [Total Heat Index ^{3}*(degrees F)*]-0.0000771 times [Total Heat Index ^{2}*(degrees F)*]+ [0.01792 times TOTAL Heat Index *(degrees F)*] +0.49239]]]

example:
The Calculated PET for January
= [[.63 times .86 *(hours)*] times [[[50 times [43.5 *(degrees F)*- 32 *(degress F)*]] divided by [9 times 74.06 *(degress F)*]] raised to [.000000675 times 74.06 *(degress F)*] -[.0000771 times 74.06 *(degrees F)*] + [.01792 times 74.06 *(degrees F)*] +0.49239]]]

=.5418 *(hours)* times [[[50 times 11.5 *(degrees F)*] divided by 666.54 *(degrees F)*] raised to[.27419207 *(degrees F)*- .42288453 *(degrees F)* + 1.3271552 +0.49239]]
=.5418 *(hours)* times [[575 *(degrees F)* divided by 666.54 *(degrees F)*] raised to 1.67085274]
=.5418 *(hours)* times [.86266391 *(degrees F)* raised to 1.67085274]
=.5418 *(hours)* times .78126939
=.4234

Influent+Zones Setup Worksheet

Adjusted Pan Data

Adjusted Pan Data *(inches)* = Pan Evaporation Data *(inches)* times 70 *percent*

example:
The Adjusted Pan Data for January *(inches)*
= 1.3 *(inches)* times .70
= .91 *(inches)*

Lagoon Losses

Lagoon Losses *(gallons)* = Adjusted Pan Data *(inches)* times Area of Lagoon *(acres)* times 27,152 *(gallons per acre-inch)*

example:
The Lagoon Losses in January with an adjusted pan of .91 *(inches)* and a lagoon 2 *(acres)* in size
=[.91 *(inches)* times 2 *(acres)*] times 27,152 *(gallons per acre-inch)*
= 1.82 *(acre-inches)* times 27,152 *(gallons per acre-inch)*
= 49,416.64 *(gallons)*

Lagoon Gains

Lagoon Gains *(gallons)* = Precipitation *(inches)* times Area of Lagoon *(acres)* times 27,152 *(gallons per acre-inch)*

example:
The Lagoon Gains in January with a precipitation of 4.71 *(inches)* and a lagoon 2 *(acres)* in size
=[4.71 *(inches)* times 2 *(acres)*] times 27,152 *(gallons per acre-inch)*
= 9.42 *(acre-inches)* times 27,152 *(gallons per acre-inch)*
= <u>255,771.84</u> *(gallons)*

Design Influent Volume per month

Design Influent Volume per month *(gallons)* = Design Daily Influent Volume *(gallons per day)* times Days per Month

example:
Design Influent Volume per month *(gallons)* for January with a Design Daily Influent Volume of 10,000 *(gallons per day)*

= 10,000 *(gallons per day)* times 31 *(days)* $_{\text{January}}$
= <u>310,000</u> *(gallons)*

Total Volume to be Disposed

Total Volume to be Disposed *(gallons)* = Design Influent Volume per month *(gallons)* - Lagoon Losses *(gallons)* + Lagoon Gains *(gallons)*

example:
Continuing with the three previous examples above, the Total Volume to be Disposed in January with an Design Daily Influent Volume of 10,000 *(gallons per day)*

= 310,000 *(gallons)* - 49,417 *(gallons)* + 255,772 *(gallons)*
= <u>516,355</u> *(gallons)*

Design Irrigation per month (for a particular Zone)

In this proceedure the Volume to be Disposed for each Zone is converted to an irrigation rate based on the application area available.

Design Irrigation per month (inches) =[Volume to be Disposed *(gallons)* divided by 27,152 *(gallons per acre-inch)*] divided by the Area of Spray Field *(acres)* for particular Zone

example:

Assume: Zone 1 irrigates 7,000 gpd over 8 acres
Assume: Zone 2 irrigates 10,000 gpd over 15 acres

Total Volume disposed by Zone 1 = 7,000 gpd *times 31 days (in January) = 217,000 gallons disposed in January*
Total Volume disposed by Zone 2 = 10,000 gpd *times 31 days (in January) = 310,000 gallons disposed in January*

Hydraulic Loading Rates for Zone 1 = 217,000 gallons divided by 27,152 (gallons per acre-inch)] divided by 8 (acres)
Hydraulic Loading Rates for Zone 1 = 1.00 inches in January

Hydraulic Loading Rates for Zone 2 = 310,000 gallons divided by 27,152 (gallons per acre-inch)] divided by 15 (acres)
Hydraulic Loading Rates for Zone 2 = 0.76 inches in January

Zone 1 through Zone 10 Worksheets

In-situ Ksat

In-situ Ksat *(inches per day)* = In-situ Ksat *(in per hour)* times 12

Calculated Soil Drainage Rate

Calculated Soil Drainage Rate *(inches per day)* = In-situ Ksat *(in per day)* times [Soil Drainage Factor *(unitless)* divided by 100]

example:
The Calculated Soil Drainage Rate of a soil with a Ksat of 15 *(inches per day)* and a Soil Drainage Factor of 0.03
= 15 *(inches per day)* times 0.03
= .45 *(inches per day)*

Calculated Soil Drainage

Calculated Soil Drainage *(inches)* = Calculated Soil Drainage Rate *(inches per day))* times Days Per Month

example:

The Calculated Soil Drainage of a soil with a Calculated Soil Drainage Rate of .45 *(inches per day)* in January
= .45 *(inches per day)* times 31 *(days)*
= <u>13.95</u> *(inches)*

Total Loss

Total Loss *(inches)* = PET *(inches)* + Soil Drainage *(inches)*

example:
The Total Loss for the month of January (Calculated PET =.42 (inches)) with a Calculated Soil Drainage of 13.95 (inches)
= .42 *(inches)* + 13.95 *(inches)*
= <u>14.37</u> *(inches)*

Maximum Allowable Irrigation

Maximum Allowable Irrigation *(inches)* = Total Loss *(inches)* - Precipitation *(inches)*

example:
The Maximum Allowable Irrigation for the month of January (Mean Monthly Precipitation = 4.25 *(inches)*)
= 14.37 *(inches)* - 4.25 *(inches)*
= <u>10.12</u> *(inches)*

Monthly Excess

Monthly Excess *(inches)* = Maximum Allowable Irrigation *(inches)* = Total Volume to be Disposed *(inches)*

example:
The Monthly Excess for the month of January (Total Volume to be Disposed = .95 *(inches)*)
= 10.12 *(inches)* - .95 *(inches)*
= <u>9.17</u> *(inches)*

Zonal Sums Worksheet

Cummulative Storage Required

This calculation converts the cummulative storage in inches from each Water Balance back to gallons, based on the specific application area of each zone, so that a cummulative storage across all zones can be determined.

Cummulative Storage Required *(gallons)* $_{\text{each zone}}$ = [Cummulative Storage Required *(inches)* times Area of Spray Field *(acres)*] times 27,152 *(gallons per acre-inch)*

example:
The Cummulative Storage Required conversion from inches to gallons for .25 *(inches)*, over an application area of 20 *(acres)*
= [.25 (inches) times 20 (acres)] times 27,152 *(gallons per acre-inch)*
= 5 (acre-inches) times 27,152 (gallons per acre-inch)
= 135,760 (gallons)

end