CHAPTER II. LITTLE WASHITA WATERSHED

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A. GENERAL HISTORY AND CHARACTERIZATION

A tributary of the Washita River in southwest Oklahoma, the Little Washita Watershed (Fig. 11-1) is unique in that over a period of several years it has been the target of extensive research. In 1936 the eastern portion of the watershed was chosen as part of a national demonstration project for soil erosion control. In the late 1930's the Civilian Conservation Corps (CCC) did extensive erosion control work, such as terracing, drop structure building, gully plugging, and tree planting. Since establishing county offices in the 1940's, the U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) has applied extensive soil and water conservation Structures and measures, including terraces, diversions, farm ponds, floodwater-retarding reservoirs, gully plugging and smoothing, scrub timber removal, and land use planning.

In 1961 the USDA's Agricultural Research Service (ARS), in compliance with U.S. Senate Document 59 (1959), began collecting hydrologic data an the Little Washita Watershed and other watersheds in the vicinity to determine the downstream hydrologic impacts of the SCS floodwater-retarding reservoirs. This data collection process involved an intensive rain gauge network and a stream gauging station near the watershed outlet that provided data on continuous flow, suspended sediment transport, and to a limited extent, water quality. Data on groundwater levels and channel geometry were also collected to determine possible effects of the treatment program. A more complete summary of the characteristics of the Little Washita Watershed and the research data and findings is contained in Allen and Naney (I991).

In 1978 this watershed was one of seven watersheds chosen across the Nation for the Model Implementation Project (MIP), which was jointly sponsored and administrated by the USDA and the U.S. Environmental Protection Agency (EPA). The main objective of the MIP was to demonstrate the effects of intensive land conservation treatments on water quality in watersheds that are larger than about 25 square miles.

The Little Washita Watershed covers 235.6 square miles and is a tributary of the Washita River in southwest Oklahoma. The watershed is in the southern part of the Great Plains of the United States. The climate is classified as moist and subhumid, and the average annual rainfall was 29.42 inches for the period of data collection by the ARS.

Summers are typically long, hot, and relatively dry. The average daily high temperature for July is 94 degrees Fahrenheit, and the average accumulative rainfall for July is 2.22 inches. Winters are typically short, temperate, and dry but are usually very cold for a few weeks. The average daily low temperature for January is 24 degrees Fahrenheit, and the average accumulative precipitation for January is 11.07 inches. Much of the annual precipitation and most of the large floods occur in the spring and fall. A more detailed review of the climate and its variability for this watershed and the surrounding area is contained in Staff (1983).

The watershed landuse areas can be grouped into 8 categories; range, pasture, forest, cropland, oil waste land, quarries, urban/highways, and water. The watershed is shown in a SPOT false color image (Fig. II-2) obtained July 3, 1992, approximately two weeks after the Washita '92 experimental period. County lines are overlain in green and major highways in yellow. As usual in false color imagery, the deep reds indicate healthy growing vegetation and the dull greens indicate absence of vegetation. The black areas indicate water bodies. Figure 11-3 is a land cover map of the watershed derived from the MIADS 200 meter data base.

The bedrock exposed in the watershed consists of Permian age sedimentary rocks. The formations, as reported by Davis (1955), dip gently to the southwest, but the surface drainage is generally to the east. The oldest formation in the watershed, the Chickasha formation, outcrops in the eastern or outlet side of the watershed and comprises 4.6 percent of the total watershed area. As reported by Davis (1955), the Chickasha formation is several hundred feet thick, is relatively impermeable, and consists of a heterogeneous mixture of sandstones, shales, and siltstones. The Dog Creek and Blaine formations, which are undifferentiated and overlie the Chickasha formation, outcrop in 8.0 percent of the watershed and consist of dark red evenbedded shales interbedded with fine-grained gypsiferous sandstones that locally grade into pure gypsum. The Marlow formation overlies the Dog Creek and Blaine formations, comprises 14.2 percent of the watershed, and consists mostly of evenbedded, brick-red sandy shale that is gypsiferous. Near the middle of the Marlow formation lies the Verden sandstone member, which consists of cross bedded dolomitic sandstone that is about 10 feet thick and one-quarter mile wide. The Rush Springs formation overlies the Marlow formation, outcrops in a central portion of the watershed, and comprises 45.6 percent of the watershed area. The Rush Springs formation consists of fine-grained sandstone and siltstone strata that are even to highly crossbedded. The Cloud Chief formation, outcrops in this watershed as outliers, so only its lower parts can be seen. Alluvial deposits generally cover the bedrock valleys throughout the watershed. The alluvium covers approximately 1 1 percent of the total area of the watershed.

Surveys of the soils in the watershed have been made by the SCS and published (Bogard et al. 1978, Moffatt 1973, Mobley et al. 1967). In these surveys 64 different soil series were defined for the watershed, and 162 soil phases were mapped within these soil series to reflect differences in surface soil textures, slopes, stoniness, degree of erosion, and other characteristics that affect land use. These survey publications also provide information associated with each soil series, such as depth to bedrock, typical texture found at each depth, permeability, available water capacity, pH, shrink-swell potential, corrosivity, and suitability for use in construction projects, such as road fill, pond embankments, building foundations, and septic tank filter fields. Hydrologic soil groups are also listed along with estimated average crop yields for each series under irrigated and nonirrigated conditions. This information is summarized in the soil texture map (Fig. 11 4) derived from the MIADS 200 meter data base.

Except for a few rocky, steep hills near Cement, OK, the upland topography is gently to moderately rolling. Maximum relief in the watershed is only about 600 feet. The flatter upland soils are those developed from the finer textured Dog Creek Shale and Blaine Formations near the eastern end of the watershed and those developed from the Cloud Chief Formation in the western portion of the watershed. The alluvial areas have the flattest slopes, usually 1 percent or less. The channel system is well developed throughout the watershed and extends nearly to the drainage divide in most areas, so the watershed is well drained except for a few alluvial areas. Drainageways in the western third of the watershed have eroded through the Cloud Chief Formation into the less erosion resistant, underlying Blush Springs Sandstone. Incised channels in the Rush Springs Sandstone are up to 60 to 70 feet deep. The ARS historic data is available on request from:

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USDA-ARS Hydrology Laboratory
Room 104, Bldg. 007, BARC-West
Beltsville, MD 20705 2350

B. REFERENCES

Allen, P.B. 1986. Drainage density versus runoff and sediment yield. In Y.H. Kuo, D.K. Leifeste, and D.S. O'Connor (eds.), Proc. Fourth Fed. Interagency Sedimentation Conf., Subcomm. on Sedimentation, Interagency Advisory Comm. on Water Data, Las Vegas, NV, March 24-27, pp.3-38-3-44. U.S. Govt. Printing Off., Washington, DC.

Bogard, V.A., Fielder, A.G., and Meinders, H.C. 1978. Soil survey of Grady County, Oklahoma. U.S. Soil Conserv. Serv. Pub., 104 pp.

Brakensiek, D.L., Osborn, H.B., and Rawls, W.J. 1979. Field manual for research in agricultural hydrology. U.S. Dept. Agric. Handb. 224, 550 pp.

Corbett, D.M, (ed.). 1943. Stream-gaging procedure. A manual describing methods and practices of the Geological Survey. U.S. Geol. Surv. Water-Supply Paper 888, 245 pp.

Cummings, T.R. 1963. Chemical character of surface waters in Oklahoma 1957 58. Okla.Div. Water Resour. Bull. 19, 165 pp.

Cummings, T.R. 1964. Chemical character of surface waters in Oklahoma 1958-59. Okla.Div. Water Resour. Bull. 20, 133 pp.

Cummings, T.R. 1965a. Chemical character of surface waters in Oklahoma 1960-61. Okla. Div. Water Resour. Bull. 23, 178 pp.

Cummings, T.R. 1965b. Chemical character of surface waters in Oklahoma 1961-62. Okla. Div. Water Resour. Bull. 24, 203 pp.

Cummings, T.R. 1966. Chemical character of surface waters in Oklahoma 1962-63. Okla. Div. Water Resour. Bull. 30, 200 pp.

Davis, L.V. 1955. Geology and ground water resources of Grady and northern Stephens counties, Oklahoma. Oklahoma Geol. Surv. Bull. 73, 184 pp.

Dover, T.B. 1953. Chemical character of surface waters in Oklahoma 1950-51. Okla. Div. Water Resour. Bull. 7, 88 pp.

Dover, T.B. 1954. Chemical character of surface waters of Oklahoma 1951-52. Okla. Div. Water Resour. Bull. 10, 115 pp.

Dover, T.B. 1956. Chemical character of surface waters of Oklahoma 1953-54. Okla. Div. Water Resour. Bull. 14, 141 pp.

Dover, T.B. 1958. Chemical character of surface waters of Oklahoma 1954-55. Okla. Div. Water Resour. Bull. 15, 117 pp.

Dover, T.B. 1959. Chemical character of surface waters of Oklahoma 1955-56. Okla. Div. Water Resour. Bull. 16, 114 pp.

Drake, L., Solomon, L.A., and Birdwell, H. Circa 1977. History of conservation in Oklahoma. Oklahoma Assn. Conserv. Districts Pub., Quintella Printing, Oklahoma City, 63 pp.

Foreman, G. 1937. Adventure on Red River. 199 pp. Univ. of Okla. Press, Norman, OK.

Hartman, M.A., Ree, W.O., Schoof, R.R., and Blanchard, B.J. 1967. Hydrologic influences of a flood control program. Am. Soc. Civ. Eng. J. 93:17-25.

Loesch, T.N. 1988. The use of satellite remote sensing and geographic information systems in a rural watershed hydrologic model. U. of OK. M.S. thesis, 120 pp.

Menzel, R.G., Smith, S.J., and Welch, N.H. 1986. Effects of impoundments on nutrient concentrations. In Y. H. Kuo, D. K. Leifeste, and D.S. O'Connor (eds.), Proc. Fourth Fed. Interagency Sedimentation Conf., Subcomm. on Sedimentation, Interagency Advisory Comm. on Water Data, Las Vegas, NV, March 24-27, 1986, pp. 7-21-7-30. U.S. Govt. Printing Off., Washington, DC.

Miller, A.M. 1984. Comparison of manual base flow separation techniques to a computer baseflow separation program and application to six drainage basins. Okla. State Univ. M.S. thesis, 161 pp.

Mobley, H.L., and Brinley, R.C. 1967. Soil survey of Comanche County, Oklahoma. U.S. Soil Conserv. Serv. Pub., 58 pp.

Moffatt, H.H. 1973. Soil survey of Caddo County, Oklahoma. U.S. Soil Conserv. Serv. Pub., 70 pp.

Murphy, J.J. 1955. Chemical character of surface water of Oklahoma 1952-53. Okla. Div. Water Resour. Bull. 11, 128 pp.

Naney, J.W., and Smith, S.J. 1983. Geologic and land-use effects on ground-water quality in shallow wells of the Anadarko Basin. Okla, Geol. Surv., Okla. Geol. Notes 43:100-109.

Naney, J.W., Smith, S.J., and Berg, W.A. 1983. Geologic and management effects on ground water quality of Oklahoma grasslands. Okla. Geol. Notes 45:224.

Naney, J.W., Smith, S.J., and Berg, W.A. 1984. Management and geologic effects on ground water quality of agricultural lands in the Southern Plains. In M.A. Collins, ed., Proc. Conf. Water for the 21st Century: Will it be There?, center for Urban Water Studies, Southern Methodist Univ., Apr. 3-5, 1985, pp. 638-648. Freshwater Soc., Dallas, TX.

Naney, J.W., Smith, S.J., and Bingaman, S.C., Jr. 1979. Water quality before MIP in Oklahoma. In K.G. Renard (ed.), Proc. ASCE Specialty Conf. on Irrig. and Drainage in the Nineteen-eighties, Albuquerque, NM, July 17-20, 1979, pp. 393-400. Am. Soc. Civ. Eng. J. Hydraul. Div., New York, NY.

Nicks, A.D., Schoof, R.R., and Allen, P.B. 1986. Off site sediment impacts using basin scale simulation. In Y.H. Kuo, D.K. Leifeste, and D.S. O'Connor (eds.), Proc. Fourth Fed. Interagency Sedimentation Conf., Subcomm. on Sedimentation, interagency Advisory Comm. on Water Data, Las Vesga, NV, March 24-27, 1986, pp. 6-137-6-147. U.S. Govt. Printing Off., Washington, DC.

Nicks, A.D., Williams, J.R., and Arnold, J.A. 1985a. SWRRB80: A basin scale model for microcomputers. Specialty Conf. In W.R. Waldrop (ed.), Hydraulics and Hydrology in the Small Computer Age, Lake Buena Vista, FL, August 12-17, 1985, pp. 1407-1412. Am. Soc. Civ. Eng. J. Hydraul. Div., New York, NY.

Nicks, A.D., Williams, J.R., and Schoof, R.R. 1985b. Modeling off-site impacts. In E.B. Jones and T.J. Ward (eds.), Watershed Management in the Eighties, ASCE Symposium Proceedings, Denver, Colorado, April 30-May 1, 1985. pp. 199-206. Am. Soc. Civ. Eng. J. Hydraul. Div., New York, NY.

Pettyjohn, W.A., and Henning, R. 1979. Preliminary estimate of regional effective ground-water recharge rates in Ohio. Ohio State Univ. Water Resour. Cent. Proj. Compl. Rep. 522, 323 pp.

Schoof, R.R., Gander, G.A., and Welch, N.H. 1987. Effect of floodwater-retarding reservoirs on selected channels in Oklahoma. J. Soil Water Conserv. 42:124-127.

Schoof, R.R., Thomas, W.O., and Boxley, W.M. 1980, Hydrologic effects of the flood abatement program in southwestern Oklahoma. Water Resour. Bull. 16, 1144 pp.

Smith, S.J., McHenry, J.R., Menzel, R.G., and Welch, N.H. 1986. Agricultural chemicals and heavy metals in upland soils and valley alluviums of the Little Washita River Basin. J. Soil Water Conserv. 41:333-336.

Smith, S.J., Naney, J.W., and Berg, W.A. 1985. Nonpoint source impacts on ground water quality in major land resource areas of the Southwest. Perspectives on Nonpoint Source Pollution, EPA 440/5-85-001.

Smith, S.J., Naney, J.W., and Berg, W.A. 1987. Nitrogen and ground water protection. In D.M. Fairchild (ed.), Ground Water Quality and Agricultural Practices, pp. 367-374. Lewis Publishers, Chelsea, MI.

Staff, Water Quality and Watershed Research Laboratory. 1983. Hydrology, erosion, and water-quality studies in the Southern Great Plains Research Watershed, Southwestern Oklahoma, 1961-78. U.S. Dept. Agric., Agric. Res. Serv. Rep. ARM-S-29, 175 pp.

U.S. Geological Survey. 1968. Surface-Water Records of Oklahoma.

U.S. Geological Survey. 1969. Surface-Water Records of Oklahoma.

U.S. Geological Survey. 1970. Surface-Water Records of Oklahoma.

U.S. Geological Survey. 1971. Surface-Water Records of Oklahoma.

Walling, I.W. 1949. Chemical character of surface waters in the Washita River Basin of Oklahoma, 1946-47. Okla. Div. Water Resour. Bull. 6, 70 pp.

Walling, I.W., Schoff, S.L., and Dover, T.B. 1951. Chemical character of surface waters in Oklahoma, 1946-49. Okla. Div. Water Resour. Bull. 5, 180 pp.

Williams, J.R., and Nicks, A.D. 1985. SWRRB, A simulator for water resources in rural basins: An overview. In D.G. DeCoursey (ed.), Proc. Nat. Resour. Model. Symp., Pingree Park, CO, October 16-21, 1983, pp. 17-24. USDA-ARS. ARS-30.

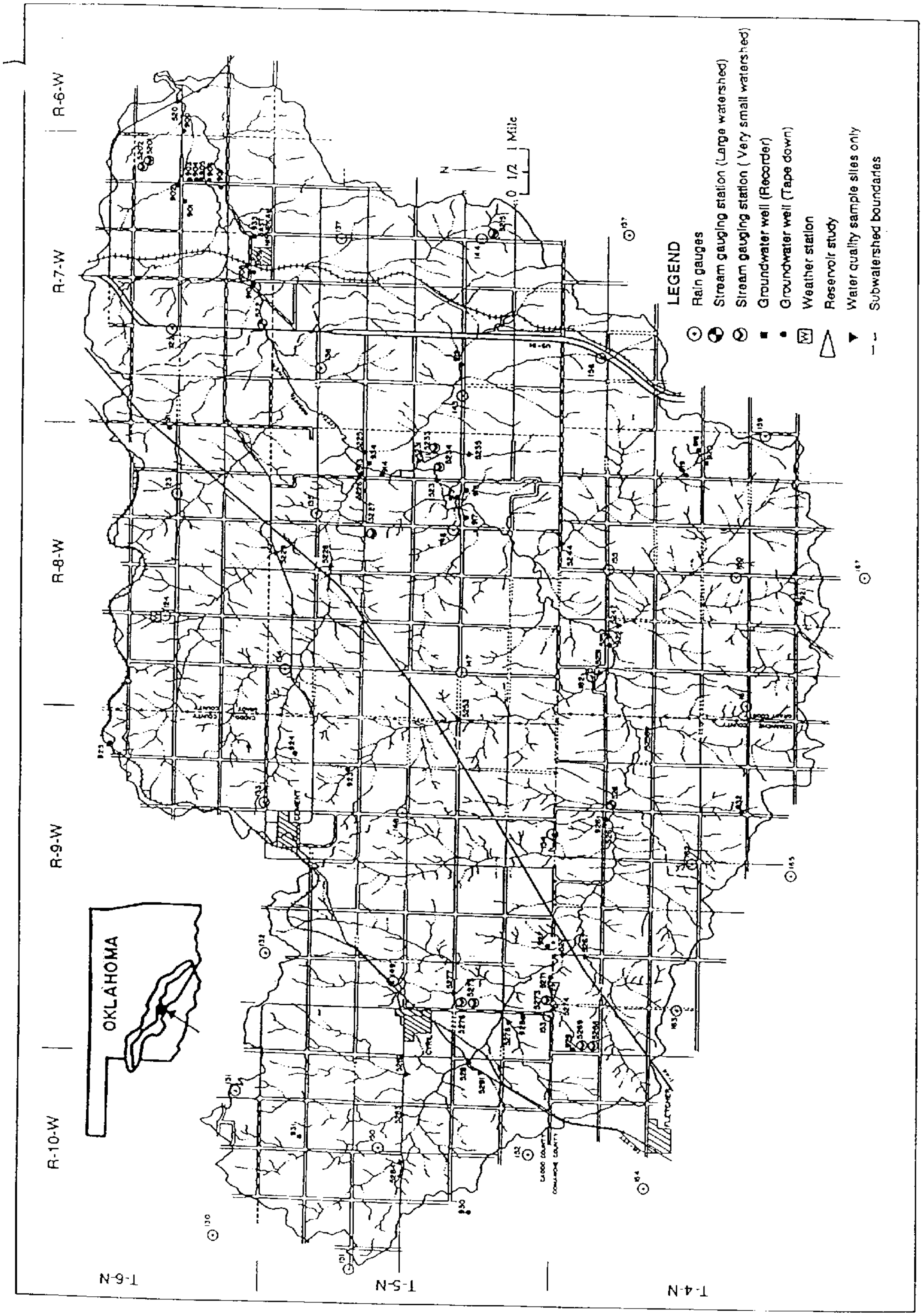

Figure II-1. Locations of climatologic and hydrologic instruments and gauges in the watershed.

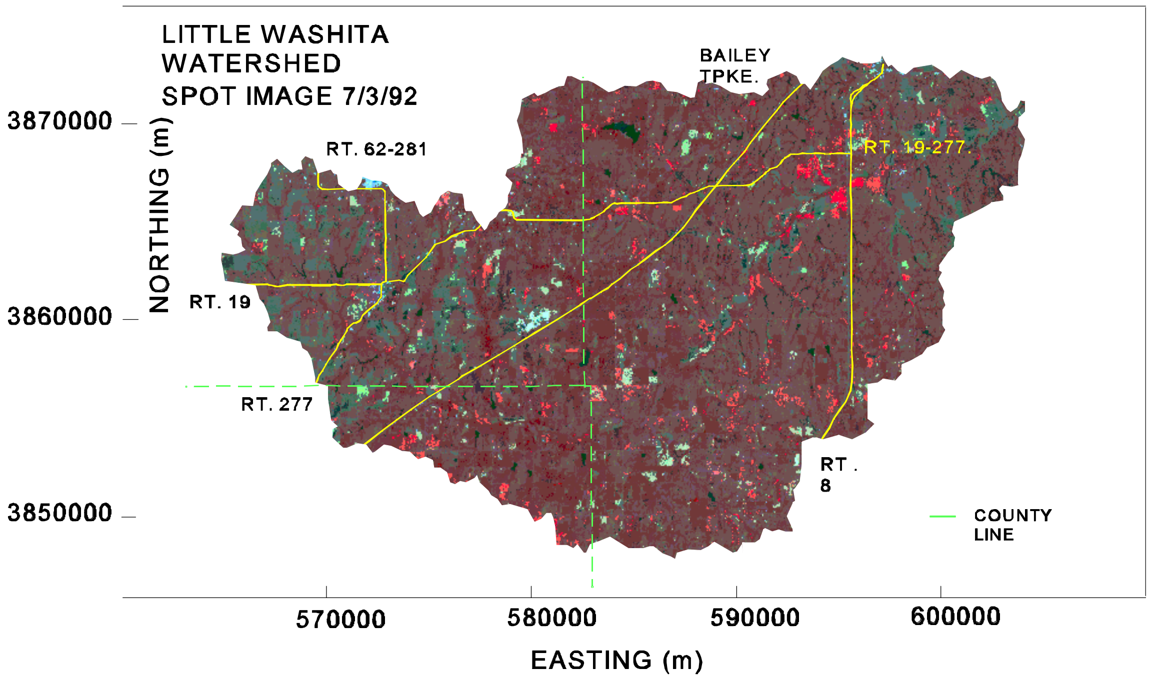

Figure II-2. SPOT satellite false color composite of the Little Washita Watershed obtained July 3, 1992.

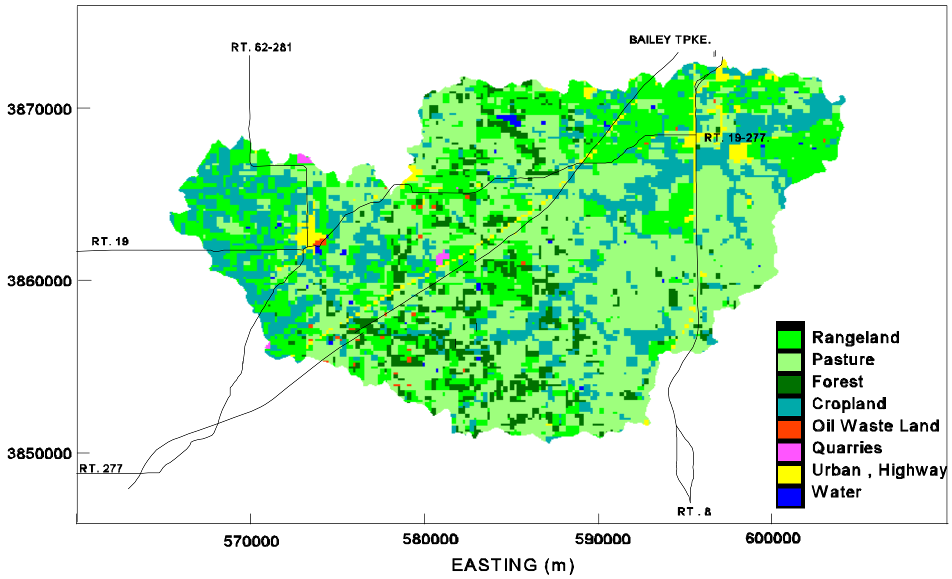

Figure II-3. Little Washita Watershed land use map derived from MIADS 200 m data base.

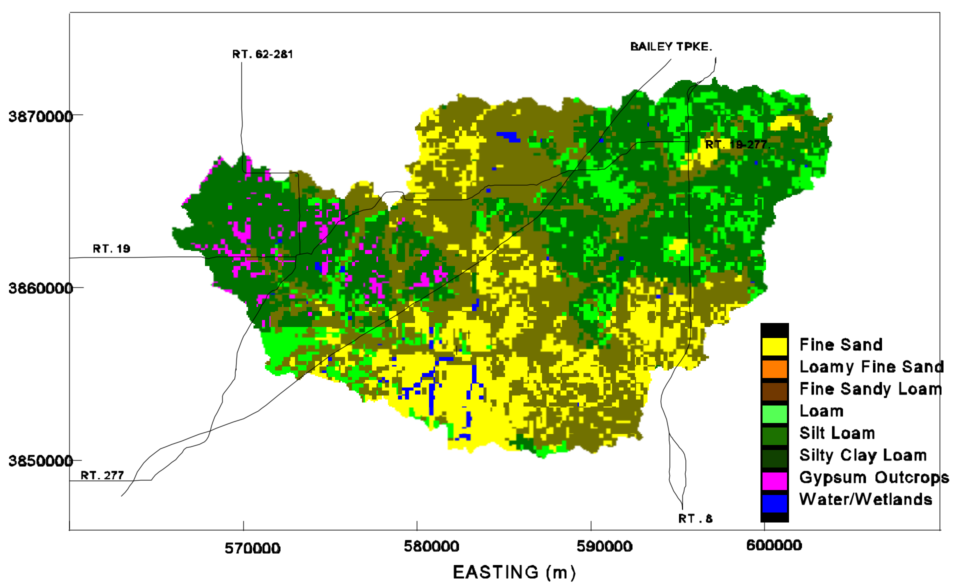

Figure II-4. Little Washita Watershed soil texture map derived from MIADS 200 m data base.