APPENDIX A
TERMINOLOGY

In order to properly understand and focus on the issues, one must first define some basic terms. The article Irrigation Water Salinity and Crop Production, by Stephen R. Grattan (SJRG Exh-02) provides an excellent, general, simple discussion of basic concepts relating to electrical conductivity, irrigation, and crop yields.

Irrigation water salinity (EC_w) is the electrical conductivity ("EC") of irrigation water.[1] (SJRG Exh-02, p2.)

Irrigation soil salinity (EC_e) is the EC of the soil water. (Id.)

Infiltration is the downward entry of water into the immediate soil surface. (United States Department of Agriculture, San Joaquin County Soil Survey (1992), p260.) The *infiltration rate* is the rate at which water penetrates the surface of the soil. (Id.) *Percolation,* by comparison, is the rate of movement of water through soil layers. (San Joaquin County Soil Survey, p261.) Infiltration rate is usually expressed as inches or millimeters of water per hour. (Id., p260.) An infiltration rate of 3 mm/hour is considered very slow, while an infiltration rate of 12 mm/hour or more is considered high. (R.S. Ayers and D. W. Westcot, Water Quality For Agriculture §3.1 (Food and Agriculture Organization of the United Nations, Irrigation and Drainage Paper, 29 Rev. 1 1985).) Infiltration rate can be affected by water quality, in addition to chemical and physical characteristics of the soil, such as soil texture and type of clay minerals. (Id.) The rate at which water enters soil under irrigation, the *intake rate,* decreases with application time and varies depending on the amount of water applied. (United States Department of Agriculture, San Joaquin County Soil Survey (1992), p260.)

[1] Dr. Brownell used EC_{iw} to represent the EC of irrigation water.

Permeability is the rate at which water moves through soil. (San Joaquin County Soil Survey, p261.) Permeability is expressed as the number of inches per hour that water moves through the soil profile. (Id.) Soil with a permeability rate of at least 0.06 inches per hour is considered "prime farmland." (San Joaquin County Soil Survey, p268.) If a crop needs to uptake water at a rate faster than the water can move through the soil to the plant, then the soil is probably less than optimal for that crop. Terms describing permeability rates are described in Table 1.

Table 1: Terms describing permeability (San Joaquin County Soil Survey, p261.)

Descriptive Terms	Rate of Movement (inches/hour)
Very Slow	Less than 0.06
Slow	0.06 to 0.2
Moderately Slow	0.2 to 0.6
Moderate	0.6 to 2.0
Moderately Rapid	2.0 to 6.0
Rapid	6.0 to 20
Very Rapid	More than 20

Leaching is the process of applying more water to the field than the soil in the crop root zone can hold. Excess water that moves through the soil drains below the crop root zone and carries salts with it. (SJRG Exh-02, p2.) As more water is applied in excess of the crop water requirement, more salts will be removed from the root zone. (Id.) This is the case regardless of the quality of the applied irrigation water, because all irrigation water contains some salt. (Id.) In arid and semi-arid areas, such as the Central Valley of California, leaching is an absolute requirement, even with irrigation water of the best quality. (Ayers and Westcot, Water Quality For Agriculture §2.4.) Leaching must be practiced to avoid salt accumulations that could ultimately affect production. (Id.)

Leaching fraction is the fraction, or percent, of water that actually drains below the crop root zone. (Id.) For example, if four inches of water are applied, the soil holds three inches of water, and one inch drains below the root zone, the leaching fraction is 25%. If six inches are applied and the soil again holds three inches of water, then the leaching fraction is 50%. The leaching fraction is therefore something that can be controlled with good water management practices. Farmers can normally achieve leaching fractions of 15% to 16% with the management of normal irrigation applications in conjunction with winter precipitation. (SJRG Exh-08, p3.)

The salinity tolerance of plants is actually related to the average soil EC, and only indirectly related to the EC of the irrigation water. (Presentation of James R. Brownell, submitted as SJRG Exh-06, p2.) The *salinity threshold* is the maximum average soil EC_e a crop can tolerate in the root zone without a decrease in crop yield. (SJRG Exh-02, p2.) For many tree and vine crops, salt tolerance is measured by growth, rather than yield. (Id., p4.) Different crops have different salinity thresholds and decline in yield or growth at different rates. (Id.) Table 2 shows estimated yields of major Delta crops with long-term use of irrigation water and soils of different salinities. (Id., p5-6.)

Table 2: Estimated salinity thresholds of major crops grown in the southern Delta for a given irrigation water salinity (EC_w). (Ayers and Westcot, Water Quality For Agriculture §2.4.3.)

Yield Potential at Given Salinity Tolerances (dS/m)								
Crop	**100%**		**90%**		**75%**		**50%**	
	EC_e	**EC_w**	**EC_e**	**EC_w**	**EC_e**	**EC_w**	**EC_e**	**EC_w**
Beans, Dry	1.0	0.7	1.5	1.0	2.3	1.5	3.6	2.4
Corn	1.7	1.1	2.5	1.7	3.8	2.5	5.9	3.9
Alfalfa	2.0	1.3	3.4	2.2	5.4	3.6	8.8	5.9
Tomato	2.5	1.7	3.5	2.3	5.0	3.4	7.6	5.0

The Legal Delta is defined by Water Code §12220. However, the SJRGA focused its analysis on the "south Delta" (sometimes also referred to as the "southern Delta"), which is defined as the Tracy, Union Island, Holt, Vernalis, Lathrop, and Stockton West United States Geological Survey quadrangles. (see Figures 2 through 7.) The proper arrangement of these maps is shown in Figure 1.

Figure 1: Arrangement of Southern Delta Topographic Maps

Holt	Stockton West
Union Island	Lathrop
Tracy	Vernalis

Southern Delta irrigation, water, and reclamation districts are depicted in Figures 8 through 11.

Topographic maps from the San Joaquin County Soil Survey representing the south Delta are depicted in Figures 12 through 17, with organic soils shaded orange.

Topographic maps with the specific locations where beans are grown are shown in Figures 18 and 19.

Figure 2: Holt quadrangle, all of which is within the Legal Delta.

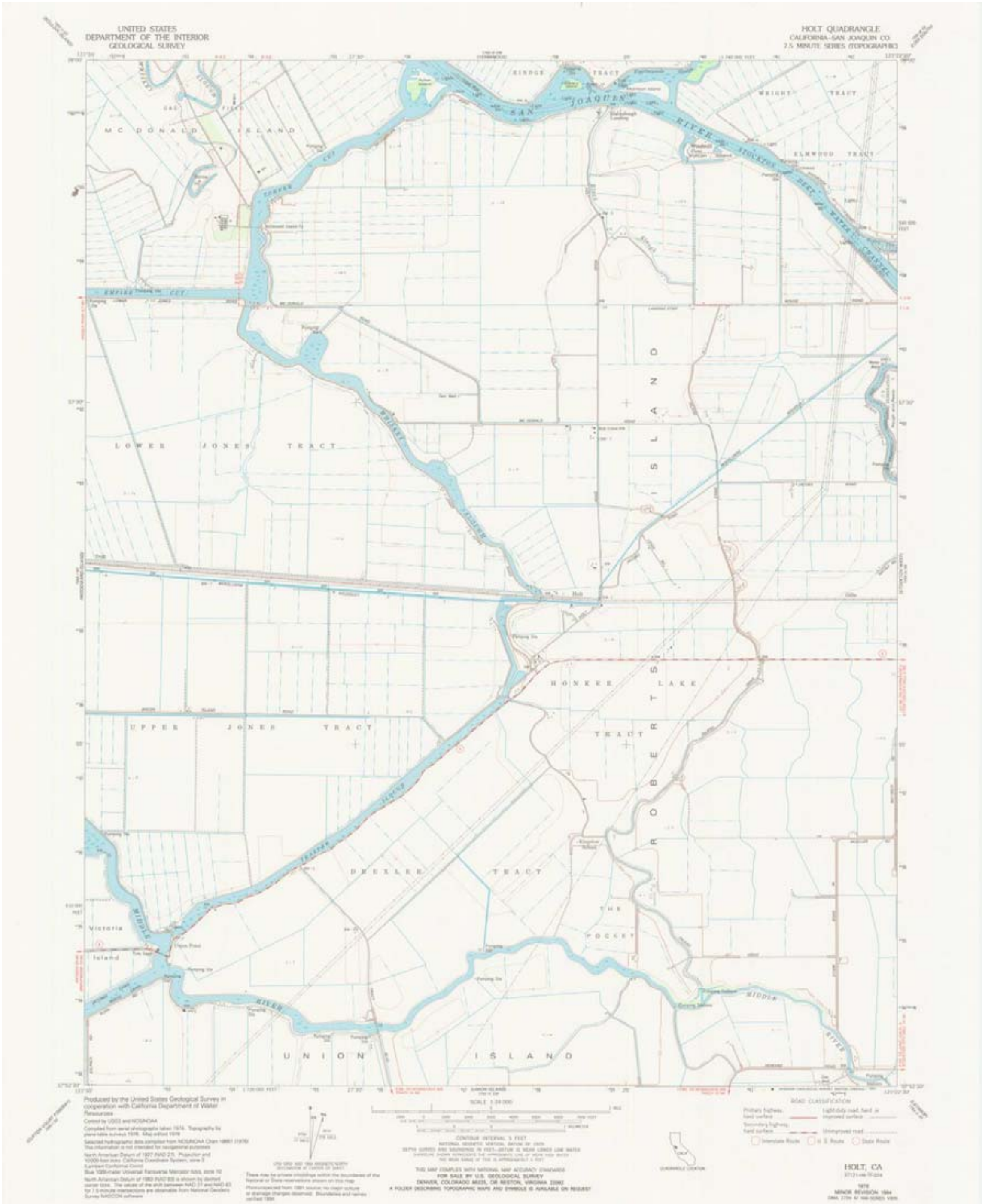

Figure 3: Union Island quadrangle, all of which is within the Legal Delta.

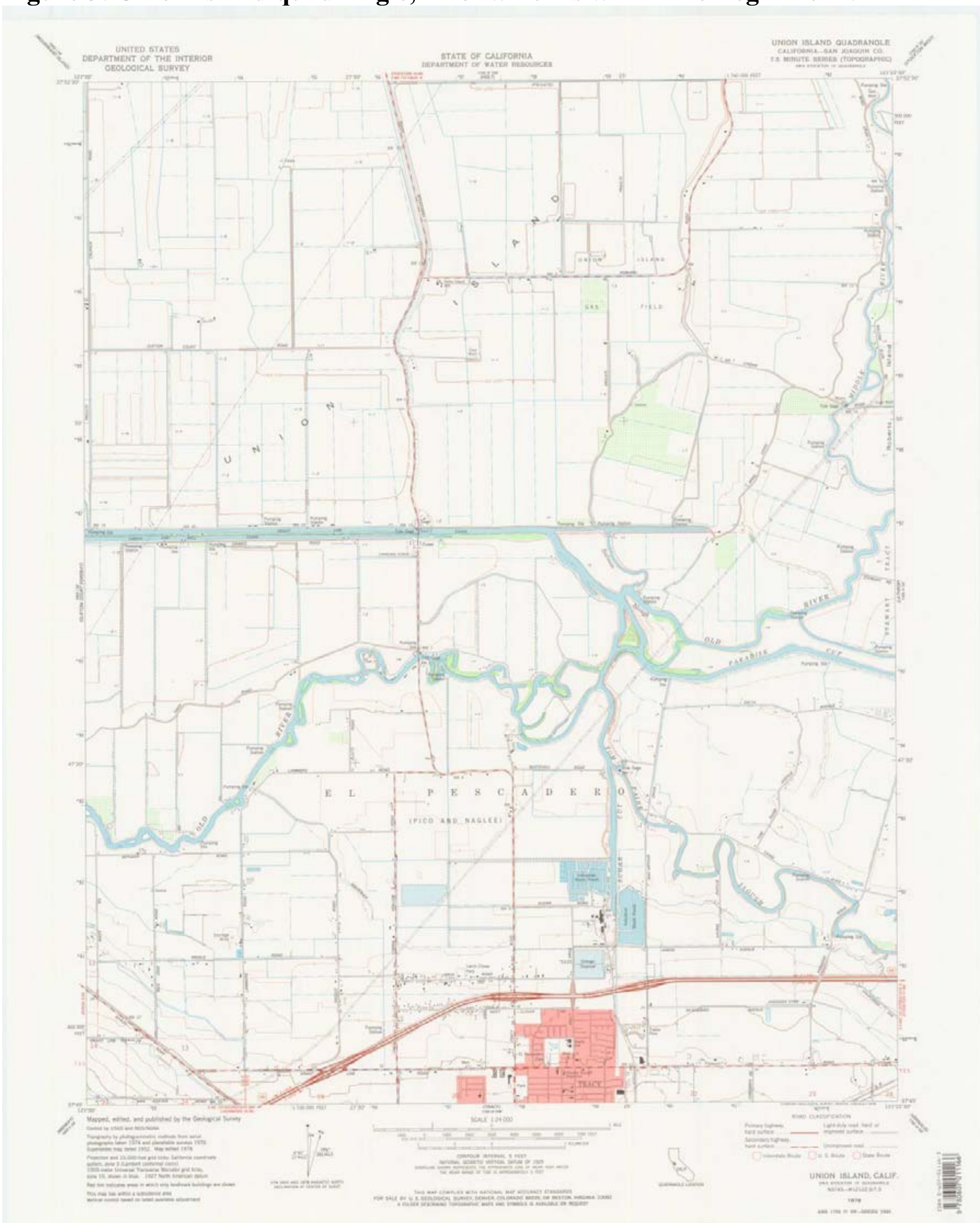

Figure 4: Tracy quadrangle showing Legal Delta boundary.

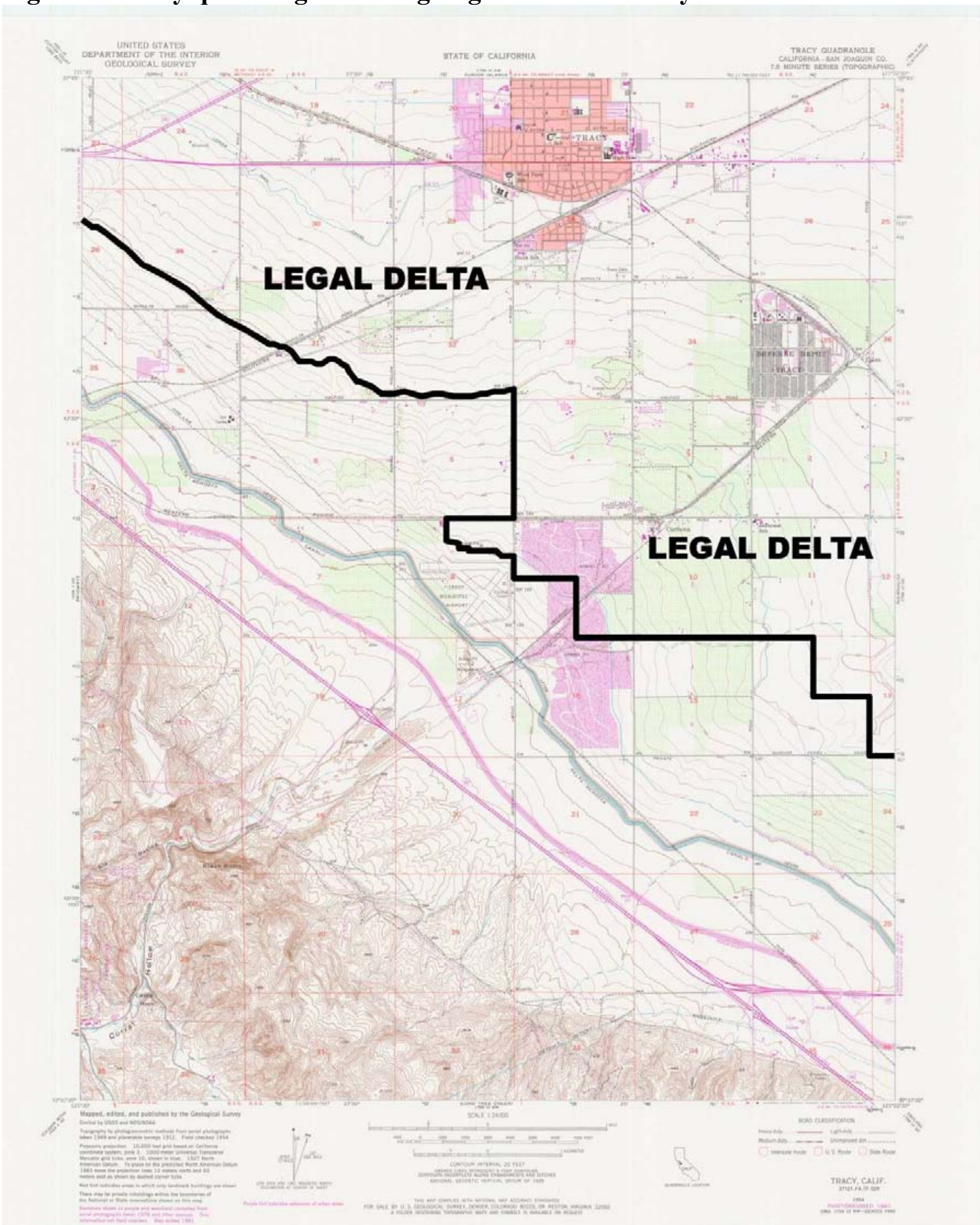

Figure 5: Stockton West quadrangle showing Legal Delta boundary.

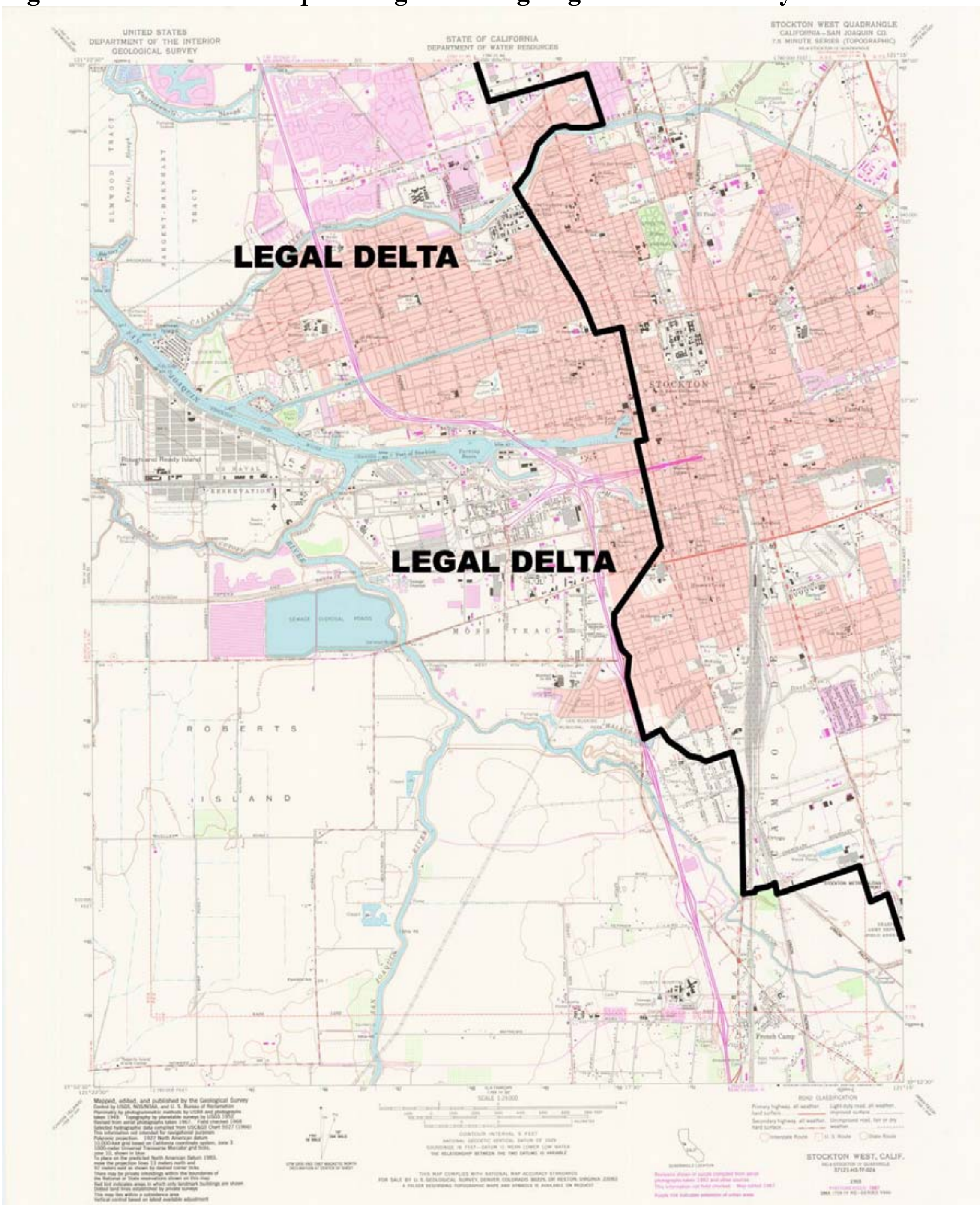

Figure 6: Lathrop quadrangle showing Legal Delta boundary.

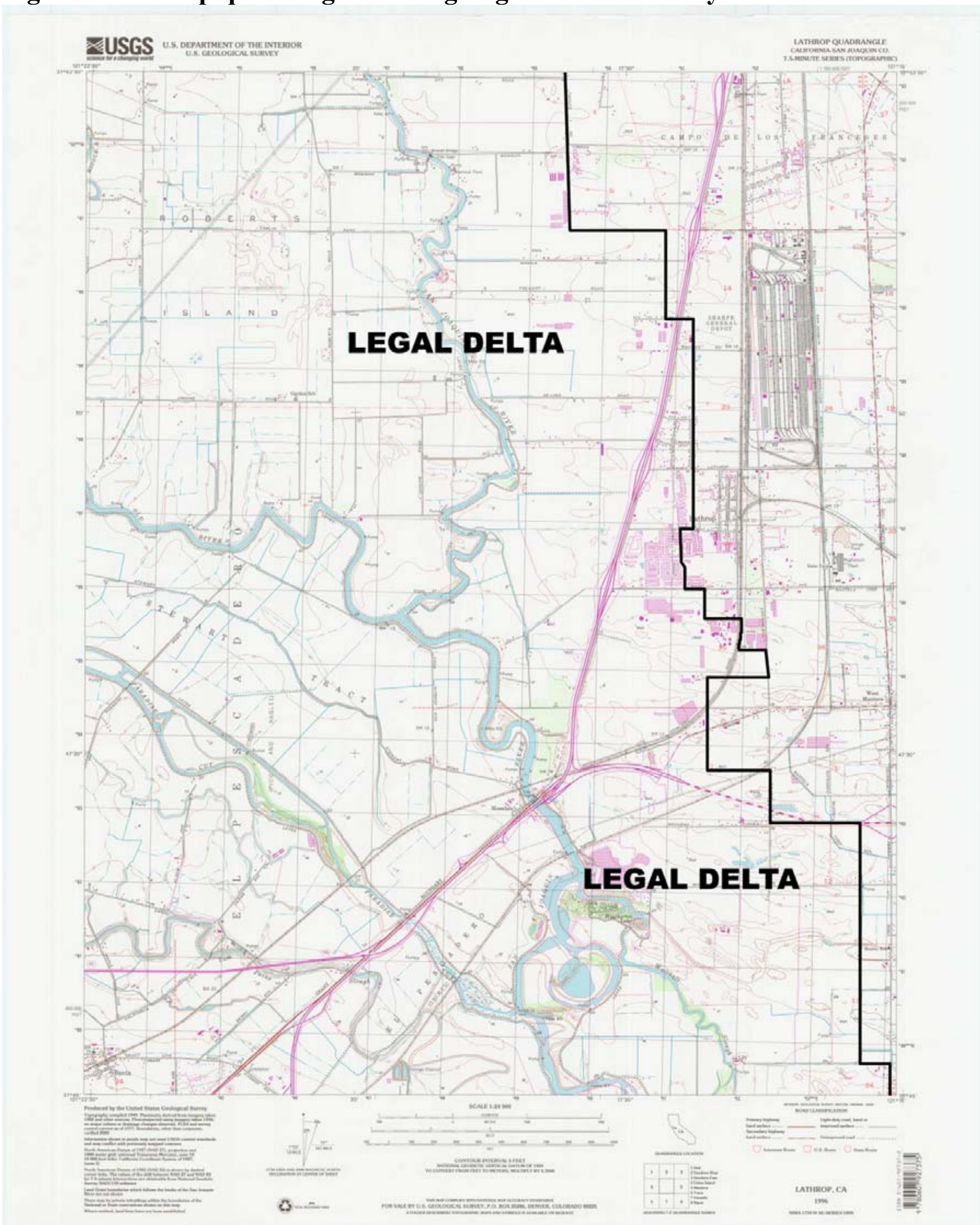

Figure 7: Vernalis quadrangle showing Legal Delta boundary.

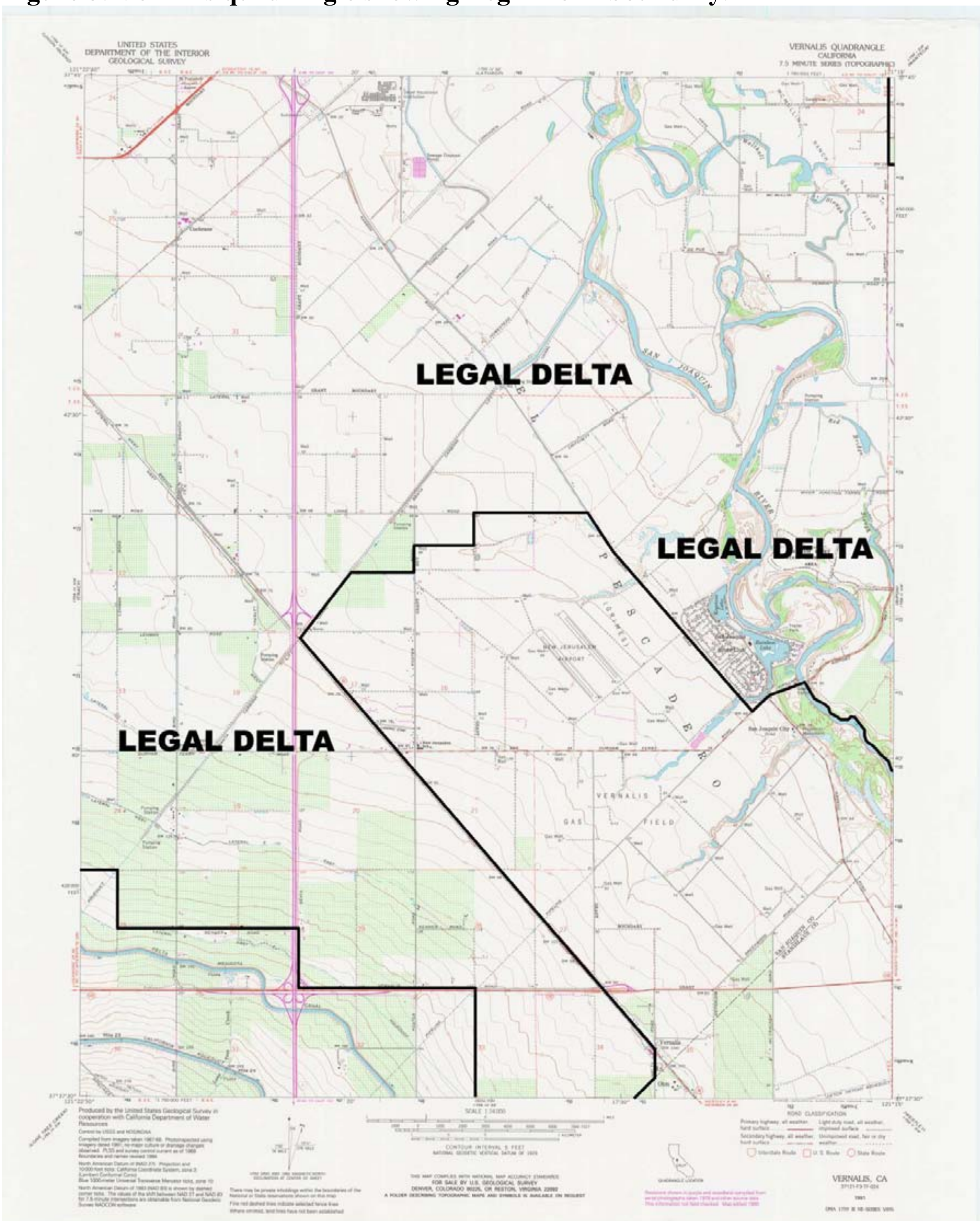

Figure 8: Holt quadrangle with Delta irrigation, water, and reclamation districts.

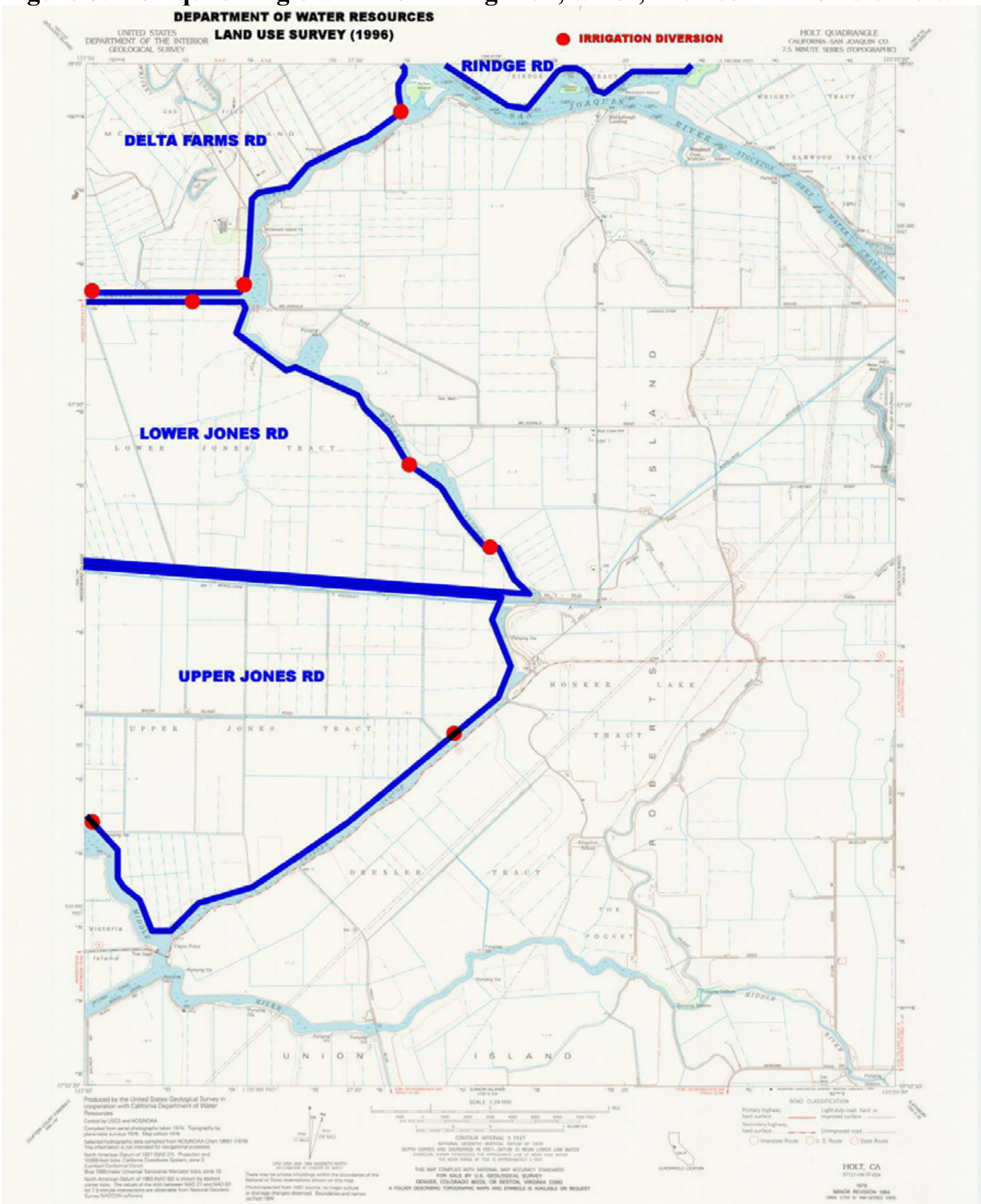

Figure 9: Union Island quadrangle with Delta irrigation, water, and reclamation districts.

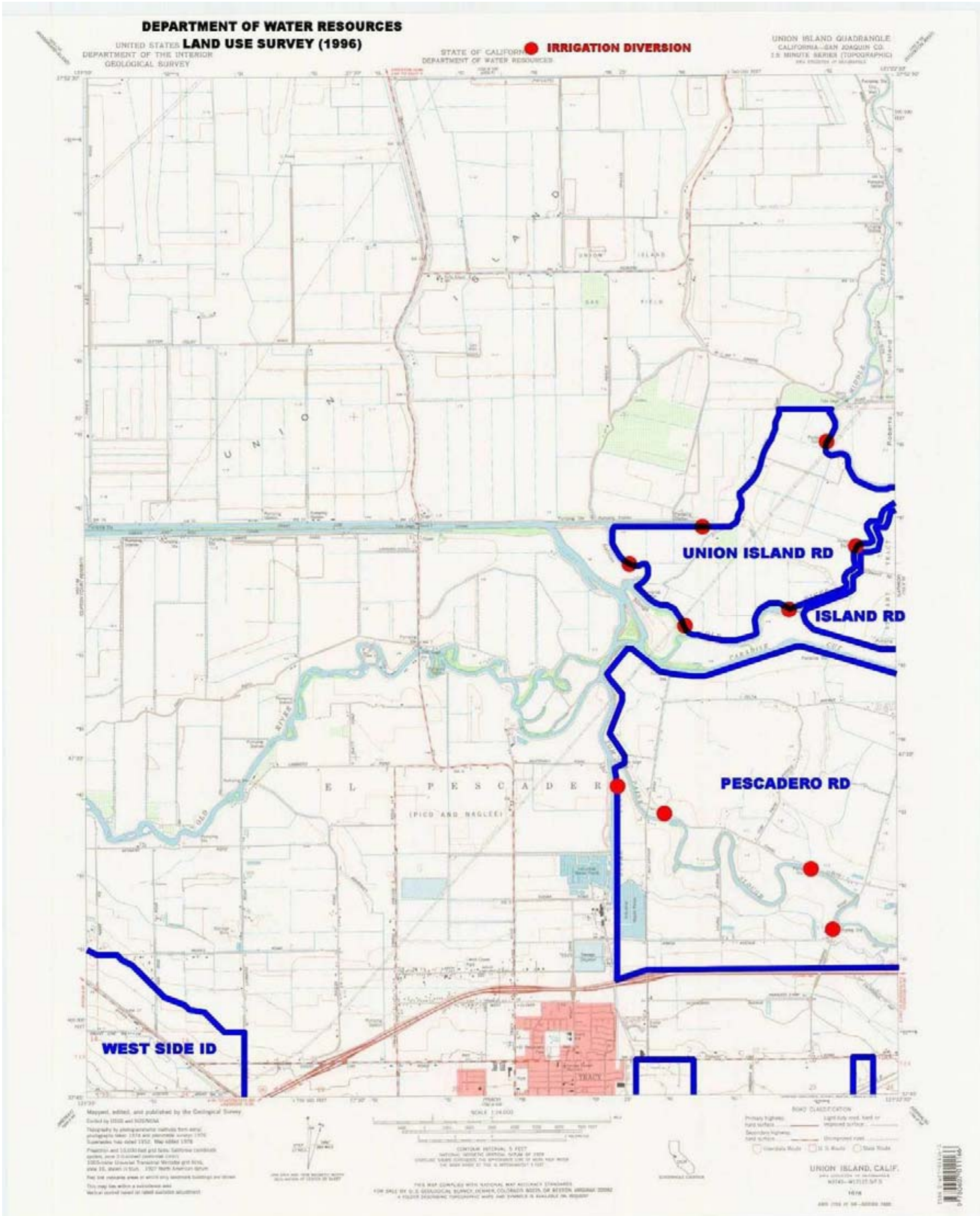

Figure 10: Lathrop quadrangle with Delta irrigation, water, and reclamation districts.

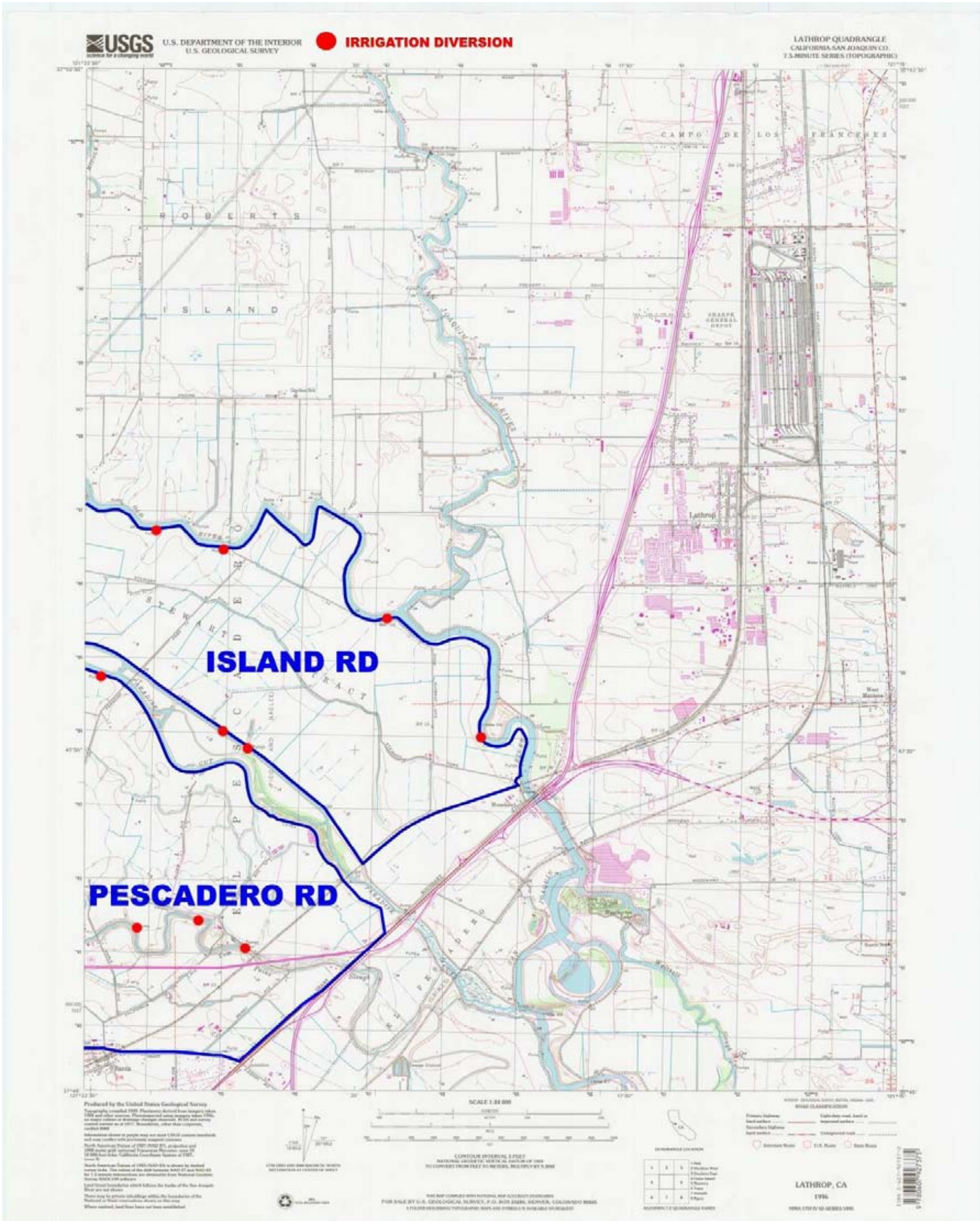

Figure 11: Tracy and Vernalis quadrangles with Delta irrigation, water, and reclamation districts.

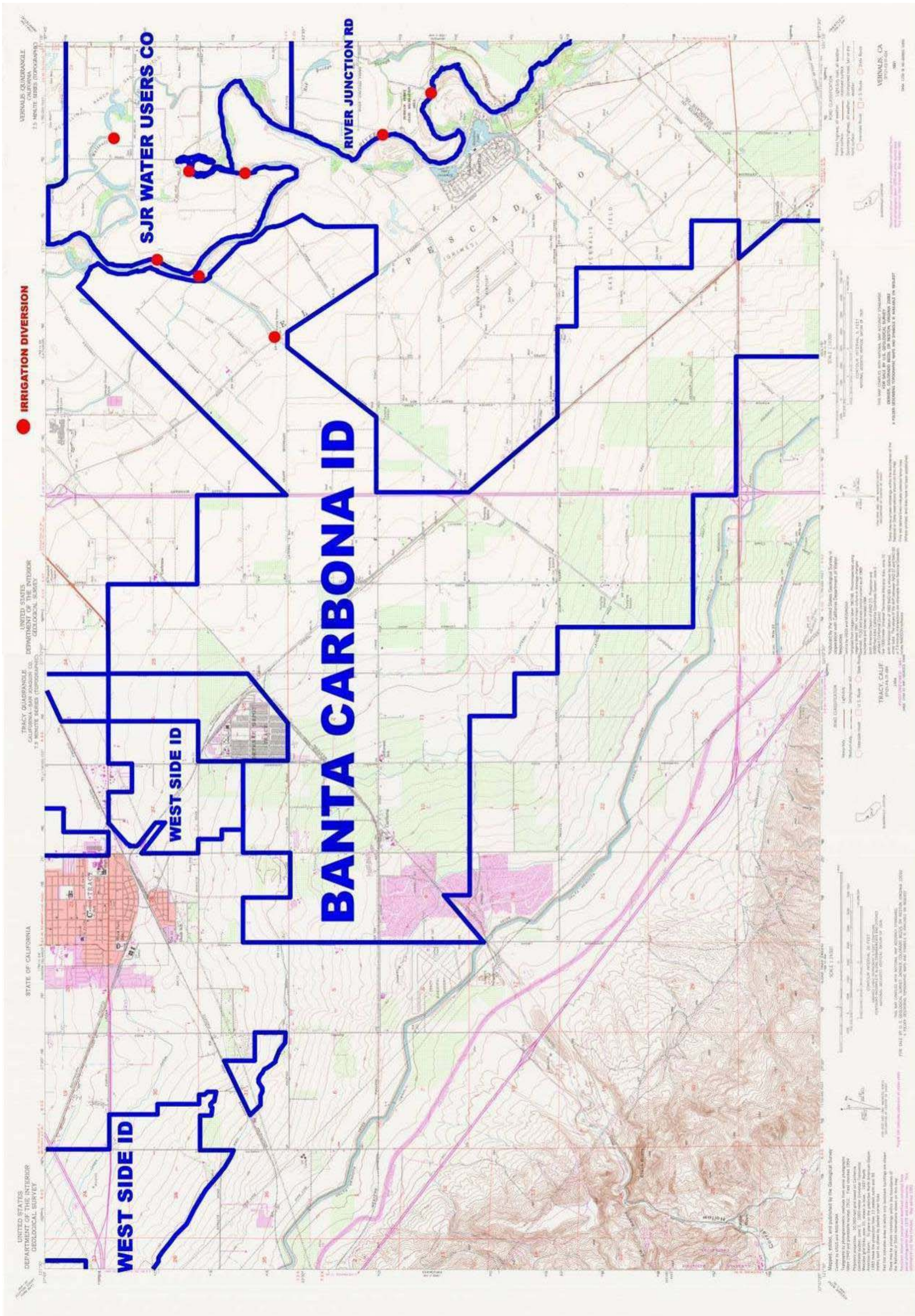

Figure 12: Holt quadrangle from the San Joaquin County Soil Survey, with organic soils shaded orange.

Figure 14: Tracy quadrangle from the San Joaquin County Soil Survey, with organic soils shaded orange.

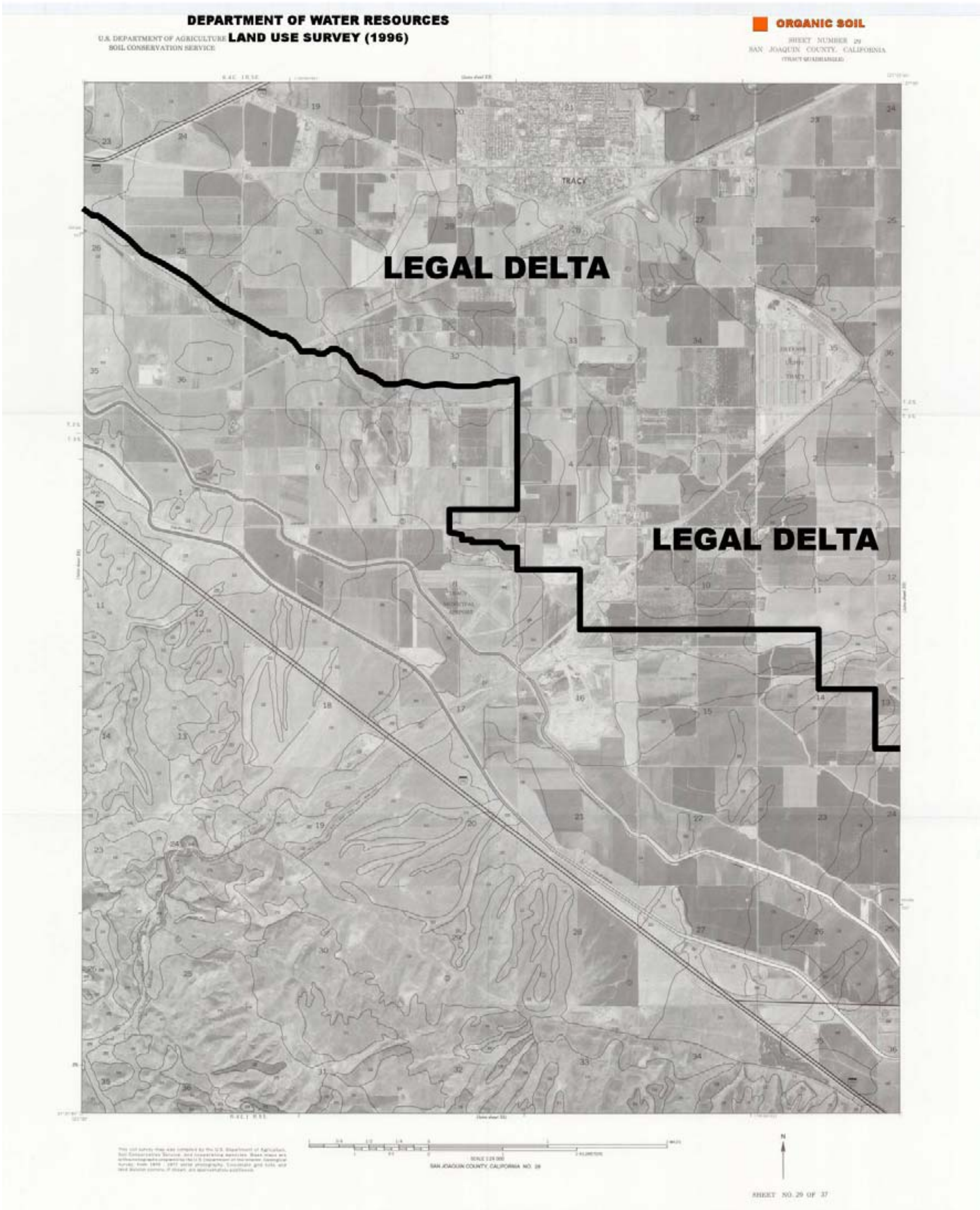

Figure 15: Stockton West quadrangle from the San Joaquin County Soil Survey, with organic soils shaded orange.

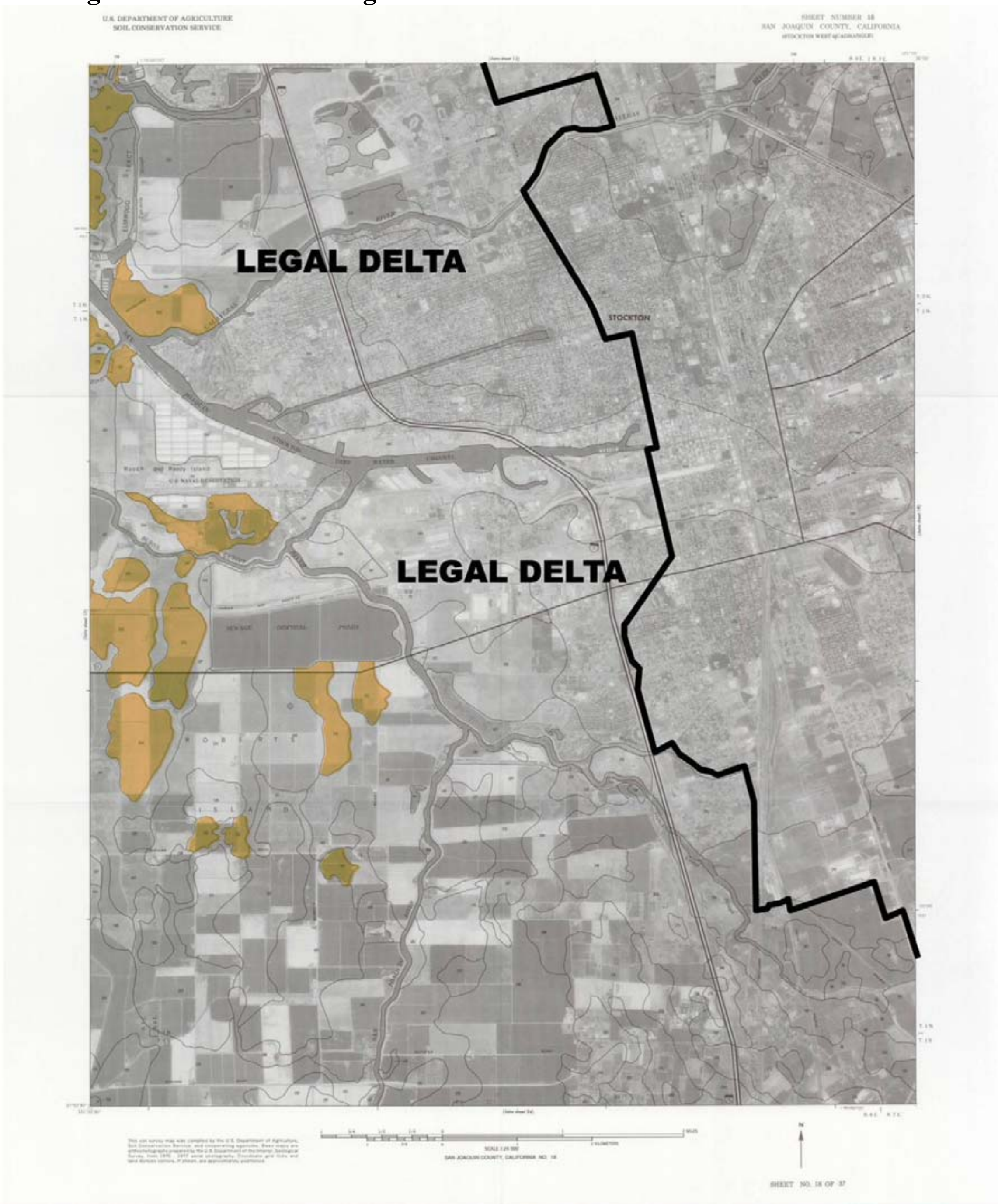

Figure 16: Lathrop quadrangle from the San Joaquin County Soil Survey, with organic soils shaded orange.

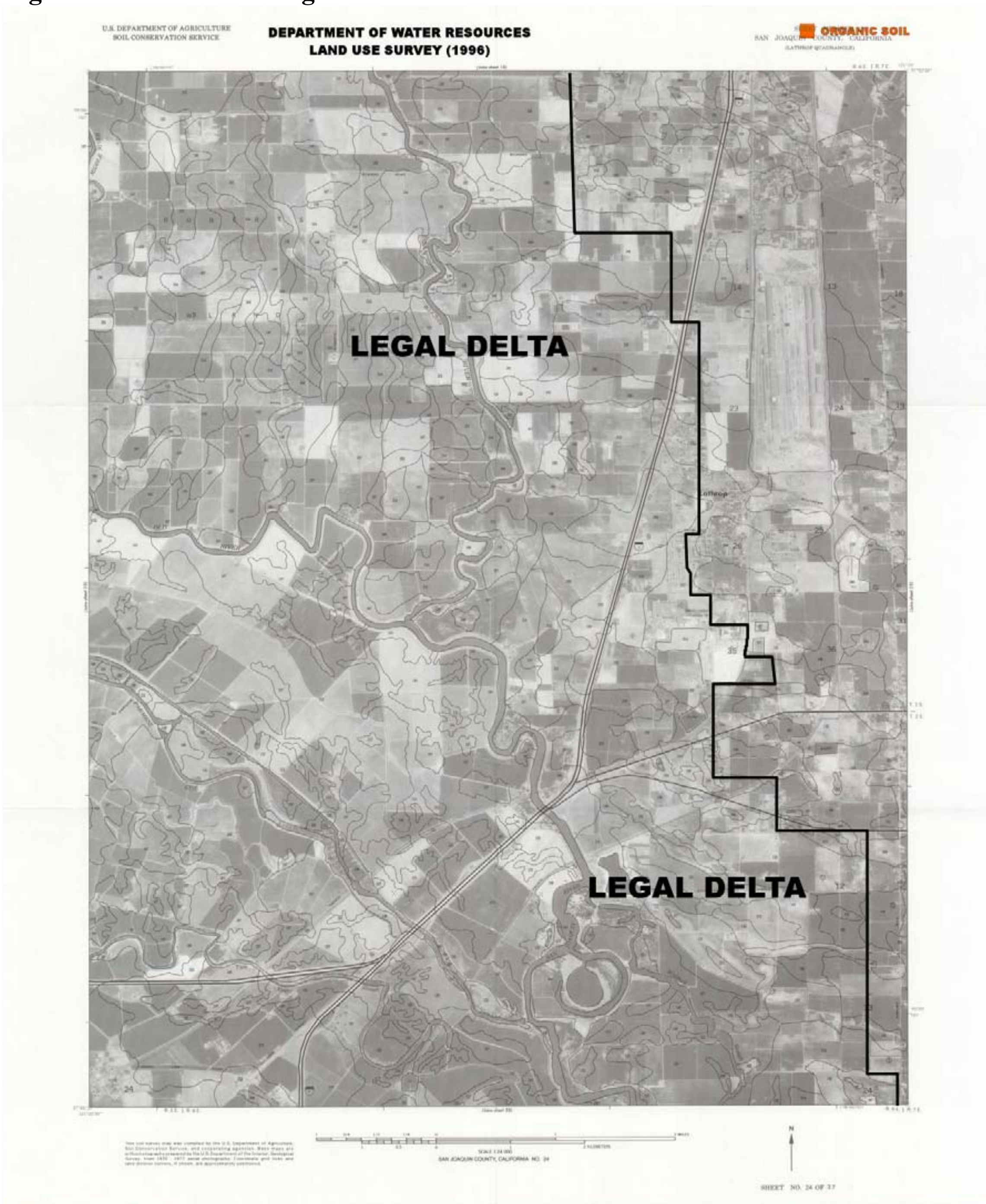

Figure 17: Vernalis quadrangle from the San Joaquin County Soil Survey, with organic soils shaded orange.

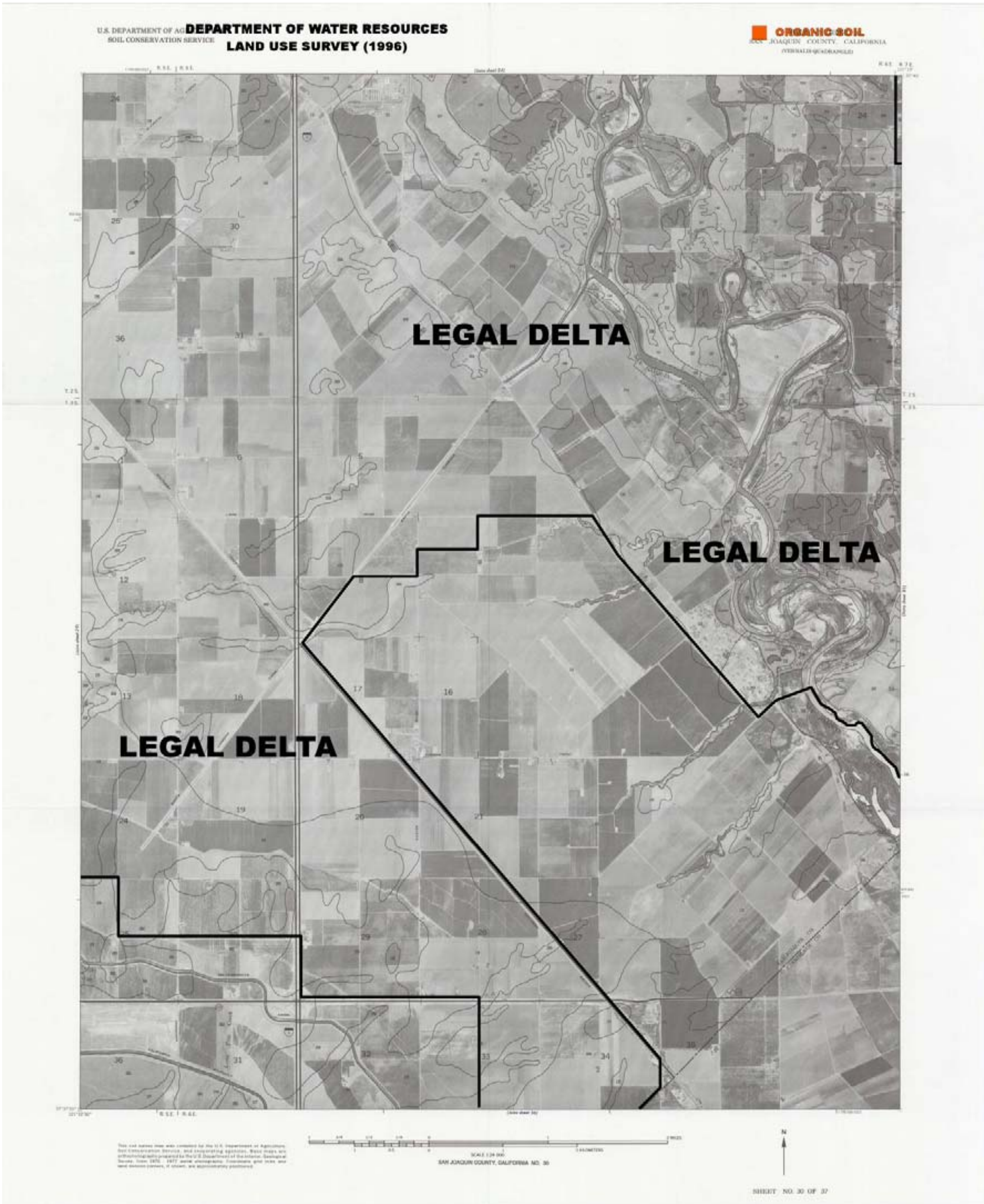

Figure 18: Lathrop quadrangle, with reclamation districts, irrigation diversions, and beans.

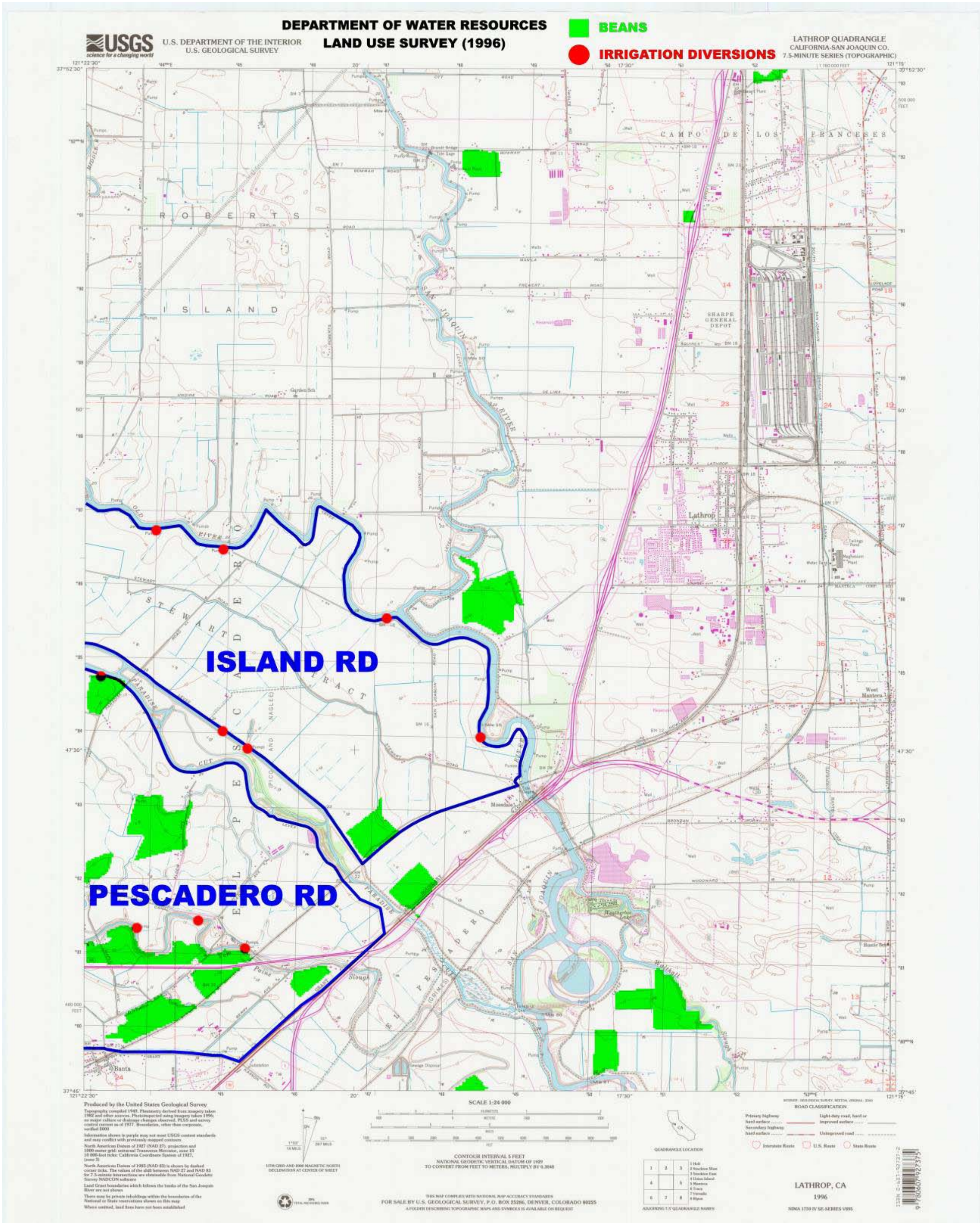

Figure 19: Combined Tracy and Vernalis quadrangles, with irrigation districts, irrigation diversions, and beans.