8. Drains. The Introduction (Chapter 1) for these design data collection guidelines contains additional information concerning: preparing a design data collection request, design data collection requirements, and coordinating the design data collection and submittal.

Specification design of drainage systems requires as a minimum the same type of basic data as feasibility design. The data are brought up to date and in more detail to show ground water conditions under irrigation and in addition includes data from any test drains which may have been installed. At the specifications stage, project lands and farm units are fixed, the irrigation distribution system has been completed, data from test drains are probably available, and the specific drainage requirements for various areas can be determined. The following paragraphs give a check list of drainage data required for specifications design.

A. **Basic Data.** The design of open drains for the collection of surface and subsurface water requires data primarily on surface conditions, i.e., topography; flood runoff; soil erosion characteristics; outlet requirements for storm water and waste water from irrigation and laterals; and county, State, Federal, and private structure requirements. For subsurface drains to control ground water and salinity, the primary data required are on soils and substrata. Design of subsurface drains is based largely upon hydraulic conductivity of the various soil strata above the uppermost slowly permeable barrier in the soil profile, the position and thickness of these strata, landforms, surface infiltration rates, contemplated land use and irrigation practices, precipitation records, topography, and historic ground water conditions.

The amount and coverage of the drainage investigations will depend on the knowledge, judgment, and experience of the drainage engineer. The reliability of the drainage requirements will depend on obtaining sufficient and proper information to be used for interpretation.

B. **General Map.** A general map showing project area with location of proposed drains, nearby towns, road, railroads, and a key map locating the general map area within the State.

C. **Location Map.** A location map usually at a scale of 1 inch equals 2,000 feet showing location of the proposed drains and any existing drains, roads, railroads, powerlines, and gravel sources. This map may be combined with the general map for small areas.

D. **Topographic Maps.** Topographic maps, usually at a scale of 1 inch = 200 feet with 1 or 2 feet contour intervals, for showing the final drainage layout and which also show existing drains, roads, improvements, canals, reservoirs, railroads, highways, wetlands, etc.

E. **Land Classification Map.** A land classification map showing land classes by standard symbols and location of any special deep test holes.

F. **Depth-to-Barrier Map.** A depth-to-barrier map for areas where clays, shales, sandstone, or other slowly permeable materials occur at depths which will adversely affect drainage.

G. **Profiles.** Appropriate multiple profiles across typical areas showing ground surface elevations, stratifications, permeabilities, and ground water levels.

H. **Plan and Profile Drawings:**

(1) **General.** These drawings are normally prepared so that both plan and profile are shown on a scale of 1 inch equals 200 feet horizontally with 1 inch equals 10 feet vertically on profile. The plan should depict location of drains, location and size of manholes, drain stationing and significant topographic features. The profile should depict bottom grade, ground surface, hydraulic properties, and sections is usually required. Plan and profile drawings should show features such as contours, roads, borrow pits, original ground surface and drain alignment and curve data. All features and details should be shown in ink.

(2) **Details to Be Shown Are:**

(a) Stationing

(b) Structures (including conduit size for siphons, turnouts, and culverts)

(c) Right-of-way and easement lines if established.

(d) North arrow and land survey lines.

(e) Original ground surface and bottom grade on profile.

(f) Hydraulic properties by reaches of proposed section.

(g) Buildings, fences and other obstructions.

I. **Typical Sections.** Typical sections showing proposed earthwork dimensions for open and closed drains should be provided. For concrete lined drains, detail views of the lining may be required for clarification.

J. **Survey Control.** Use of an existing coordinate system or to the township and range system is acceptable, but tying to the State or national Plane Coordinate system is recommended if practical.

K. **General Description as it Affects Drainage Requirements and Covering:**

(1) Regional geology and geomorphology, topography, and climate.

(2) Texture, structure, hydraulic conductivity, infiltration, chemical characteristics, and stratification of soils, subsoils, and substrata. Agronomic classification should be shown but the unified system is a useful supplement if available.

(3) Chemical characteristics of ground water and irrigation water.

(4) Ground water conditions, including sources, position, any artesian pressures, and gradients.

(5) Contemplated land use and irrigation practices.

(6) Natural surface drainage, flood history, and channel locations and characteristics.

L. **Hydrologic Data:**

(1) Precipitation and runoff records.

(2) Area-discharge curve of 5-, 10-, and 25-year storms for use in design of drains to remove surface water from irrigable lands.

(3) Permissible additional capacity of natural channels which will convey drain water, based on consideration of probable frequency of flooding and the resultant damages to crops and project works.

(4) Drain design capacity including water accretion from canal and lateral losses, and surface waste and deep percolation losses from farm-water application.

(5) Hydrographs showing typical ground water fluctuations in selected observation wells.

(6) Stability of natural channels receiving drain flow.

M. **Existing Systems.** Comparative data from lands in the vicinity having similar soils and drainage conditions and already under irrigation:

(1) Map of the existing drainage system.

(2) General discussions of soil and substrata characteristics and the depths, capacities, and spacings of the drains.

(3) Detailed data on particular drains where the factors affecting drainage are similar to those in the project area. The data will cover type of drain, design, soil and substrata characteristics, ground water conditions, construction and maintenance problems, discharge, land use, irrigation practices, and area effectively drained for good crop production.

N. **Miscellaneous Data:**

(1) Unusual conditions for excavation or construction.

(2) Availability of construction materials including gravel for filters.

(3) Permeabilities and gradations of gravel sources.

(4) Structure requirements of other agencies, corporations, and individuals.

(5) Information on local labor supply and labor problems.

(6) Identify impoundments, streams, and/or wetlands likely to be affected by drain flows.

(7) Identify probably range of concentrations for various constituents such as pesticides, selenium, etc.

O. **Quantities.** Estimated quantities for drain excavation, envelope material, compacting embankment, borrow, overhaul (with free haul distance), pipe size and length, manholes, guard fences, right-of-way fencing and gates, cattle guards, etc. Also provide location of drainage discharge with a copy of discharge permit including discharge requirements.

P. **Data Sheets.** Data sheets and centerline borings for structures and drains which cannot be obtained until after the definite drainage layout is established. Detailed data sheets will be needed for such structures as:

(1) Highway, canal, and railroad crossings.

(2) Manholes, outlet structures, and pipe end details.

Q. **Environmental Considerations.** During the investigation studies, the environmental impacts of the drainage system on other features, such as municipal, industrial, recreational, water quality, water quality standards, fish and wildlife, and aesthetic requirements should be considered. Close cooperation on environmental matters should be established and maintained between drainage personnel and personnel working in other technical disciplines. Liaison should also be established with the environmental groups in the area.