Field Methods For Hydrologic and Environmental Studies

Chapter 4

Ground-Water-Data Collection

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INTRODUCTION

Ground-water-data collection includes a wide variety of methods, which are intended to provide information about the physical framework (lithology stratigraphy, structure, dimensions), hydraulic properties (porosity, hydraulic conductivity, storativity), and water-quality of ground-water systems. In order to properly employ and fully benefit from most data-collection methods, an understanding of and integration with a variety of methods is essential. This course will emphasize several of the basic data-collection methods, including measurement of ground-water levels in monitoring and water-supply wells, single-well aquifer testing (slug testing) and analysis, and ground-water quality-sampling. In addition to the hands-on experience provided for these methods, demonstrations and (or) discussions will be provided in monitoring-well construction, borehole geophysical logging, packer testing, well purging, multiple-well aquifer testing, and data-collection planning. The issues of quality assurance will be addressed.

Much of the material for the CEE 398 FM class notes presented in the sections on ground-water-study design, selection and installation of wells, and data documentation is drawn from:

- Lapham, W.W., Wilde, F.D., and Koterba, M.T., 1997, Guidelines and standard procedures for studies of ground-water quality: Selection and installation of wells, and supporting documentation: U.S. Geological Survey Water-Resources Investigations Report 96-4233, 110 p.

Much of the material presented in the section on water-quality sampling is drawn from materials prepared by Lapham, W.W., Wilde, F.D., and Koterba, M.T for a water-quality-sampling workshop for the U.S. Geological Survey National Water Quality Assessment program.

SOME REASONS TO COLLECT GROUND-WATER DATA

- Assessment of Ground-Water Availability
- Well-Field Design
- Monitoring of Drinking Water Quality
- Well-Head Protection/Capture-Zone Delineation
- Contaminant Distribution and Travel Times

- Ground-Water/Surface-Water Interaction
- Water Use

TYPES OF GROUND-WATER DATA

- Ground-Water Levels in Monitoring and Water-Supply Wells
- Hydraulic Gradients and Velocities
- Porosity
- Lithology of Geologic Materials
- Hydraulic Conductivity of Geologic Materials
- Structure (Fracture Patterns) of Geologic Materials
- Barometric Efficiency of Aquifers/Wells
- Water-Quality Parameters (Field Characteristics/Chemical Composition)
- Withdrawals
- Soil-Moisture Content and Pressure Head in the Unsaturated Zone

SOME AGENCIES THAT COLLECT GROUND-WATER DATA

- U.S. Geological Survey
- U.S. Environmental Protection Agency
- Illinois Department of Natural Resources, State Water Survey
- Illinois Department of Natural Resources, State Geological Survey

- IllinoisEnvironmental Protection Agency
- Illinois Department of Public Health

SOURCES OF GROUND-WATER DATA

- U.S. Geological Survey
  Ground-Water Site Inventory (GWSI)
  Water-Quality Data Base (QWDATA)

- Illinois State Geological and Water Surveys
  Drilling and well construction records

- Illinois State Geological Survey
  Drill cuttings and rock-core collection

- Illinois State Water Survey
  Hydraulic Properties Inventory

- Illinois Environmental Protection Agency
  Leaking Underground Storage Tank records
  Hazardous-waste-site studies

As in all scientific studies, the protection of data integrity is the guiding principle. For ground-water studies, the principle would apply to the full variety of data that may be collected, including water-quality and hydraulic-property data. Although the diversity of among ground-water studies in relation to study objectives, environmental settings, and spatial and temporal scales precludes the establishment of all-encompassing protocols, three protocols apply to all such investigations and will help ensure and document data quality:

- Design and implement each aspect of the study to reduce undesirable bias in the data collected

- Integrate quality-assurance procedures into work plans and activities

- Integrate documentation into each phase of the study

Most ground-water studies that require field data collection follow the following

***BASIC ELEMENTS IN PLANNING AND CONDUCTING THE STUDIES*[1]**:

- State the problem that initiated the study
- Define the purpose and scope of the study

- Develop a conceptual framework for the study, including a description of the environmental setting
- Define the objectives of the study and formulate hypothesis to be tested
- Develop a scientific and technical approach for network design, data collection, and quality assurance

    Incorporate a multidisciplinary perspective, if appropriate (for example, hydrogeological, geophysical, and statistical methods)

    Use knowledge of site geology and hydrology to determine location of wells and sample-collection (screened or open interval)

- Implement the approach for network design, data collection, and quality assurance, including:

    Complete site reconnaissance of geomorphology, surficial hydrologic features, and natural and anthropogenic environmental factors

    Collect geologic and geophysical data

    Select well locations and install wells

    Determine aquifer characteristics and hydraulic properties

    Collect water-quality and quality-control samples and related data

    Complete supporting documentation of data collection

- Analyze and interpret data
- Report results

SITE RECONNAISSANCE AND HYDROGEOLOGIC FRAMEWORK

An essential first step in beginning a field-data-oriented ground-water investigation is to establish a conceptual model of the study area. Such a model requires extensive research of available data and information, as well as reconnaissance of the study area. Review of the available data and the reconnaissance, ensures better conceptualization of the hydrogeologic framework the study area. A sound conceptual model is necessary for the selection of appropriate field methods, sampling locations, and sampling intervals.

SITE RECONNAISSANCE

Site reconnaissance involves a first-hand inspection of the study area. This usually includes a walk-over and drive-over of the site and surrounding area. If the study area is large, only a drive-over may be feasible. Site reconnaissance also may include a fly-over. The following hydrogeologic and land-use features should be noted:

- Areas of ground-water recharge and discharge (highlands, bedrock outcrops, lakes and streams)
- Surficial soil types and vegetation
- Land-use (agricultural, urban, industrial)
- Potential point and non-point sources of contamination (industries, service stations, liquid storage tanks, livestock operations, fertilizer-distribution facilities, intensely farmed areas)
- Present indications of contamination (stained soils, loss of or stressed vegetation)
- Well locations and conditions (verify on available USGS (or other) topographic Map -- 1:24,000 scale or less; note location with GPS)

AVAILABLE DATA AND INFORMATION

Available sources of data may come from:

- Libraries -- professional, government-agency, and consultant reports, journal articles
- USGS – NWIS data bases (GWSI, QWDATA)
- ISGS/ISWS – Drilling and well construction records
- ISGS – Drill cuttings and rock-core collection; geophysical log collection
- ISWS – Aquifer property data base
- USEPA – STORET water-quality data base; hazardous-waste-site reports
- IEPA – Leaking underground storage tank records; hazardous-waste site reports
- Canvassing – Information from study area residents

HYDROGEOLOGIC FRAMEWORK

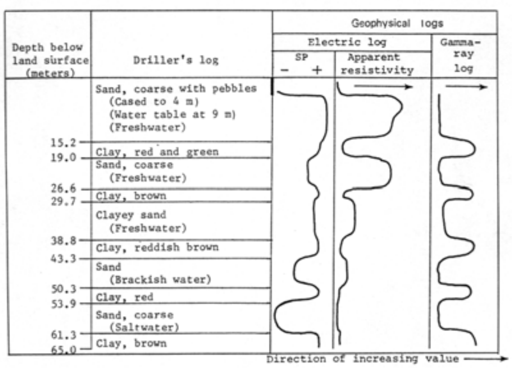
- Stratigraphy and lithology are vital to the study of ground-water systems have been collected previously and interpreted for most settings in the U.S., and most are readily available.

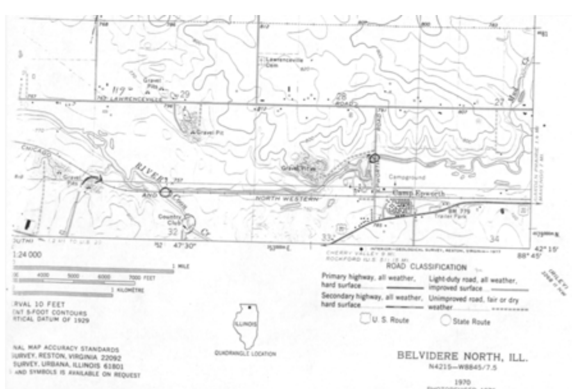
- Stratigraphic and lithologic data are important because they describe basic characteristics of the solid part of the hydrogeologic system and help delineate the hydrogeologic units (aquifers and confining units).

- Stratigraphy identifies the sequence of rocks, which in Illinois occur as glacial deposits and flat-lying sedimentary rocks.

- Lithology identifies the texture and composition, including arrangement of grains and particles, grain size, and mineralogy.

THESE DATA DEFINE THE NATURE OF
GROUND-WATER FLOW, POROSITY, AND WATER-QUALITY





ILLINOIS DEPARTMENT OF PUBLIC HEALTH
WELL CONSTRUCTION REPORT

1. Type of well
 a. Dug____, Bored____, Hole Diam.____in. Depth 228 ft.
 b. Driven____, Drive Pipe Diam.____in. Depth____ft.
 c. Drilled X, Finished in Drift____, In Rock X.
 Tubular____, Gravel Packed____.
 d. Grout:

(Kind)	From (ft)	To(ft)
CUTTINGS	-6	213

2. Distance to Nearest:
 Building 22 ft. Seepage Tile Field 82
 Cess Pool____ Sewer (non Cast iron)____
 Privy____ Sewer (Cast iron)____
 Septic Tank 97 Barnyard____
 Leaching Pit____ Manure Pile____
3. Well furnishes water for human consumption? Yes X No____
4. Date well completed 09/26/86
5. Permanent Pump Installed? Yes X Date 10/24/86 No____
 Capacity 10 gpm. Depth of Setting 120 ft.
6. Well Top Sealed? Yes X No____ Type MARTINSON
7. Pitless Adapter Installed? Yes____ X No____
8. Well Disinfected? Yes____ X No____
9. Pump and Equipment Disinfected? Yes X No____
10. Pressure Tank Size____gal. Type WELL-X-TROL WX202
11. Water Sample Submitted? Yes____ No X
REMARKS:
No Envelope JUL 17 1989

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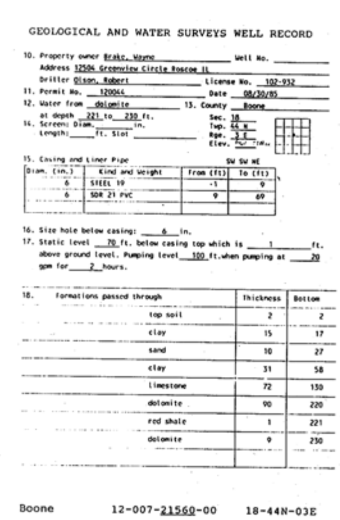

GEOLOGICAL AND WATER SURVEYS WELL RECORD

10. Property owner Brake, Wayne Well No.____
 Address 12506 Greenview Circle Roscoe IL
 Driller Olson, Robert License No. 102-932
11. Permit No. 120044 Date 08/30/85
12. Water from dolomite 13. County Boone
 at depth 221 to 230 ft. Sec. 18
14. Screen: Diam.____in. Twp. 44 N
 Length:____ft. Slot____ Rge. 3 E
 Elev.

15. Casing and Liner Pipe SW SW NE

Diam. (in.)	Kind and Weight	From (ft)	To (ft)
6	STEEL 19	-1	9
6	SDR 21 PVC	9	69

16. Size hole below casing: 6 in.
17. Static level 70 ft. below casing top which is 1 ft. above ground level. Pumping level 100 ft. when pumping at 20 gpm for 2 hours.

18. Formations passed through	Thickness	Bottom
top soil	2	2
clay	15	17
sand	10	27
clay	31	58
limestone	72	130
dolomite	90	220
red shale	1	221
dolomite	9	230

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Figure – Examples of available data and information to be used for conceptualization of hydrogeologic framework of study area. Clockwise from top left: geophysical log, driller's log, USGS 1:24,000 topographic quadrangle map.

CONCEPTUAL MODEL

Determining the hydrologic framework of a study area is essential to developing a reliable conceptual model of the ground-water system. Model will focus data collection. Additional data will be used in iterative improvement of the conceptual model. Example of models include:

- Confined/Unconfined/Leaky or Semi-confined
- Porous/Fractured/Karstic/Dual Porosity
- Isotropic/Homogeneous/Heterogeneous
- Bounded/Locally Unbounded

ISSUES OF SCALE IN DEFINING CONCEPTUAL MODEL AND PLANNING DATA COLLECTION

Why do we care about scale and definition of aquifer system?

- Incorrect investigative techniques employed
  - EX: Blind drilling of monitoring wells in fractured aquifers. Failure to double case wells in multiple aquifer systems.
- Faulty conclusions on aquifer characteristics resulting in wasted efforts and delays
  - EX: Applying isotropic aquifer assumptions to aquifers in fractured systems or highly heterogeneous formations. Extrapolating information obtained in small study area to larger areas in heterogeneous formation.
- Inappropriate clean-up technologies employed or unreasonable expectations of technologies
  - EX: Assuming pump and treat technologies will work without characterizing the flow system, boundaries, and nature of contaminants

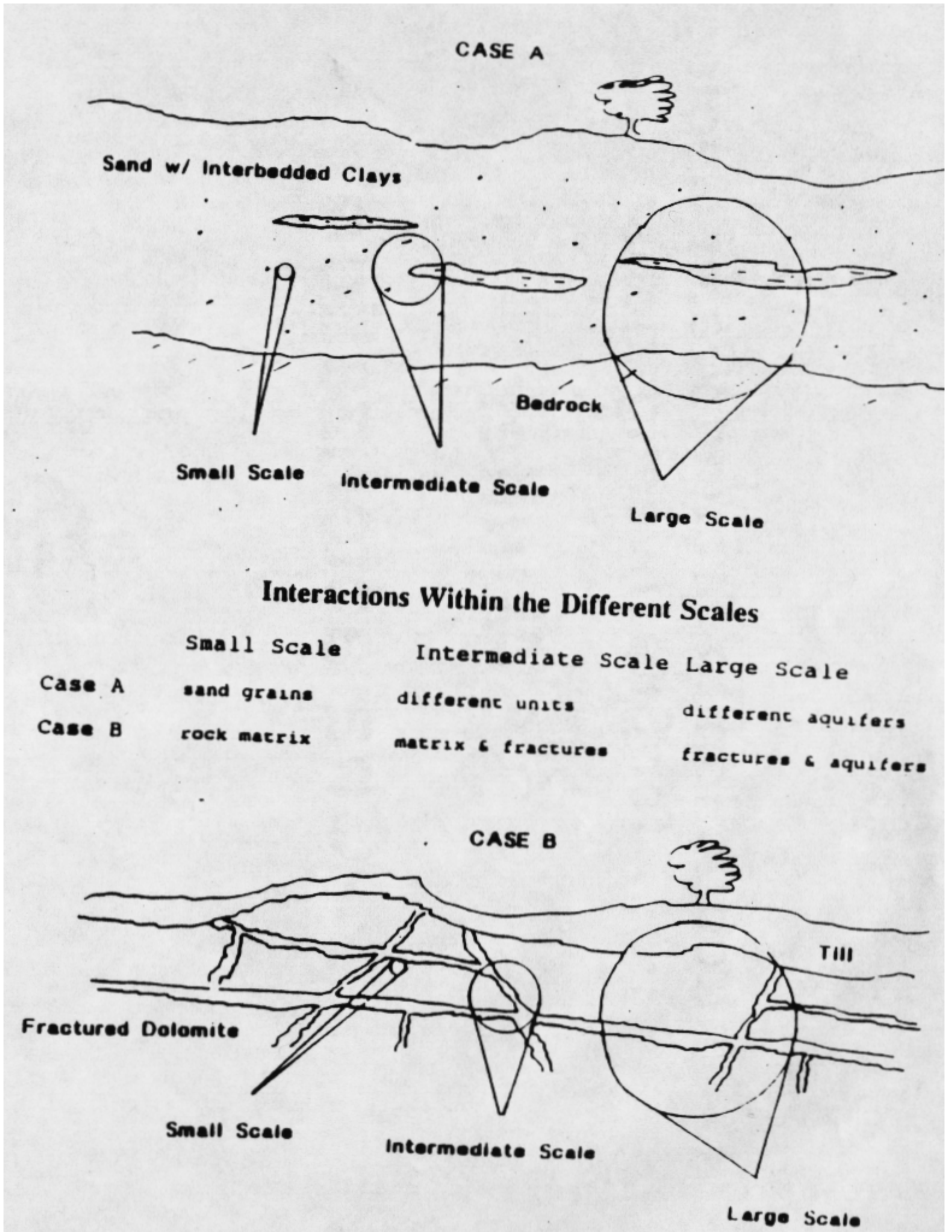

Figure – Conceptualization of the scale factor.