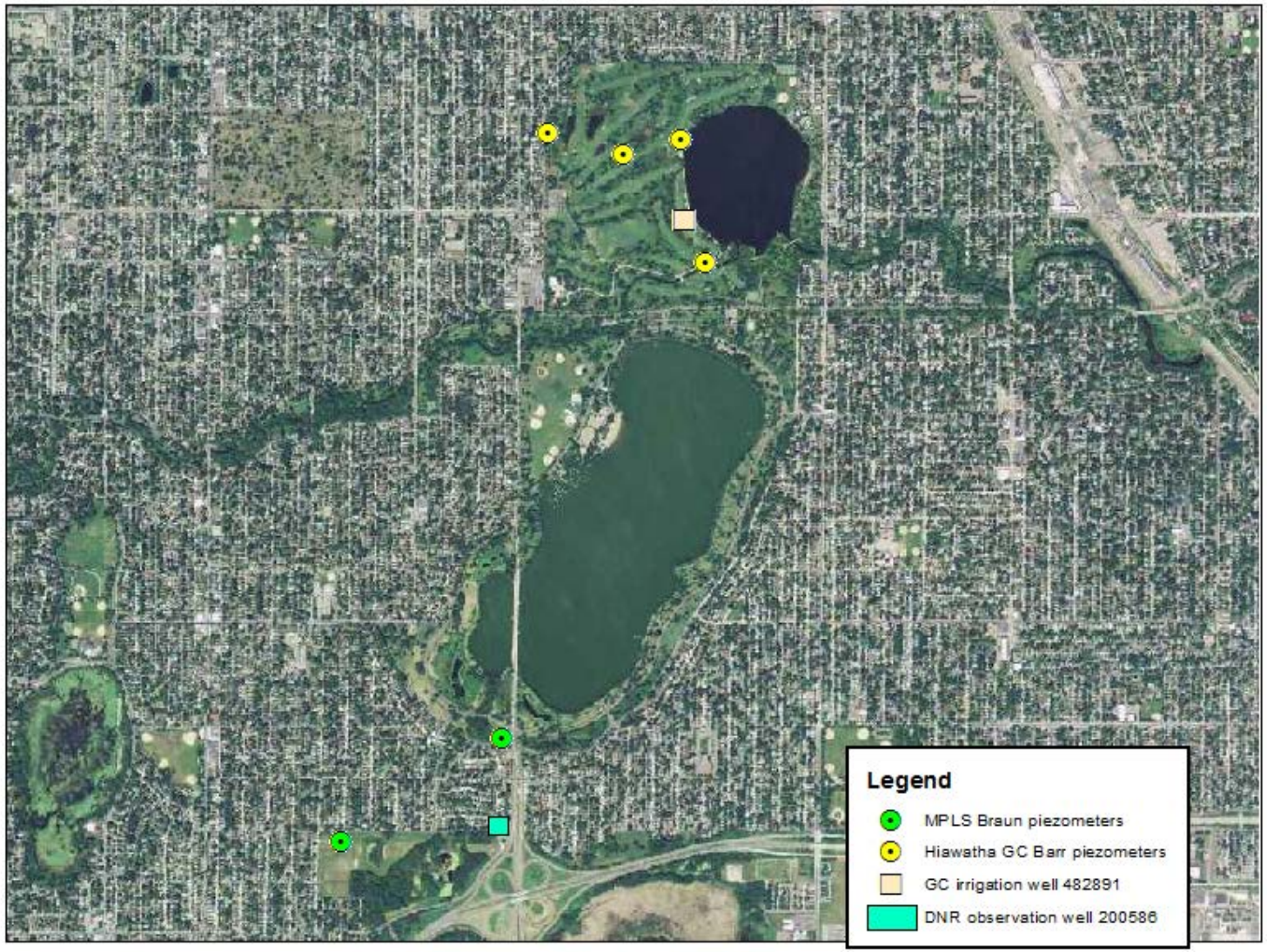
Status of DNR groundwater technical review of MPLS groundwater issues with level monitoring recommendations

Scott's Goals:

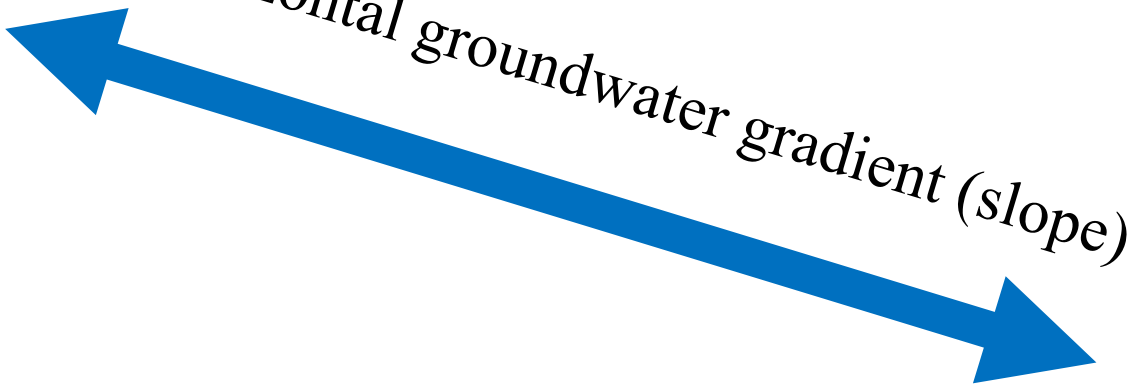
- Design a groundwater monitoring subnetwork to establish information regarding groundwater and surface water connectivity.
- Review existing information and develop theories on what may cause groundwater to rise.

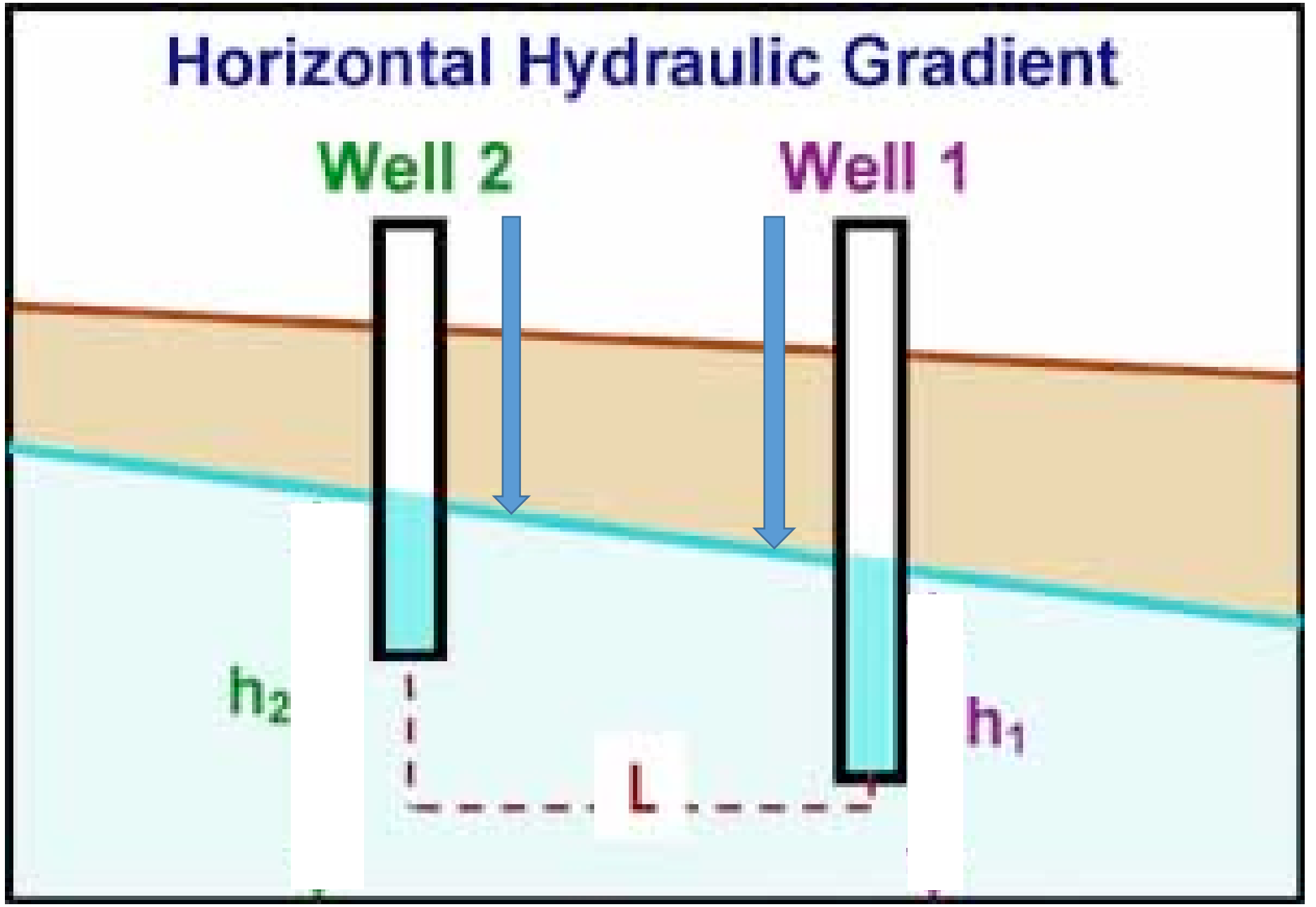
Existing groundwater monitoring locations



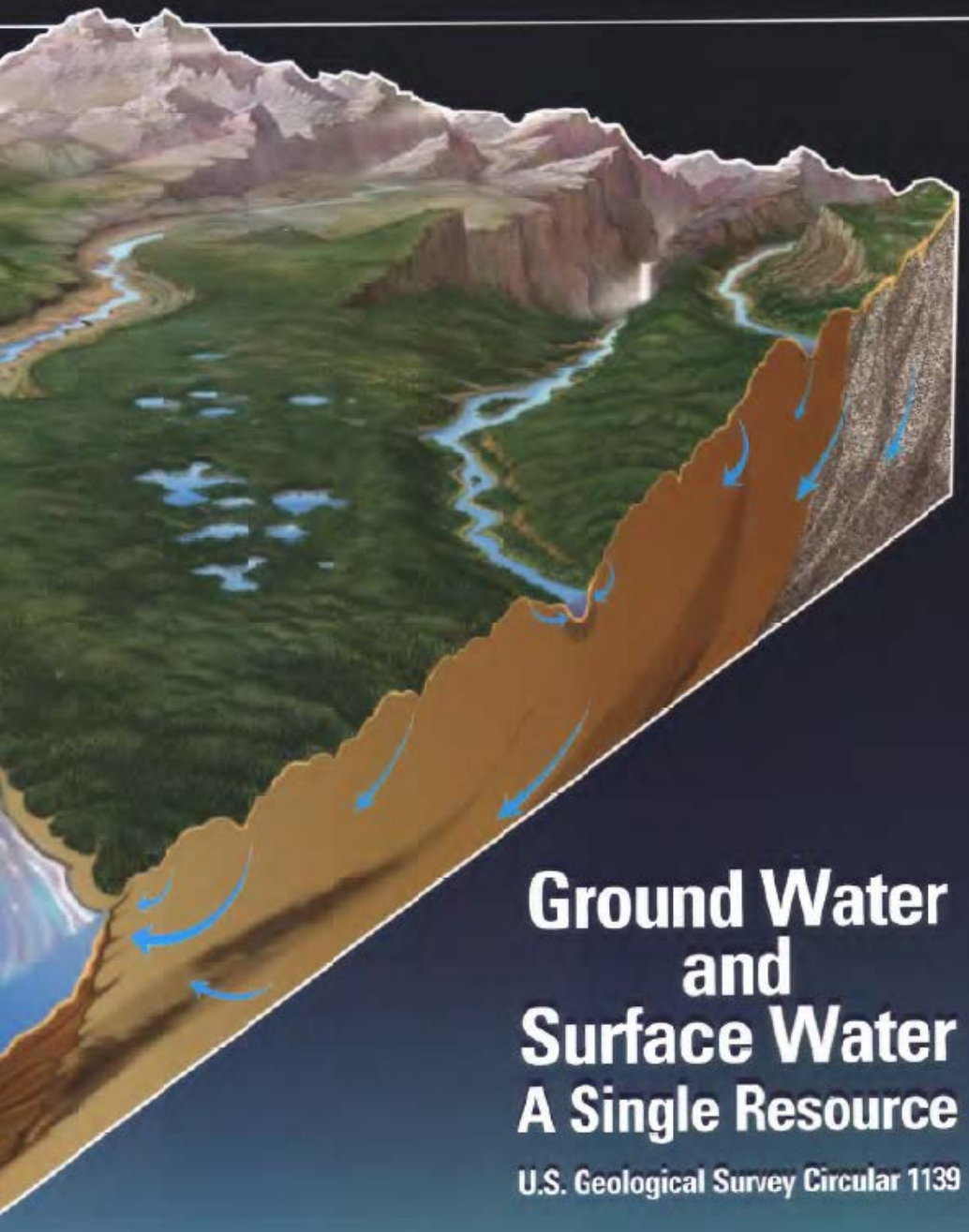
Groundwater and surface water connectivity

Vertical groundwater gradient (head)




Horizontal Hydraulic Gradient
Well 2
Well 1
h2
h1
L

USGS
science for a changing world



Ground Water and Surface Water
A Single Resource

U.S. Geological Survey Circular 1139

Concepts of Ground Water, Water Table, and Flow Systems

SUBSURFACE WATER

Water beneath the land surface occurs in two principal zones, the unsaturated zone and the saturated zone (Figure A–1). In the unsaturated zone, the voids—that is, the spaces between grains of gravel, sand, silt, clay, and cracks within rocks—contain both air and water. Although a considerable amount of water can be present in the unsaturated zone, this water cannot be pumped by wells because it is held too tightly by capillary forces. The upper part of the unsaturated zone is the soil-water zone. The soil zone is crisscrossed by roots, voids left by decayed roots, and animal and worm burrows, which enhance the infiltration of precipitation into the soil zone. Soil water is used by plants in life functions and transpiration, but it also can evaporate directly to the atmosphere.

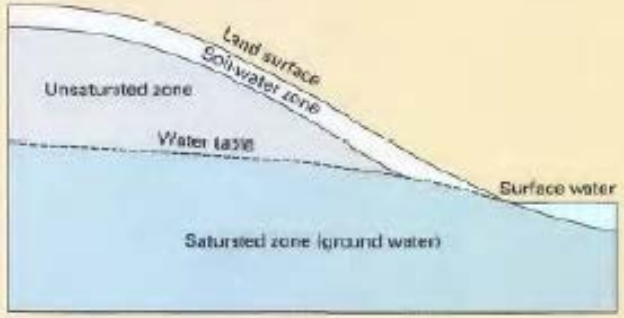
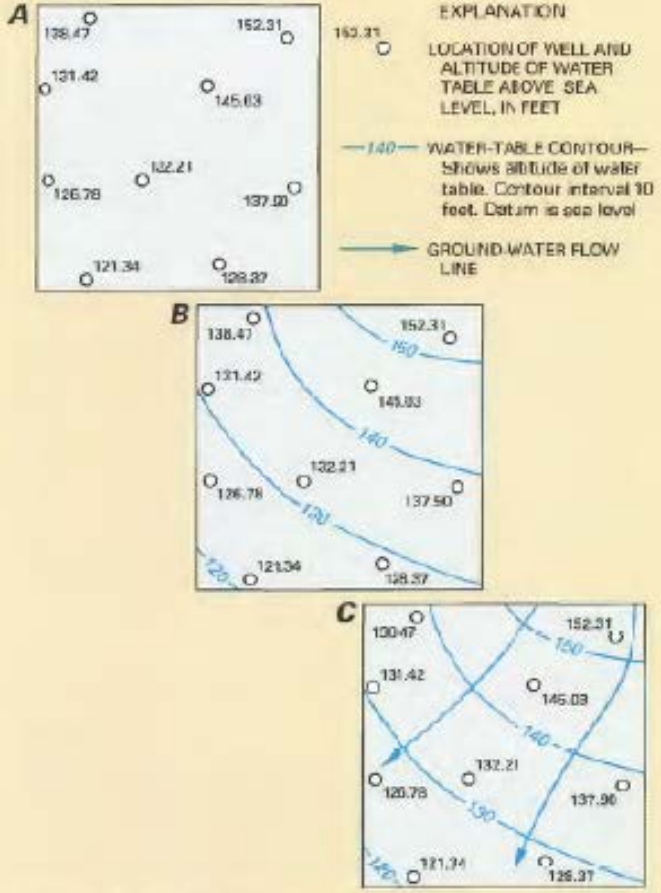


Figure A–1. *The water table is the upper surface of the saturated zone. The water table meets surface water bodies at or near the shoreline of surface water if the surface-water body is connected to the ground-water system.*

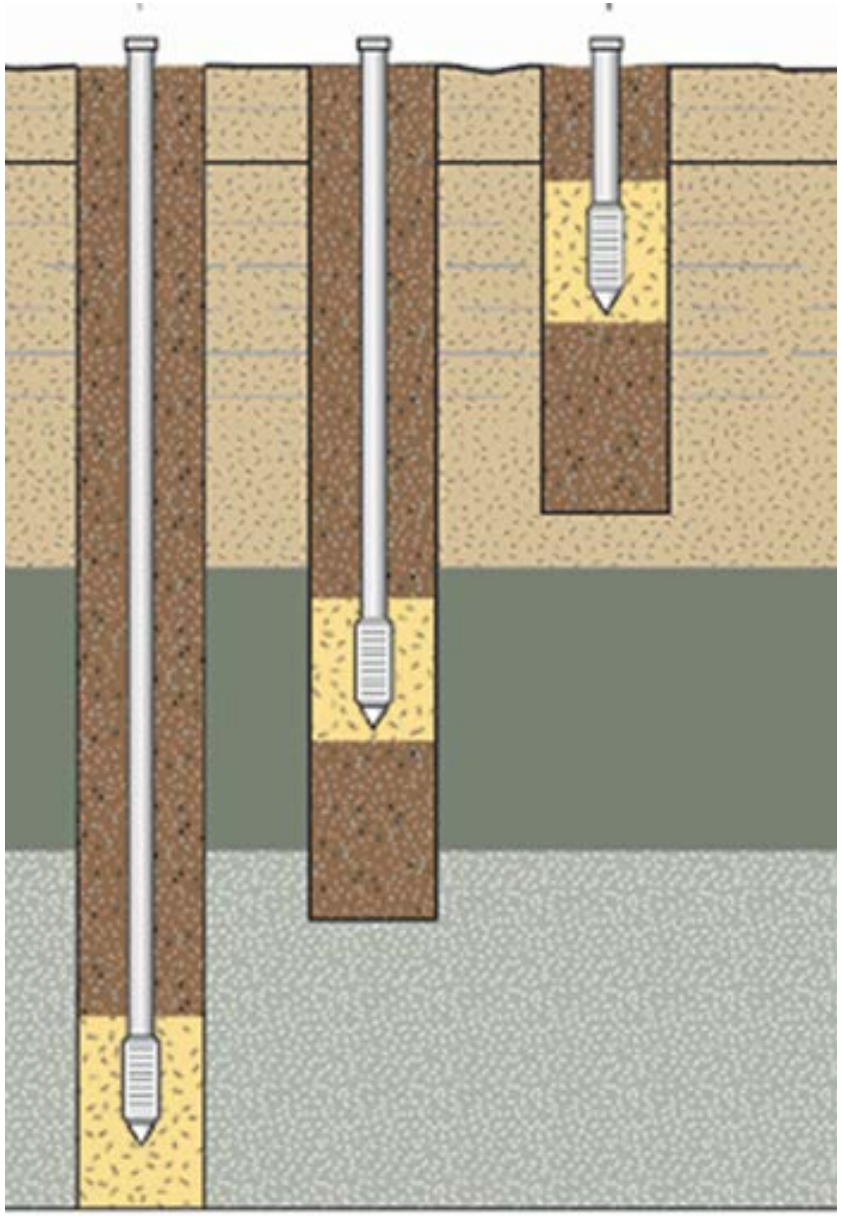
In contrast to the unsaturated zone, the voids in the saturated zone are completely filled with water. Water in the saturated zone is referred to as ground water. The upper surface of the saturated zone is referred to as the water table. Below the water table, the water pressure is great enough to allow water to enter wells, thus permitting ground water to be withdrawn for use. A well is constructed by inserting a pipe into a drilled hole; a screen is attached, generally at its base, to prevent earth materials from entering the pipe along with the water pumped through the screen.

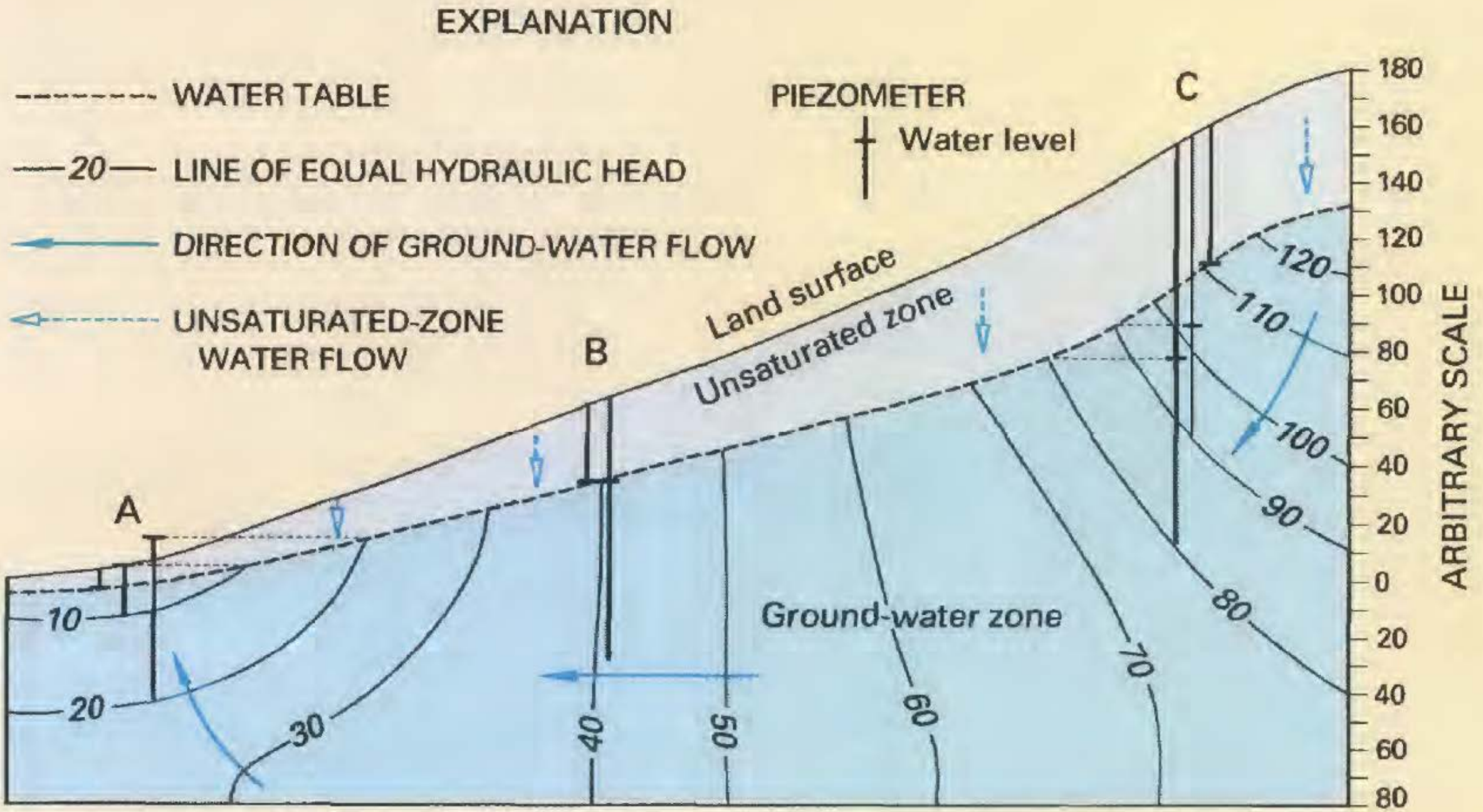
THE WATER TABLE

The depth to the water table can be determined by installing wells that penetrate the top of the saturated zone just far enough to hold standing water. Preparation of a water-table map requires that only wells that have their well screens placed near the water table be used. If the depth to water is measured at a number of such wells throughout an area of study, and if those water levels are referenced to a common datum such as sea level, the data can be contoured to indicate the configuration of the water table (Figure A–2).



Vertical Hydraulic Gradient from nested wells

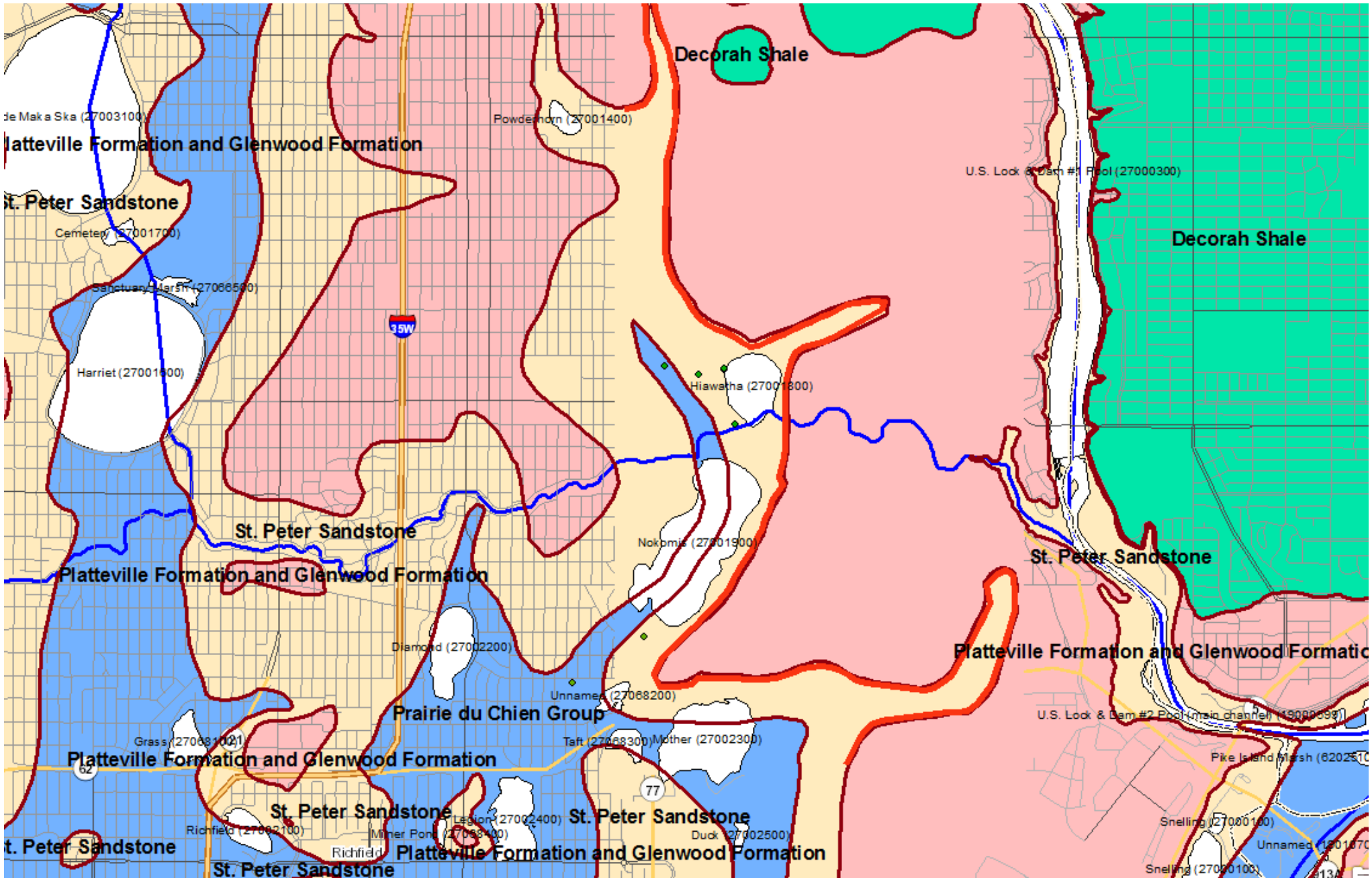



EXPLANATION
WATER TABLE
20
LINE OF EQUAL HYDRAULIC HEAD
DIRECTION OF GROUND-WATER FLOW
UNSATURATED-ZONE WATER FLOW
PIEZOMETER
Water level
A
B
C
Land surface
Unsaturated zone
Ground-water zone
10
20
30
40
50
60
70
80
90
100
110
120
180
160
140
120
100
80
60
40
20
0
20
40
60
80
ARBITRARY SCALE


Unconsolidated
Platteville Limestone
Glenwood Shale
St. Peter Sandstone

M-194 Bedrock Geology of the Twin Cities Ten-County Metropolitan Area, Minnesota

Mossler, John H. (2013)



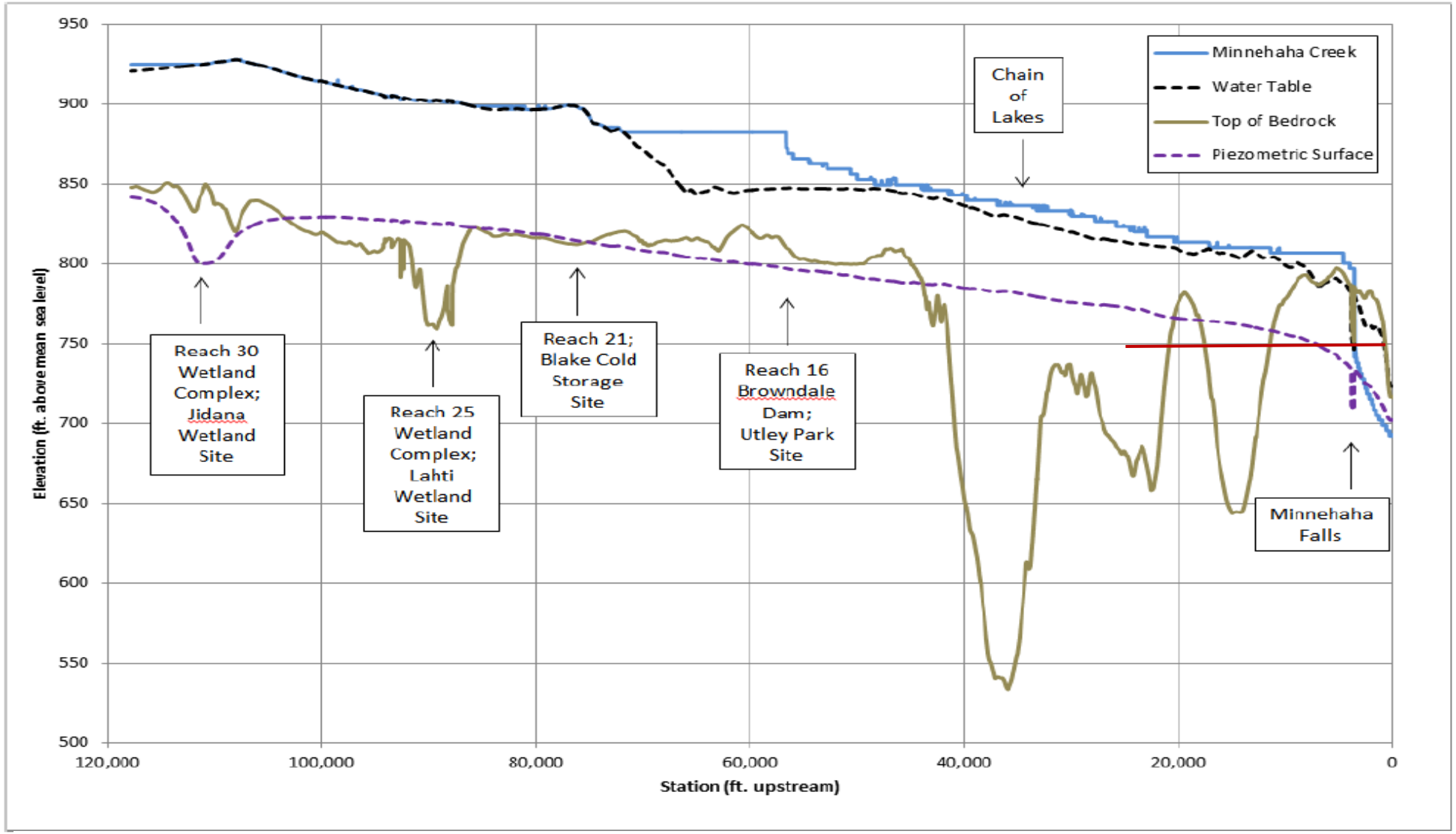
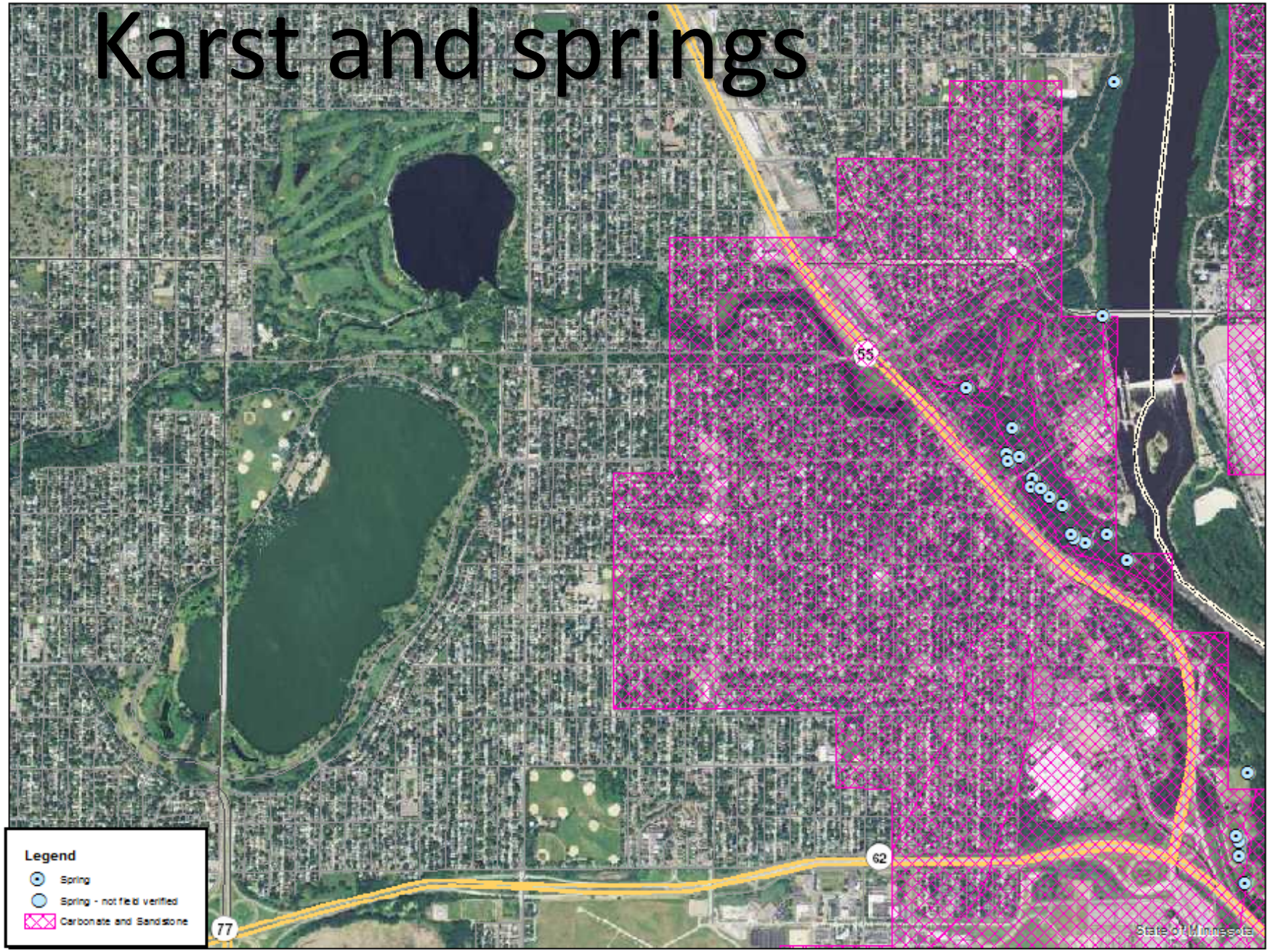
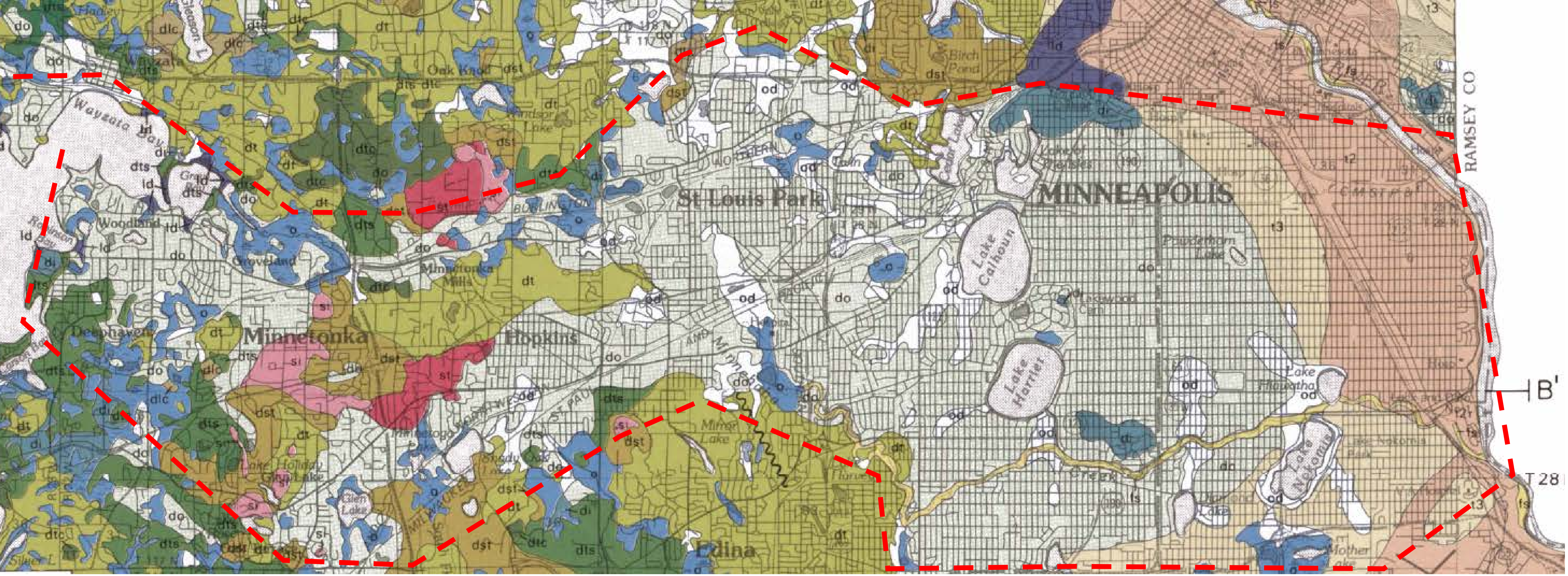
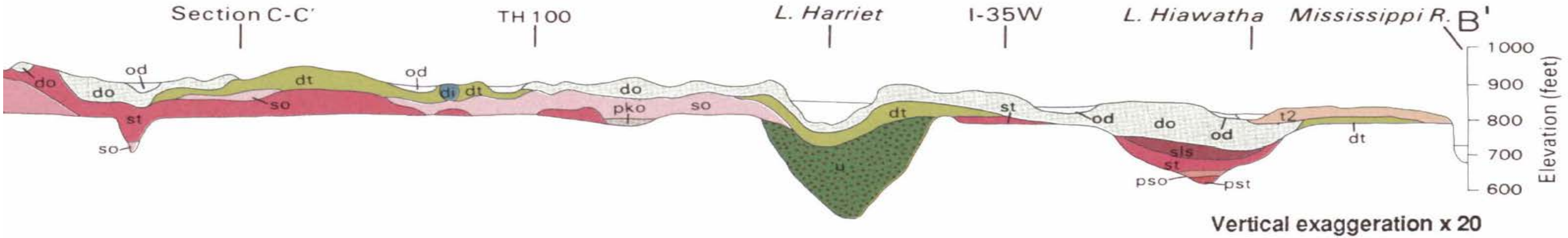


Figure 17. Long profile depicting surficial and bedrock aquifer systems along the length of Minnehaha Creek. Long profile created within ArcScene using 1 M LiDAR surface (MnGeo 2011) and water table, top of bedrock, and piezometric surface data (Tipping, 2011).

Karst and springs

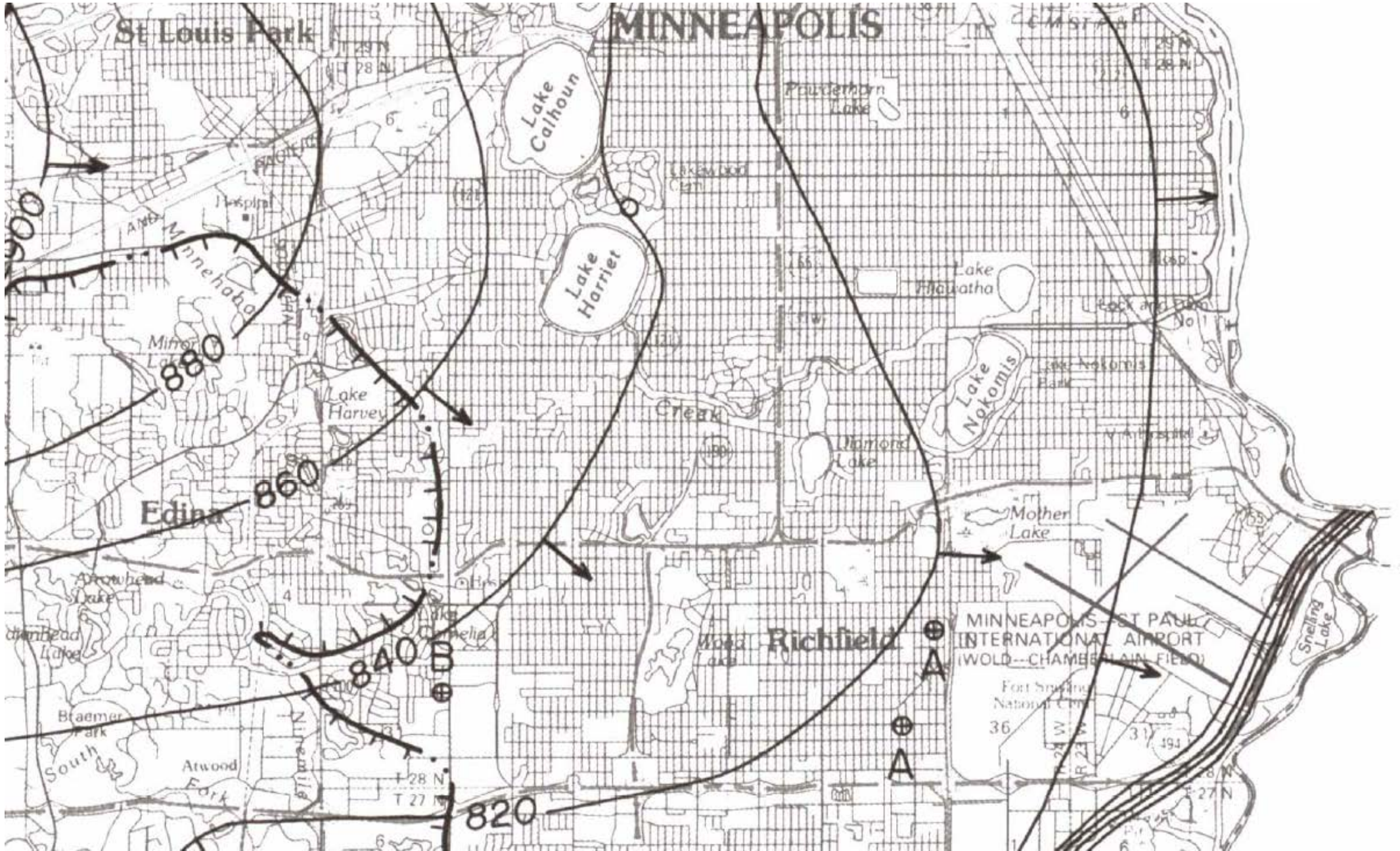



Wayzata
Wayzata Bay
Woodland
Groveland
Deephaven
Minnetonka
Minnetonka Mills
Hopkins
St Louis Park
MINNEAPOLIS
Edina
Oak Knoll
Birch Pond
Lake Calhoun
Lake Harriet
Lake Hiawatha
Lake Nokomis
Powderhorn Lake
Mirror Lake
Glen Lake
RAMSEY CO
B'
T 28
BURLINGTON
NORTHERN
do
od
dt
dts
dtc
dlc
dst
ld
di
o
si
st
t2
t3
fs


Section C-C'
TH 100
L. Harriet
I-35W
L. Hiawatha
Mississippi R.
B'
1000
900
800
700
600
Elevation (feet)
do
od
dt
di
so
st
pko
u
sls
pso
pst
t2
Vertical exaggeration x 20

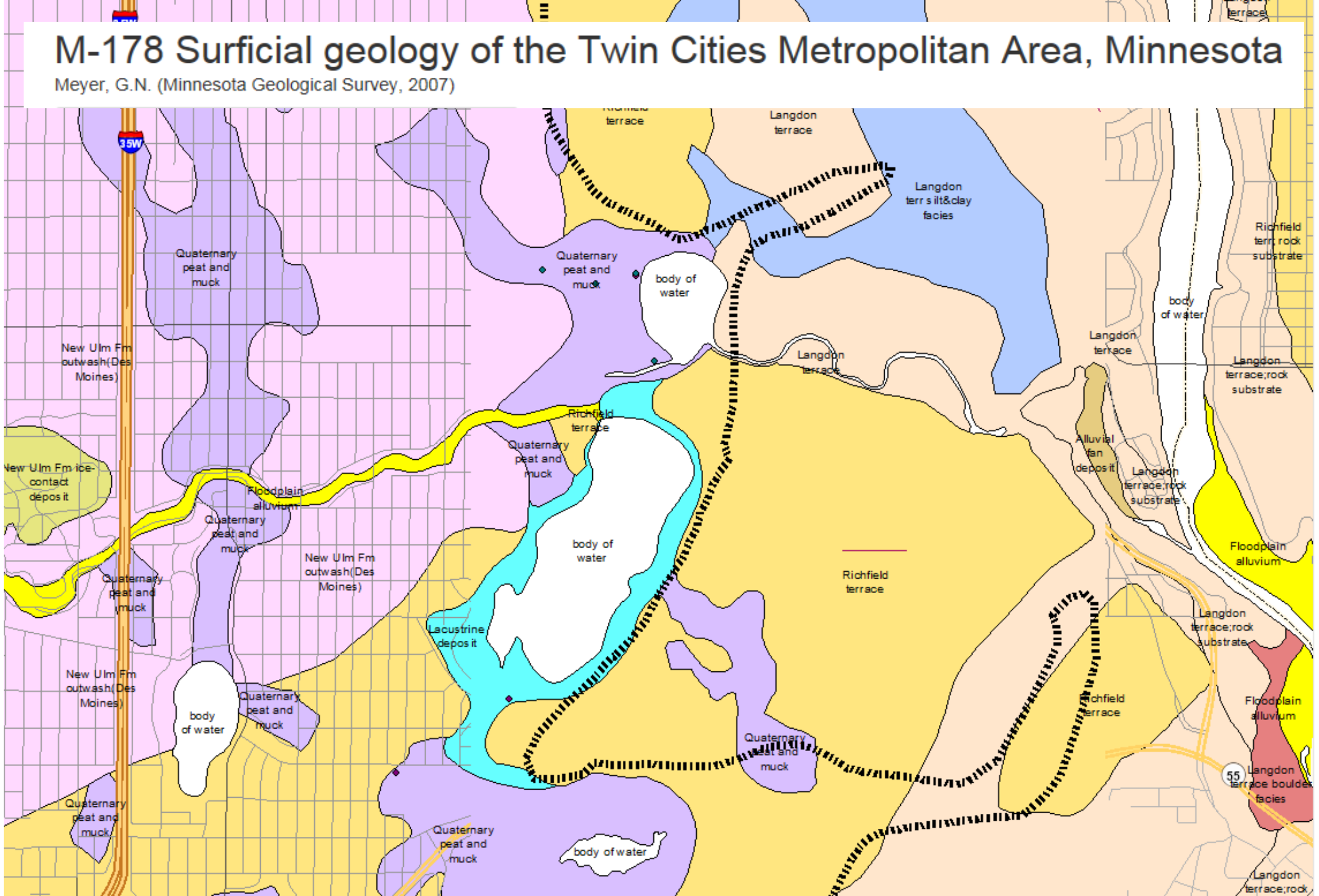
C-04 Geologic atlas of Hennepin County, Minnesota

Balaban, N.H. (Minnesota Geological Survey, 1989)

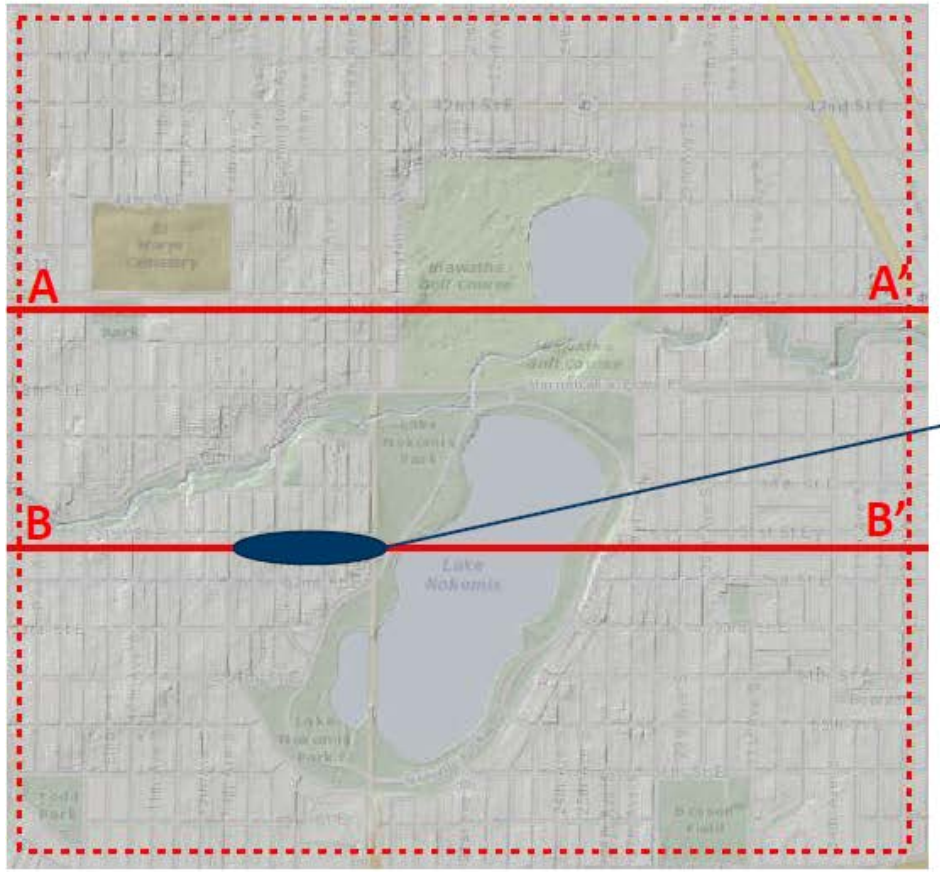


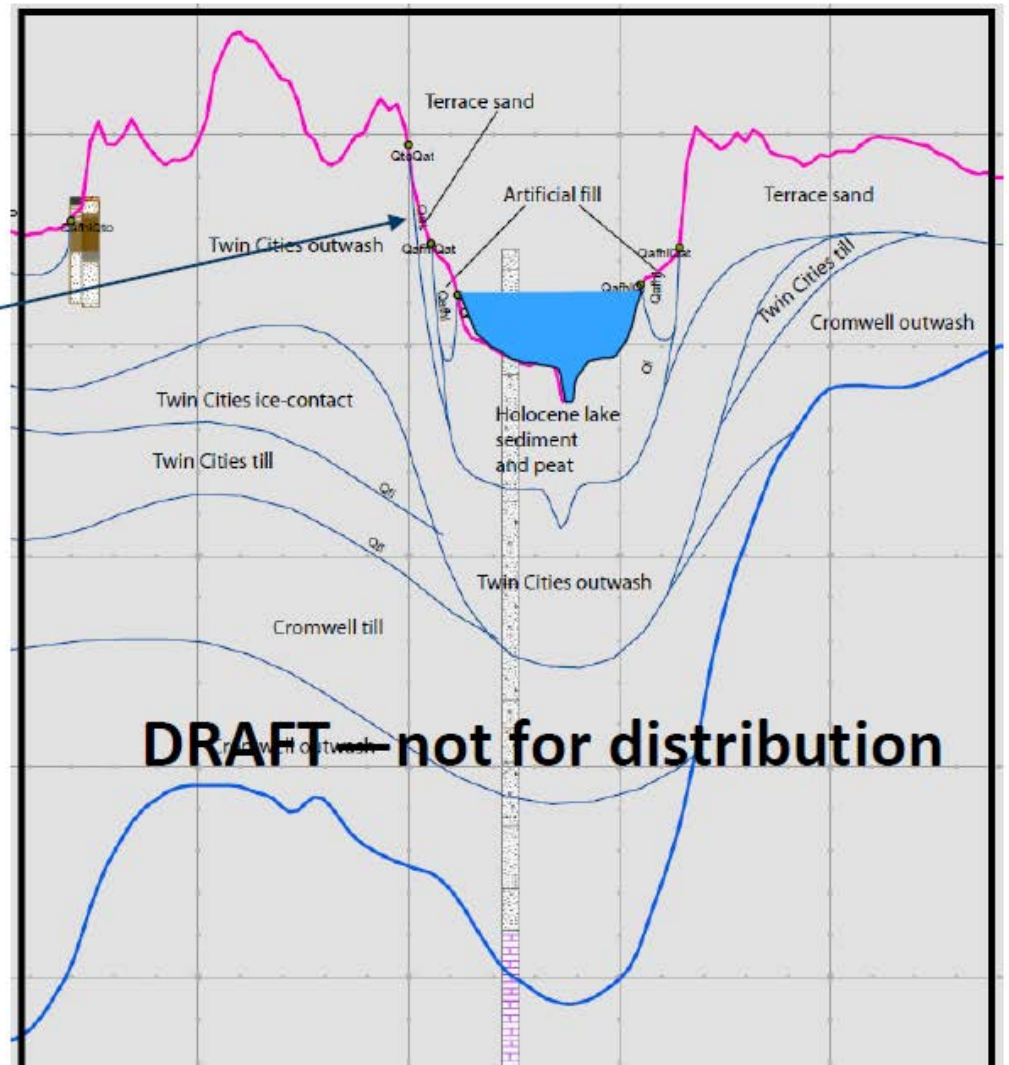
M-178 Surficial geology of the Twin Cities Metropolitan Area, Minnesota

Meyer, G.N. (Minnesota Geological Survey, 2007)

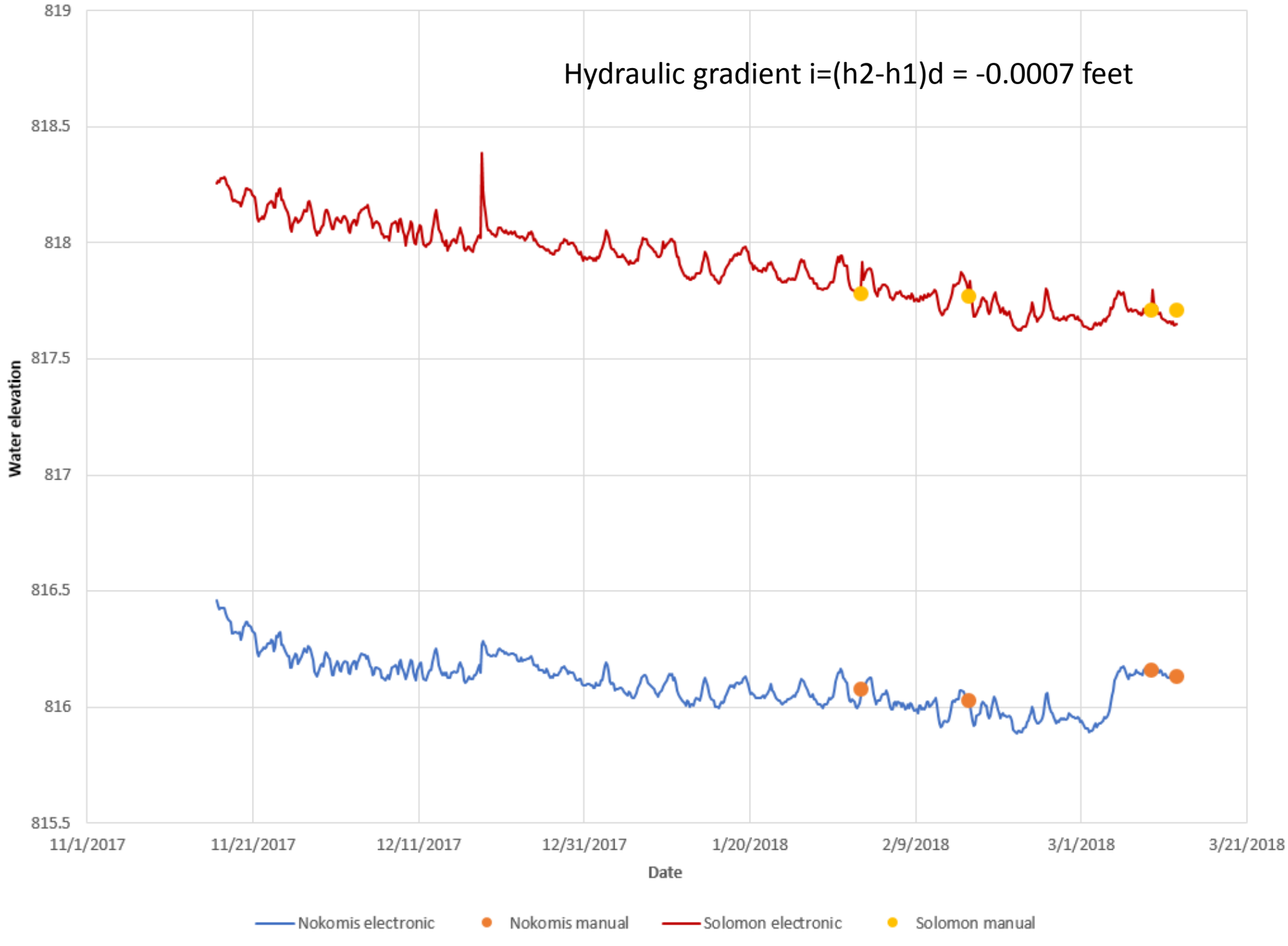


Local hydrogeology—geologic cross-sections

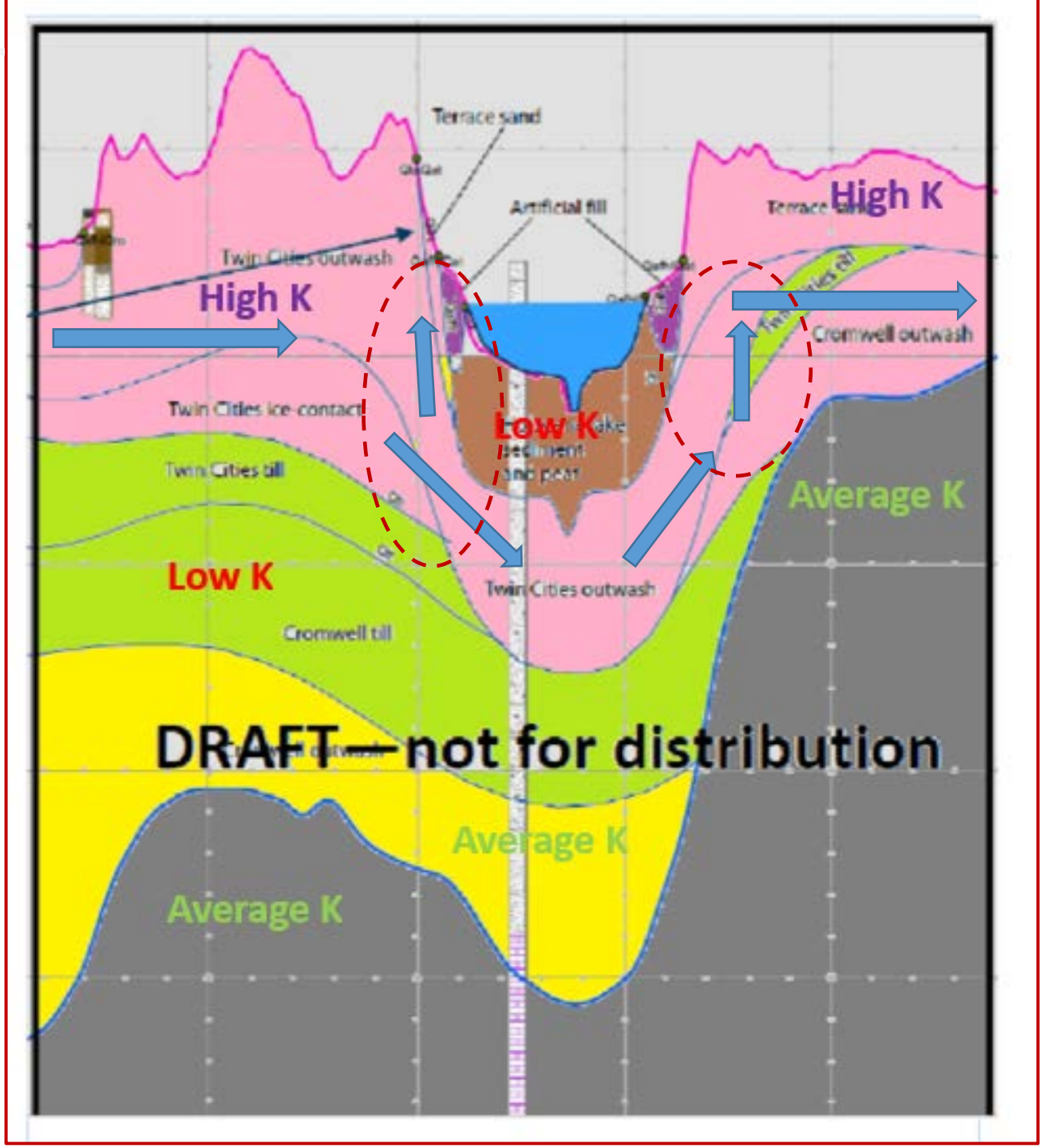




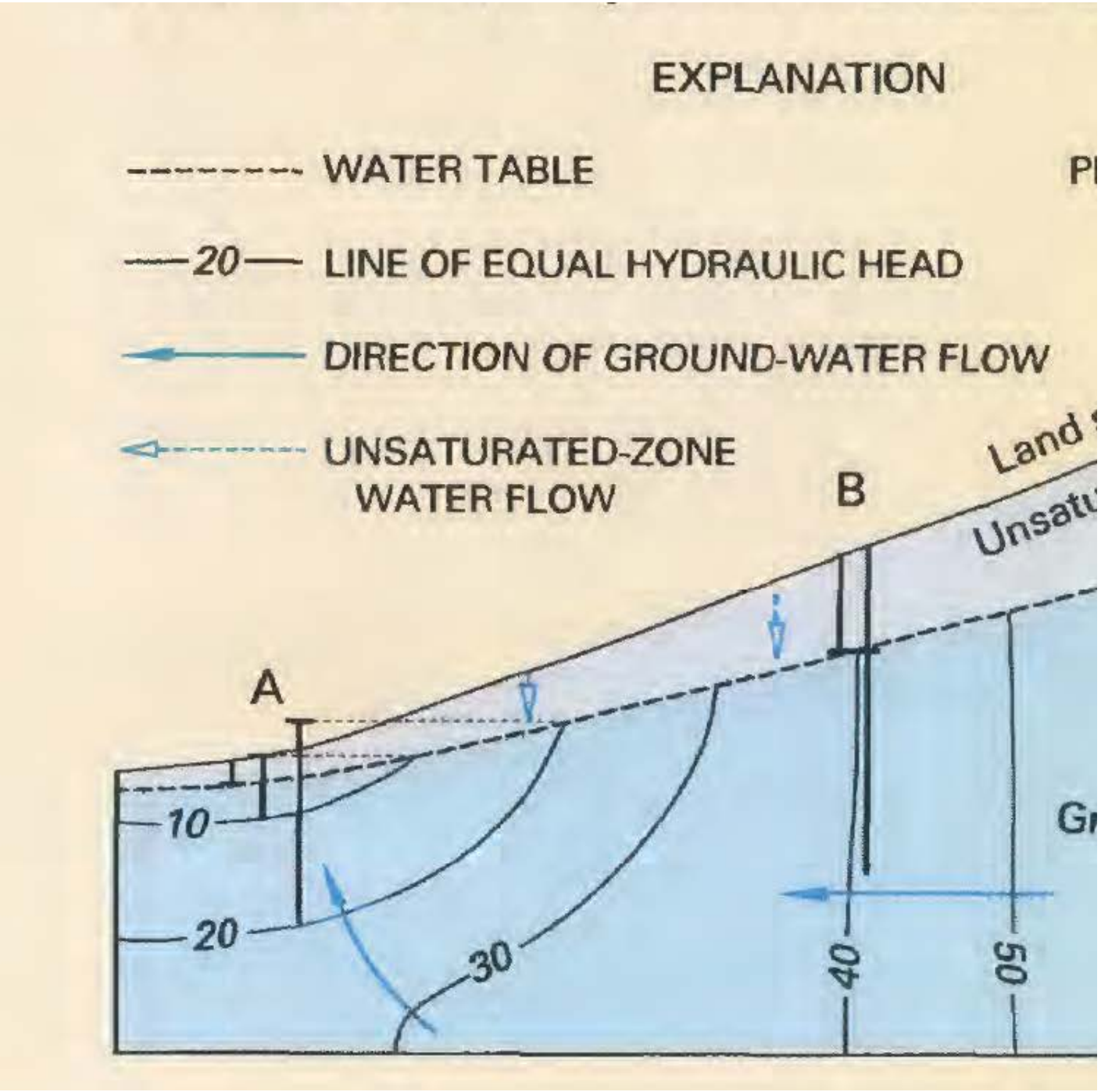
Cross-sections courtesy of Angela Berthold with the Minnesota Geological Survey


Hydraulic gradient i=(h2-h1)d = -0.0007 feet
819
818.5
818
817.5
817
816.5
816
815.5
Water elevation
11/1/2017
11/21/2017
12/11/2017
12/31/2017
1/20/2018
2/9/2018
3/1/2018
3/21/2018
Date
Nokomis electronic
Nokomis manual
Solomon electronic
Solomon manual

Theory



Or around….


EXPLANATION
WATER TABLE
20
LINE OF EQUAL HYDRAULIC HEAD
DIRECTION OF GROUND-WATER FLOW
UNSATURATED-ZONE WATER FLOW
A
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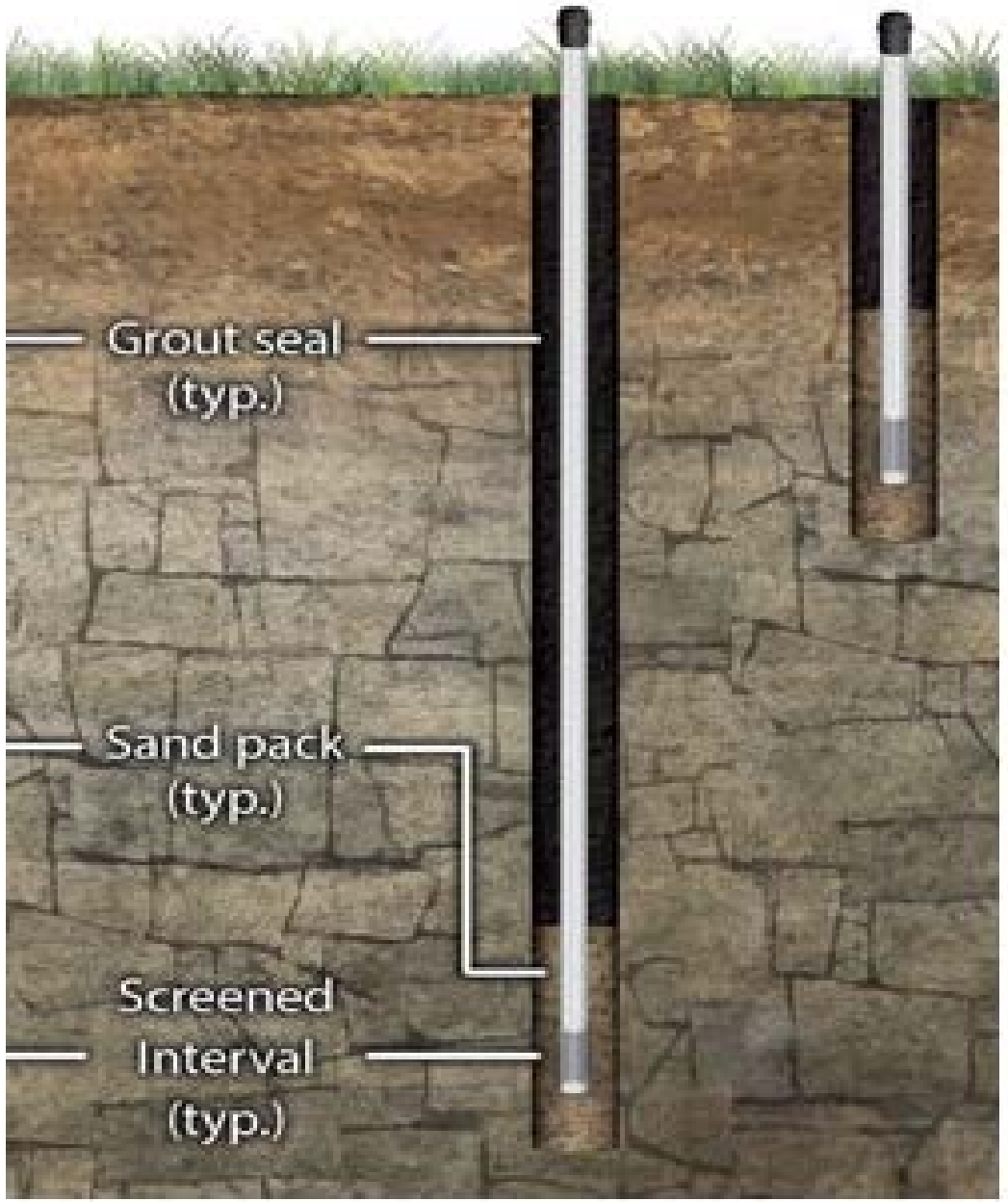
10
20
30
40
50


Grout seal (typ.)
Sand pack (typ.)
Screened Interval (typ.)


Legend
Proposed nested observation wells
City_of_MPLS_observation_wells
GC_irrigation_well
GC_water_table_observation_wells
DNR_observation_well_OPDC

Take away points

1. Two geologic features have been identified which may affect water levels in the water table aquifer.
   A. Bedrock.
   B. Peat and fine grained earth materials.
2. The DNR recommends installing four new observations wells to identify and collect water level information to determine the horizontal and vertical gradients in the water table aquifer.