

HOW WATER MOVES THROUGH SOIL

A BRIEF REFRESHER

CHRISTOPHER HOMES, P.GEO.

WESTERN WATER ASSOCIATES LTD. 2020

HOW WATER MOVES THROUGH SOIL

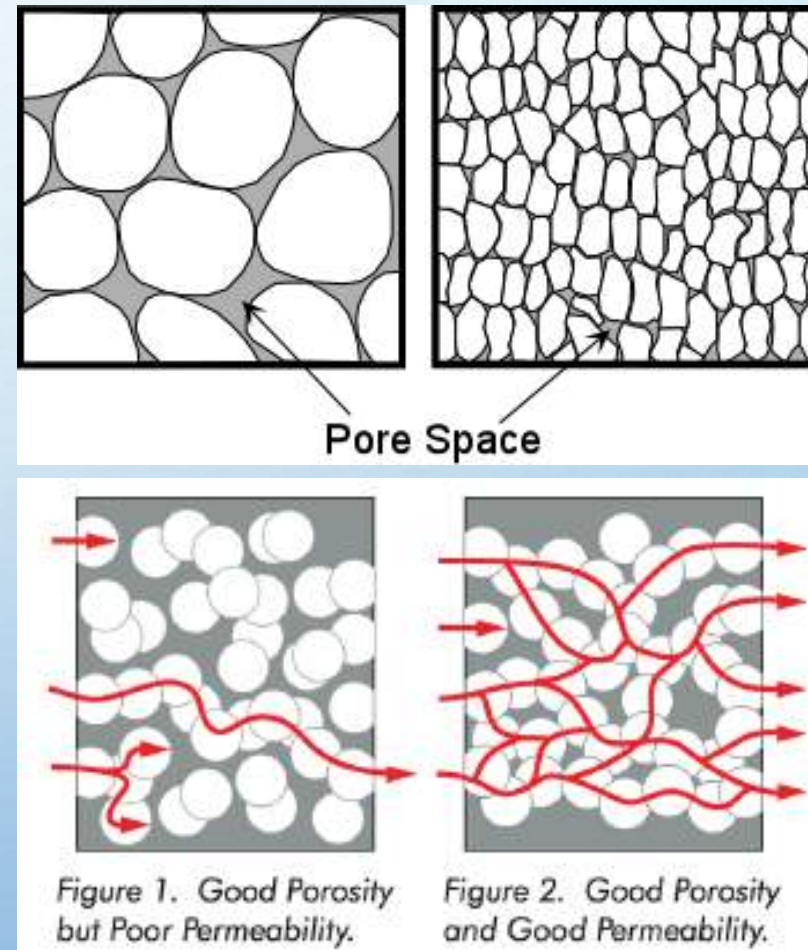
- THE EFFECT OF SOIL TEXTURE AND STRUCTURE ON WATER FLOW THROUGH SOILS
- HOW WE MEASURE INFILTRATION INTO THE SOIL
 - PERCOLATION TESTS
 - PERMEAMETERS
 - DOUBLE RING INFILTROMETER
- TRANSIT TIMES THROUGH SOIL – SATURATED VS UNSATURATED
- GROUNDWATER MOUNDING
- PERCHED WATER TABLES
- AEROBIC AND ANAEROBIC CONDITIONS

HOW WATER MOVES THROUGH SOIL

- THE EFFECT OF SOIL TEXTURE AND STRUCTURE ON WATER FLOW THROUGH SOILS

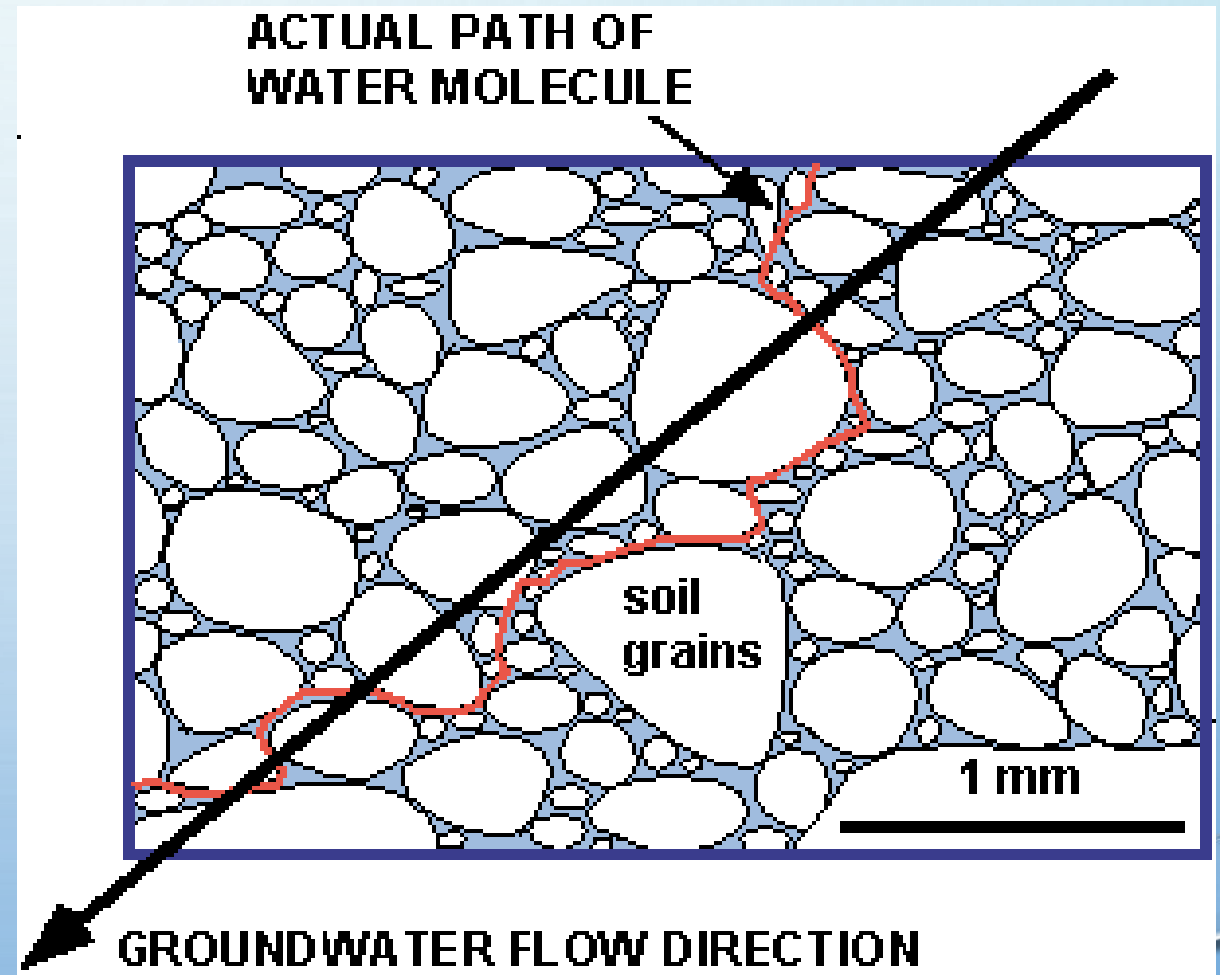
THE EFFECT OF SOIL TEXTURE AND STRUCTURE ON WATER FLOW THROUGH SOILS

- SOIL IS MADE UP OF SOIL AND VOID SPACE
- WATER MOVES THROUGH SOIL AT A RATE GOVERNED BY THE SIZE AND ARRANGEMENT OF THE SOIL PARTICLES
 - POROSITY
 - PERMEABILITY
 - HYDRAULIC CONDUCTIVITY
 - TRANSMISSIVITY
- IF THAT WERE ALL, ONE GRAIN SIZE DISTRIBUTION WOULD BE ENOUGH

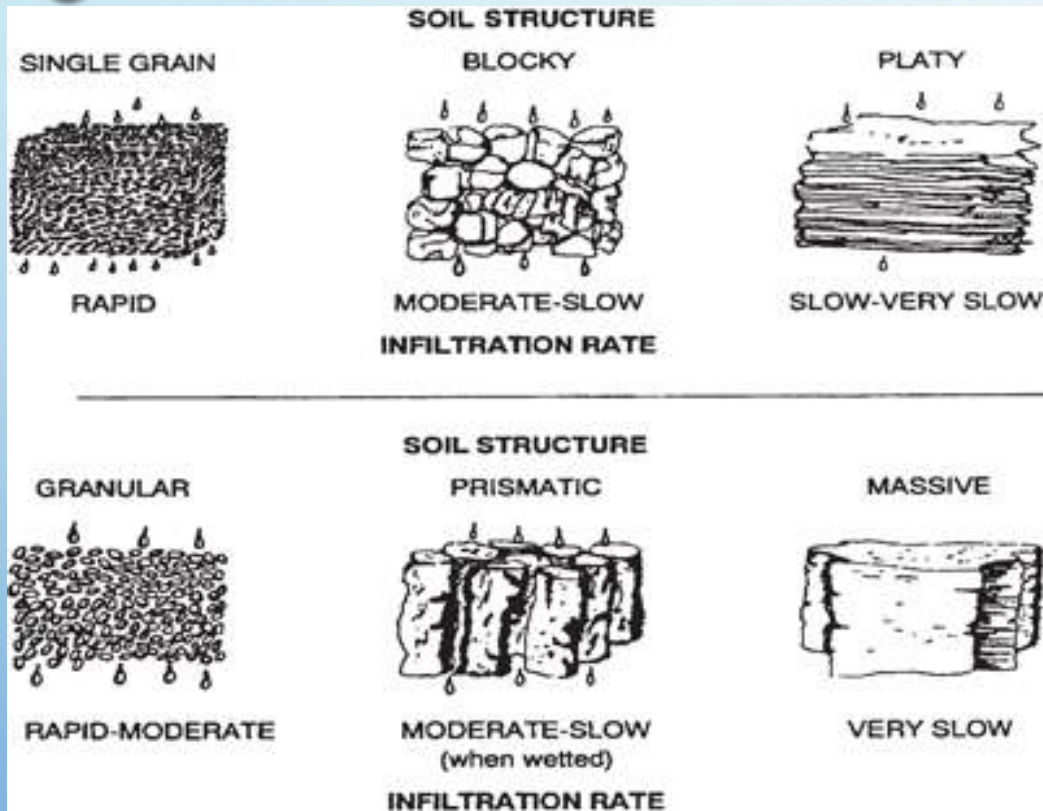


THE EFFECT OF SOIL TEXTURE AND STRUCTURE ON WATER FLOW THROUGH SOILS

- SOIL IS MADE UP OF SOIL AND VOID SPACE
- WATER MOVES THROUGH SOIL AT A RATE GOVERNED BY THE SIZE AND ARRANGEMENT OF THE SOIL PARTICLES
 - POROSITY
 - PERMEABILITY
 - HYDRAULIC CONDUCTIVITY
 - TRANSMISSIVITY
- IF THAT WERE ALL, ONE GRAIN SIZE DISTRIBUTION WOULD BE ENOUGH



THE EFFECT OF SOIL TEXTURE AND STRUCTURE ON WATER FLOW THROUGH SOILS



- SOIL ALSO HAS FABRIC AND STRUCTURE
- HOMOGENEOUS VS HETEROGENEOUS
- DEPENDANT ON PARENT ROCK, ENERGY, DEPOSITIONAL ENVIRONMENT
 - FLUVIAL
 - LACUSTRINE
 - GLACIAL
 - AEOLIAN
- NEED FOR SITE-SPECIFIC HYDRAULIC TESTING TO CHARACTERIZE INFILTRATION

THE EFFECT OF SOIL TEXTURE AND STRUCTURE ON WATER FLOW THROUGH SOILS



- SOIL ALSO HAS FABRIC AND STRUCTURE
- HOMOGENEOUS VS HETEROGENEOUS
- DEPENDANT ON PARENT ROCK, ENERGY, DEPOSITIONAL ENVIRONMENT
 - FLUVIAL
 - LACUSTRINE
 - GLACIAL
 - AEOLIAN
- NEED FOR SITE-SPECIFIC HYDRAULIC TESTING TO CHARACTERIZE INFILTRATION

THE EFFECT OF SOIL TEXTURE AND STRUCTURE ON WATER FLOW THROUGH SOILS



- SOIL ALSO HAS FABRIC AND STRUCTURE
- HOMOGENEOUS VS HETEROGENEOUS
- DEPENDANT ON PARENT ROCK, ENERGY, DEPOSITIONAL ENVIRONMENT
 - FLUVIAL
 - LACUSTRINE
 - GLACIAL
 - AEOLIAN
- NEED FOR SITE-SPECIFIC HYDRAULIC TESTING TO CHARACTERIZE INFILTRATION

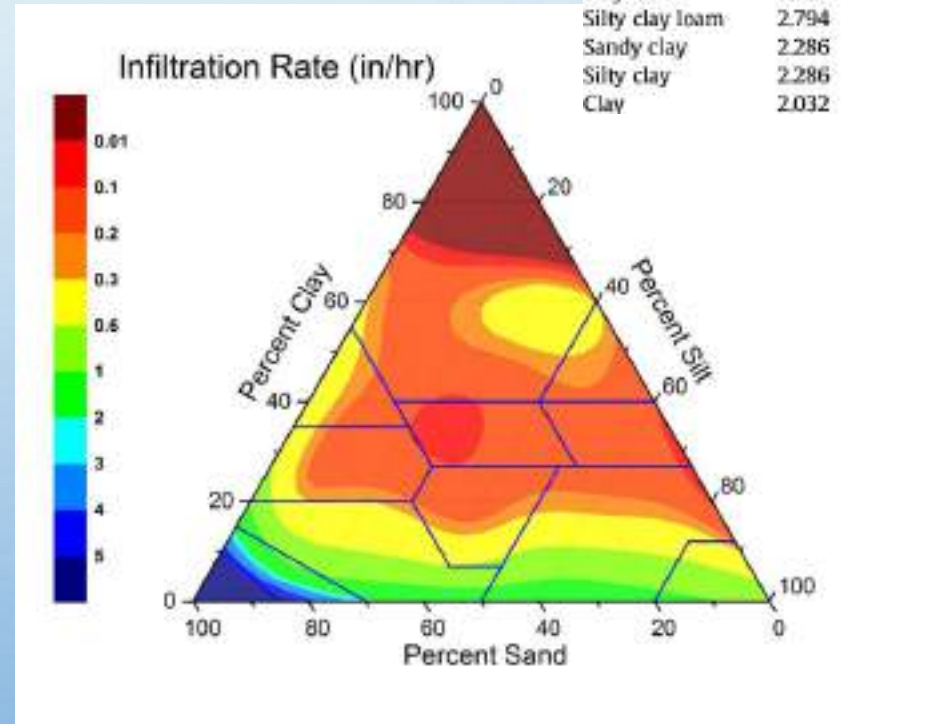
HOW WATER MOVES THROUGH SOIL

- HOW WE MEASURE INFILTRATION INTO THE SOIL
 - PERCOLATION TESTS
 - PERMEAMETERS
 - DOUBLE RING INFILTROMETER

HOW WE MEASURE INFILTRATION INTO THE SOIL

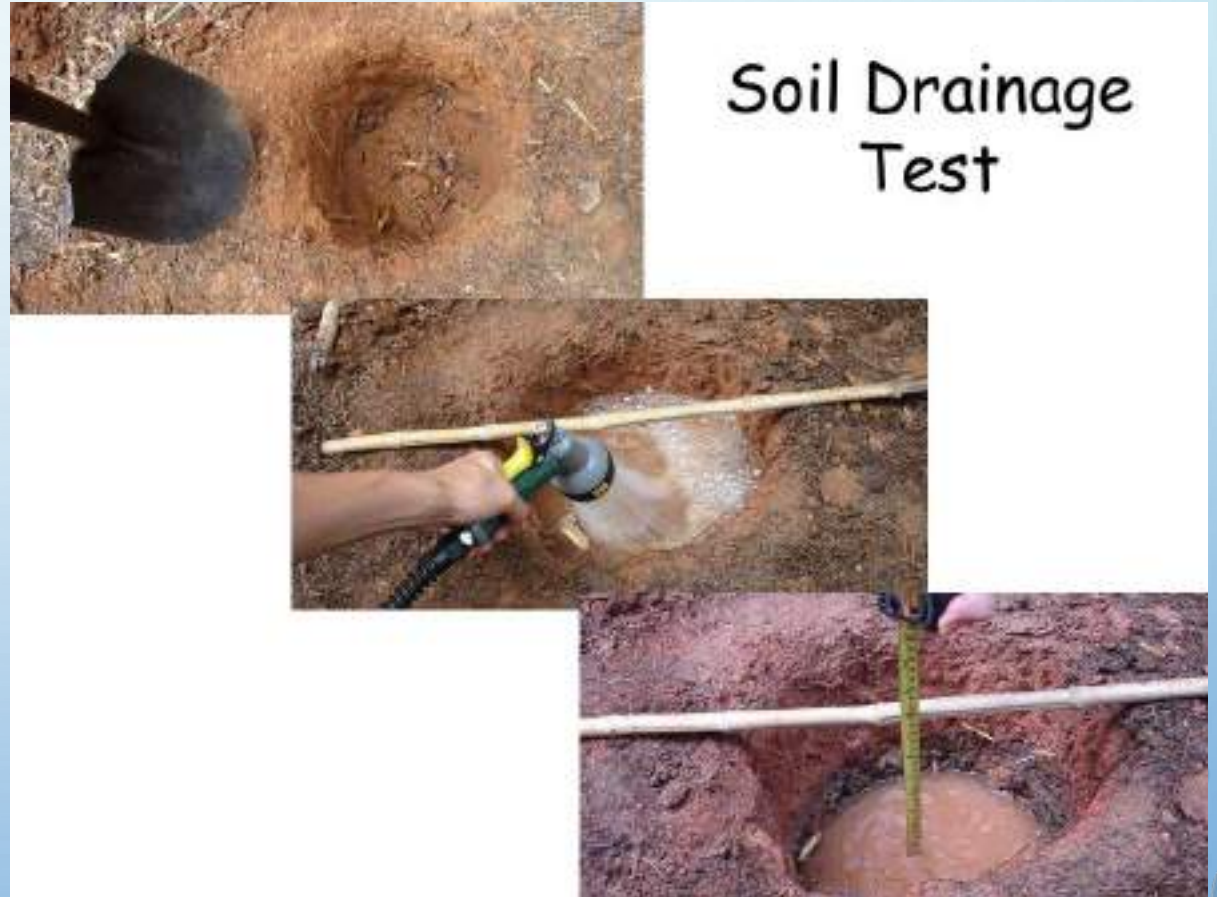
- GOVERNED BY THE DEGREE OF RELIABILITY REQUIRED
- “TEXTBOOK VALUES”
- PERCOLATION TEST
- PERMEAMETER TEST
- DOUBLE-RING INFILTROMETER
- LARGER SCALE TEST-PITS OR BASINS

| Texture class | Effective water capacity (C _w) (mm) | Infiltration rate (f) (mm/hour) | Hydrologic soil grouping |
|-----------------|---|---------------------------------|--------------------------|
| Sand | 8.89 | 210.1 | A |
| Loamy sand | 7.874 | 61.2 | A |
| Sandy loam | 6.35 | 25.9 | A |
| Loam | 4.826 | 13.2 | B |
| Silt loam | 4.318 | 6.9 | B |
| Sandy clay loam | 3.556 | 4.3 | C |
| Clay loam | 3.556 | 2.3 | D |
| Silty clay loam | 2.794 | 1.5 | D |
| Sandy clay | 2.286 | 1.3 | D |
| Silty clay | 2.286 | 1.0 | D |
| Clay | 2.032 | 0.5 | D |



HOW WE MEASURE INFILTRATION INTO THE SOIL

- GOVERNED BY THE DEGREE OF RELIABILITY REQUIRED
- “TEXTBOOK VALUES”
- PERCOLATION TEST
- PERMEAMETER TEST
- DOUBLE-RING INFILTROMETER
- LARGER SCALE TEST-PITS OR BASINS



HOW WE MEASURE INFILTRATION INTO THE SOIL

- GOVERNED BY THE DEGREE OF RELIABILITY REQUIRED
- “TEXTBOOK VALUES”
- PERCOLATION TEST
- PERMEAMETER TEST
- DOUBLE-RING INFILTROMETER
- LARGER SCALE TEST-PITS OR BASINS



HOW WE MEASURE INFILTRATION INTO THE SOIL

- GOVERNED BY THE DEGREE OF RELIABILITY REQUIRED
- “TEXTBOOK VALUES”
- PERCOLATION TEST
- PERMEAMETER TEST
- DOUBLE-RING INFILTROMETER
- LARGER SCALE TEST-PITS OR BASINS



HOW WE MEASURE INFILTRATION INTO THE SOIL

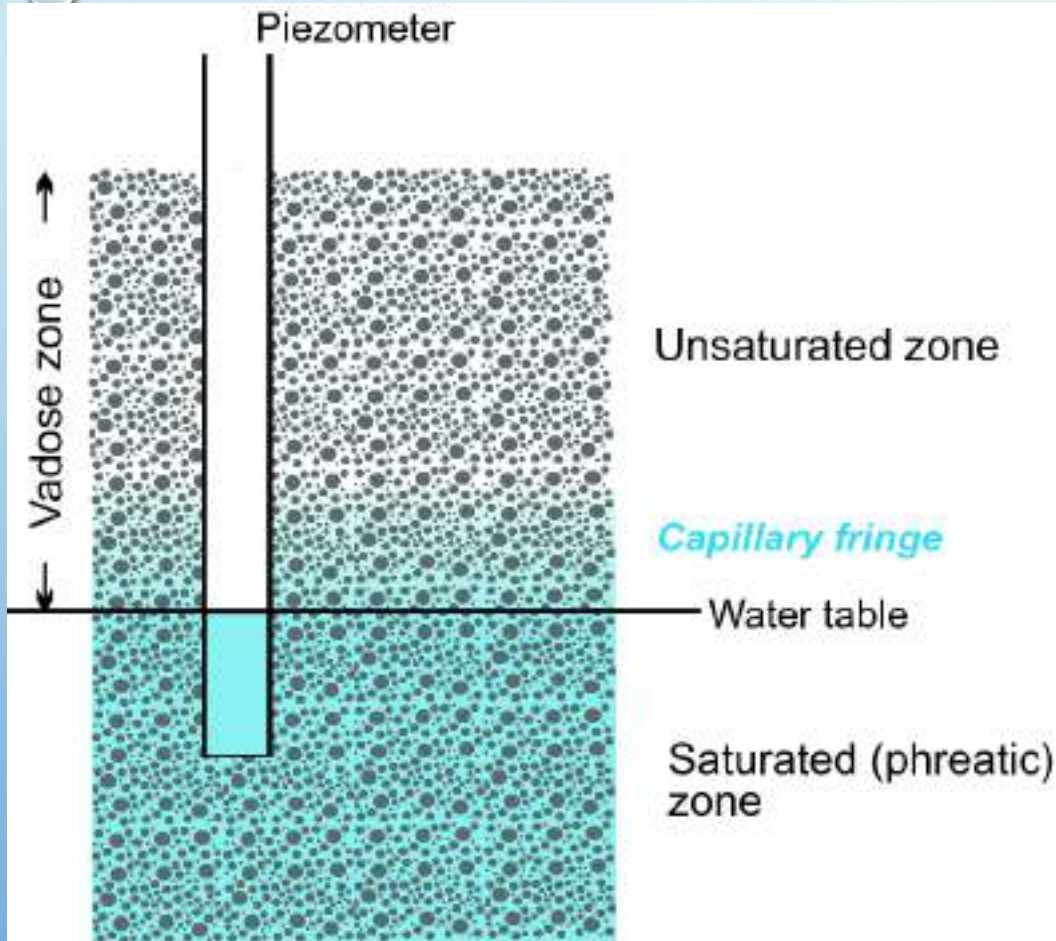
- GOVERNED BY THE DEGREE OF RELIABILITY REQUIRED
- “TEXTBOOK VALUES”
- PERCOLATION TEST
- PERMEAMETER TEST
- DOUBLE-RING INFILTROMETER
- LARGER SCALE TEST-PITS OR BASINS



HOW WATER MOVES THROUGH SOIL

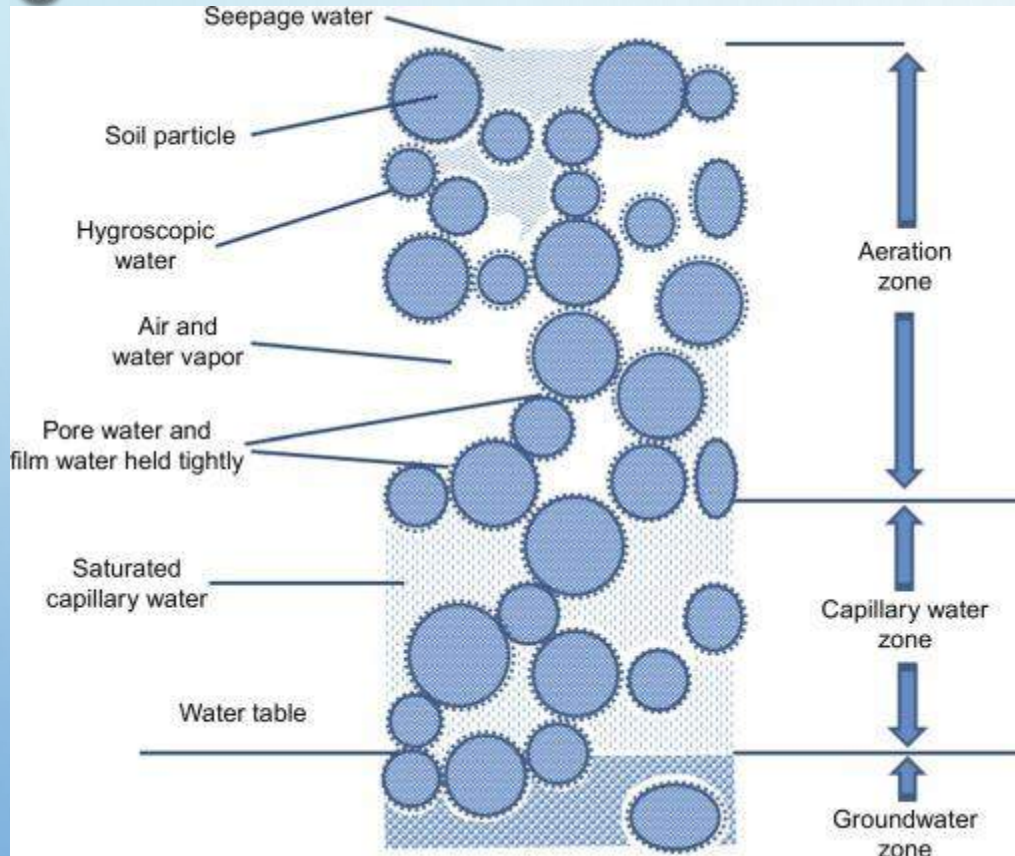
- TRANSIT TIMES THROUGH SOIL – SATURATED VS UNSATURATED

TRANSIT TIMES THROUGH SOIL SATURATED VS UNSATURATED



- SOIL HAS SEVERAL “ZONES” CLASSIFIED BY MOISTURE CONTENT AND SATURATION
 - UNSATURATED = VADOSE ZONE
 - SATURATED = PHREATIC ZONE
- SOIL CAN CONTAIN WATER = MOISTURE
- CAN BE INACCESSIBLE, DEPENDS ON GRAIN SPACING, SHAPE, COMPOSITION
- MATH WORKS FOR SATURATED CONDITIONS

TRANSIT TIMES THROUGH SOIL SATURATED VS UNSATURATED



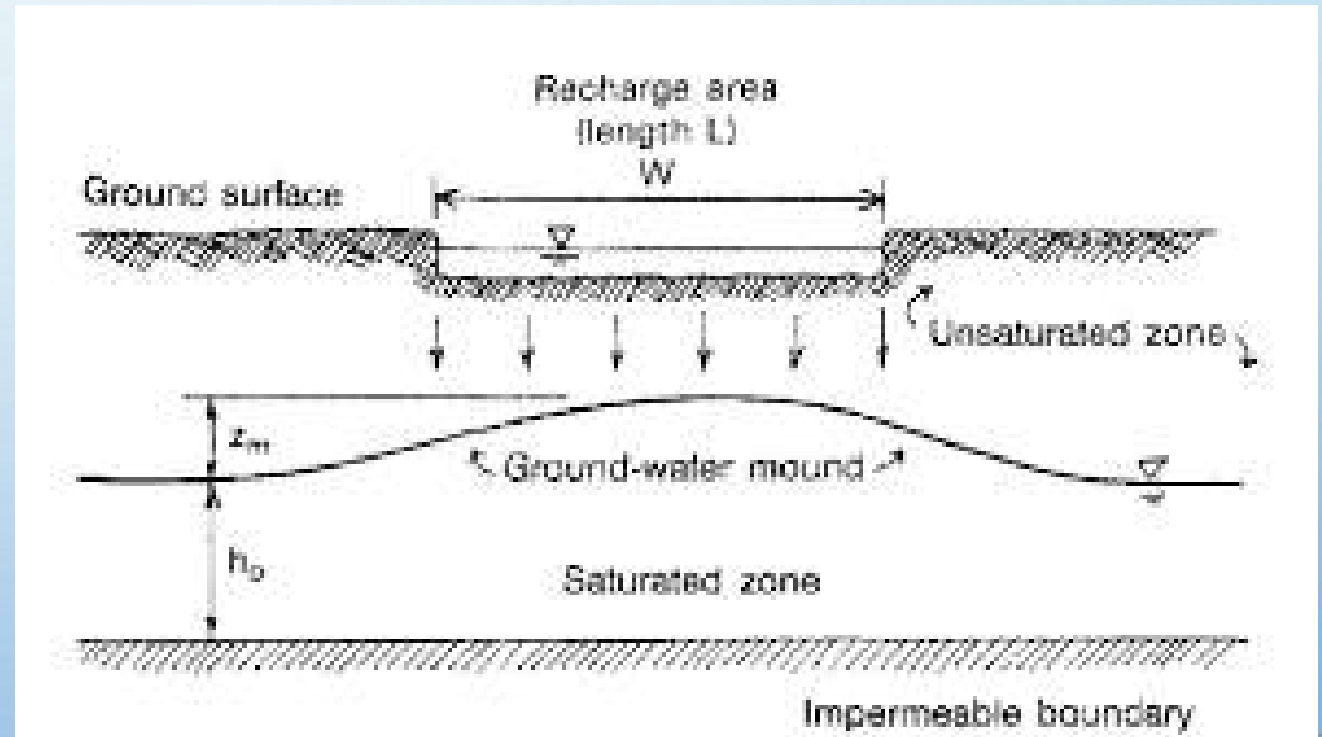
- SOIL HAS SEVERAL “ZONES” CLASSIFIED BY MOISTURE CONTENT AND SATURATION
 - UNSATURATED = VADOSE ZONE
 - SATURATED = PHREATIC ZONE
- SOIL CAN CONTAIN WATER = MOISTURE
- CAN BE INACCESSIBLE, DEPENDS ON GRAIN SPACING, SHAPE, COMPOSITION
- MATH WORKS FOR SATURATED CONDITIONS

HOW WATER MOVES THROUGH SOIL

- GROUNDWATER MOUNDING

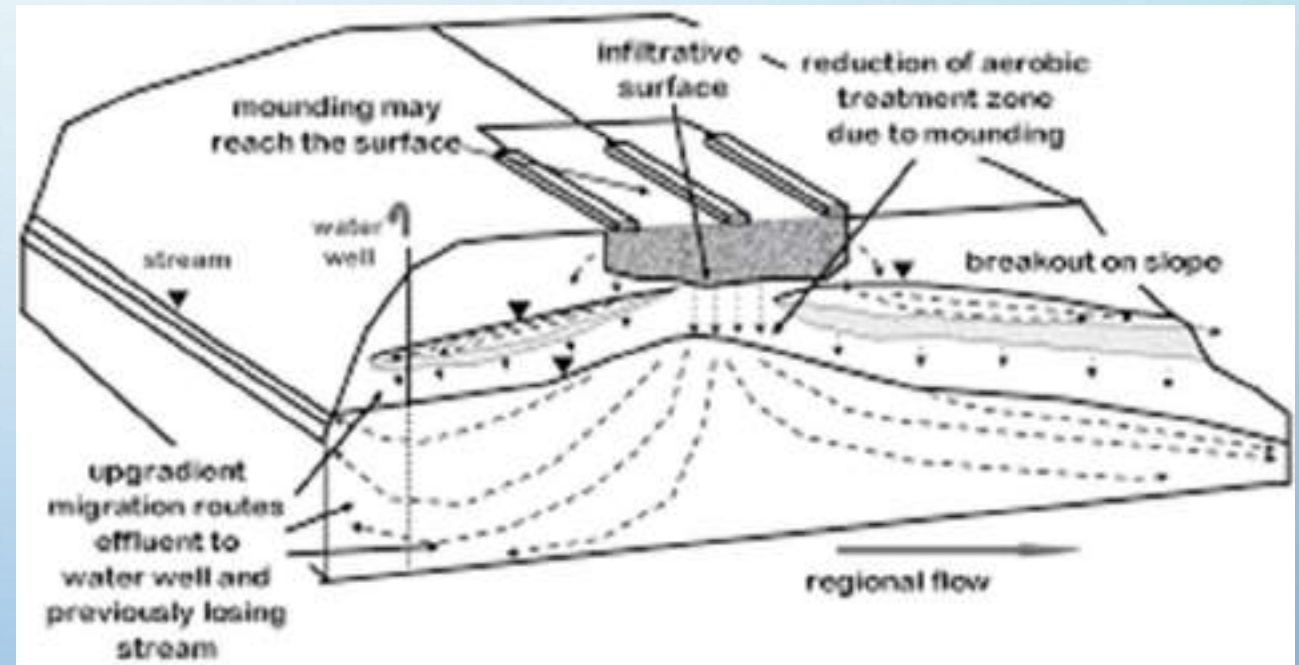
GROUNDWATER MOUNDING

- BENEATH AN AREA OF RECHARGE
- UPWARD DEFLECTION OF THE GROUNDWATER TABLE
- DEPENDANT ON GRADIENT, DIFFERENCE IN HYDRAULIC CONDUCTIVITY
- VERTICAL SEPARATION OF BASE OF BEDS TO WATER TABLE
- AFFECT DOWNGRADIENT RECEPTORS
 - FOUNDATIONS, PARKING GARAGES
 - BREAKOUT



GROUNDWATER MOUNDING

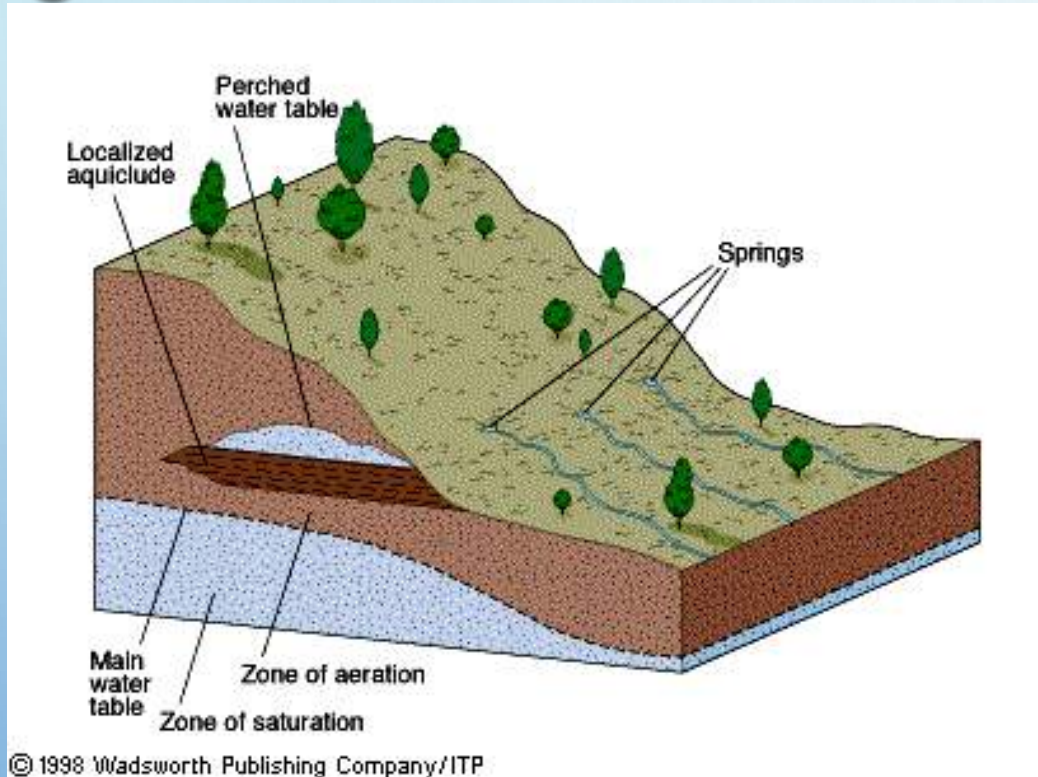
- BENEATH AN AREA OF RECHARGE
- UPWARD DEFLECTION OF THE GROUNDWATER TABLE
- DEPENDANT ON GRADIENT, DIFFERENCE IN HYDRAULIC CONDUCTIVITY
- VERTICAL SEPARATION OF BASE OF BEDS TO WATER TABLE
- AFFECT DOWNGRADIENT RECEPTORS
 - FOUNDATIONS, PARKING GARAGES
 - BREAKOUT



HOW WATER MOVES THROUGH SOIL

- PERCHED WATER TABLES

PERCHED GROUNDWATER TABLES



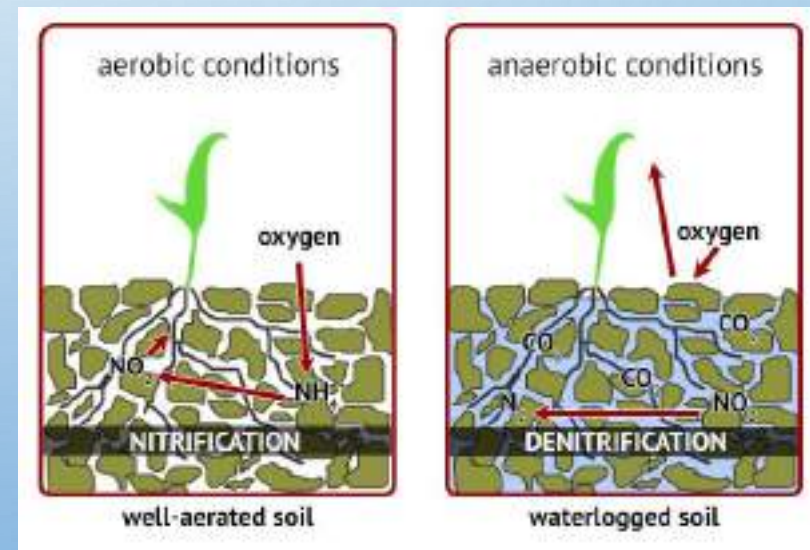
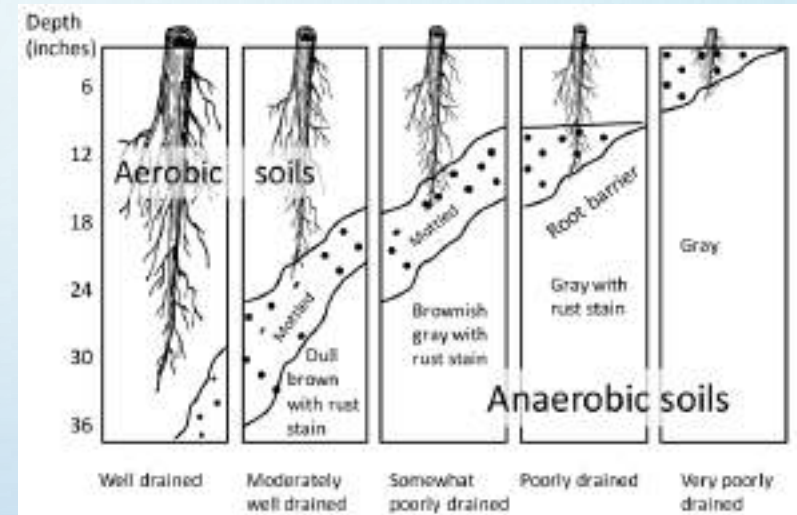
- AREA OF SATURATED SOIL CONDITIONS ABOVE THE REGIONAL GROUNDWATER TABLE
- LOCALIZED, TEMPORAL
- DEPENDANT ON A CHANGE IN HYDRAULIC CONDUCTIVITY (IMPEDANCE)
- OFTEN A RESULT OF FABRIC OR STRUCTURE
- CAN BE A CHALLENGE FOR SEPTIC DESIGN, FOUNDATION DESIGN, EXCAVATION DEWATERING

HOW WATER MOVES THROUGH SOIL

- AEROBIC AND ANAEROBIC CONDITIONS

AEROBIC AND ANAEROBIC CONDITIONS

- BIOLOGICAL RESPONSE TO AMOUNT OF OXYGEN PRESENT
 - AEROBIC PROCESSES TYPICALLY FASTER
 - ANAEROBIC PROCESSES TYPICALLY SLOWER
- DETERMINE FACULTATIVE DIGESTION OF WASTES IN THE SUBSOIL
- AFFECT EFFECTIVENESS OF TREATMENT
 - “SEPTIC” CONDITIONS
 - SYSTEM SIZING, RESIDENCE TIME
 - NITROGEN CYCLE



HOW WATER MOVES THROUGH SOIL

A BRIEF REFRESHER



THANK YOU!

CHRISTOPHER HOMES, P.GEO.

CHRIS@WESTERNWATER.CA

WWW.WESTERNWATER.CA

WESTERN WATER ASSOCIATES LTD. 2020