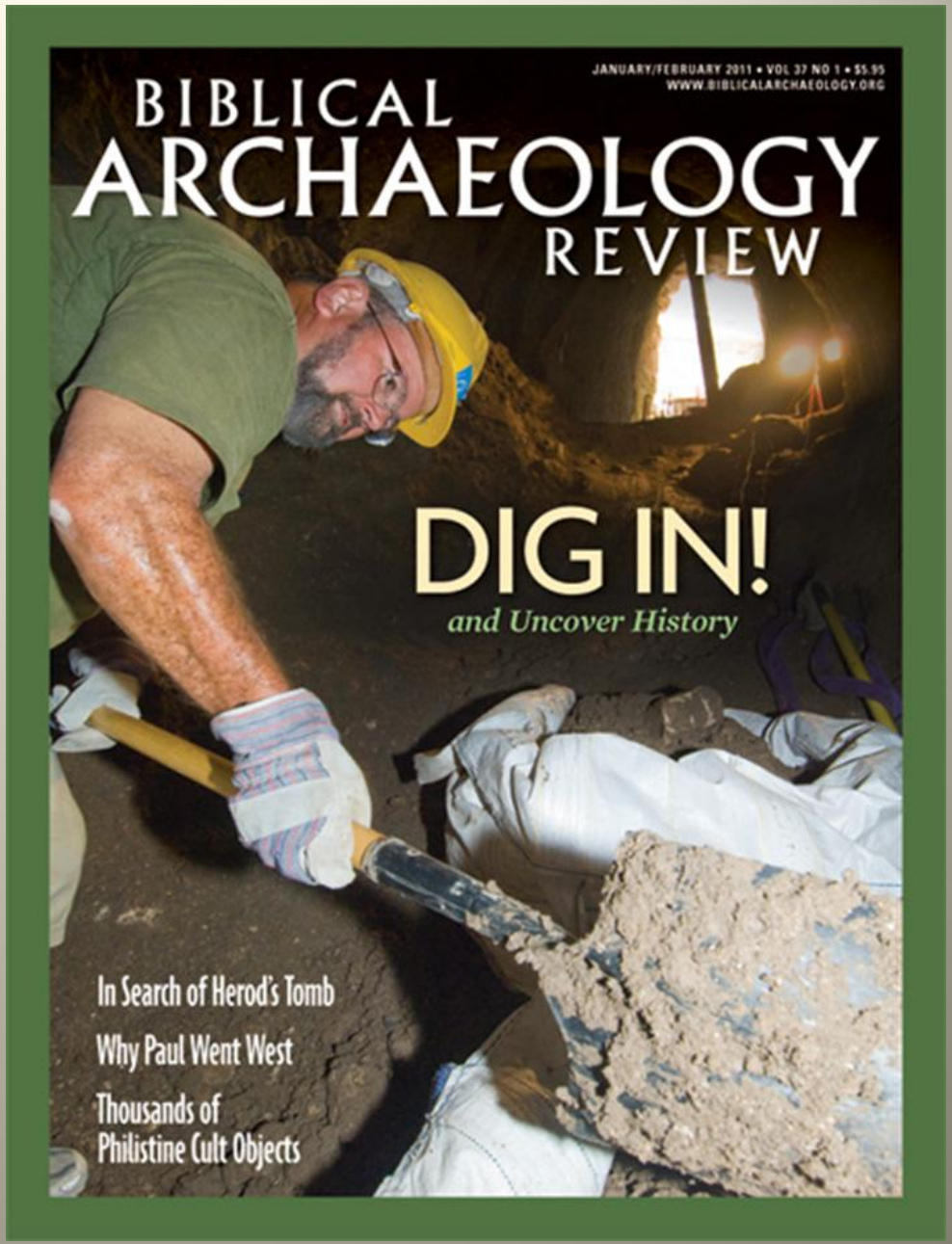
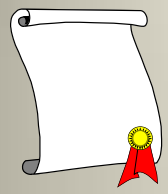
Ancient Water Systems In Israel





Guiding Principles

- Water - a source of life & people always need water
- Water use - private & public in ancient settlements
- Availability of water in antiquity - as large or larger than today
- Challenge - construct water systems & divert the water to the settlements
- Pumps not available & transportation of water was only by gravitation

Quantities of Water Per Capita Per Year

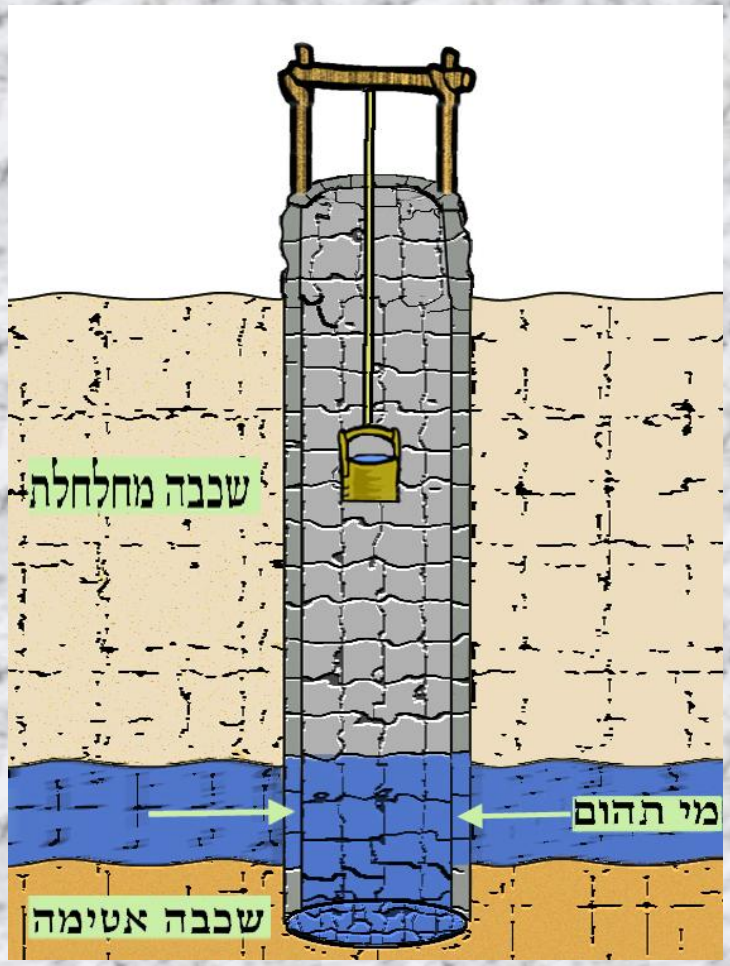
- Bedouins 1.5 CM = 1 gallon per day
- Biblical period 5 CM = 3.5 gallons per day
- Byzantine period 7 CM = 5 gallons per day
- Jerusalem during the 1948 siege - 1.5-2.5 gallons per day
- 1970 - 70 CM = 50 gallons per day
- Today - 120 CM = 82.5 gallons per day

Typology of Ancient Water Systems

1. Wells
2. Nearby springs (natural)
3. Cisterns
4. Reservoirs or pools collecting runoff
5. Reservoirs - beyond the city walls
6. Dams
7. Natural inner springs (w/in the city walls)
8. Underground - hewn down to the level of the water table
9. Aqueducts

Which are the most ancient water systems?

Wells



Cisterns

Cisterns

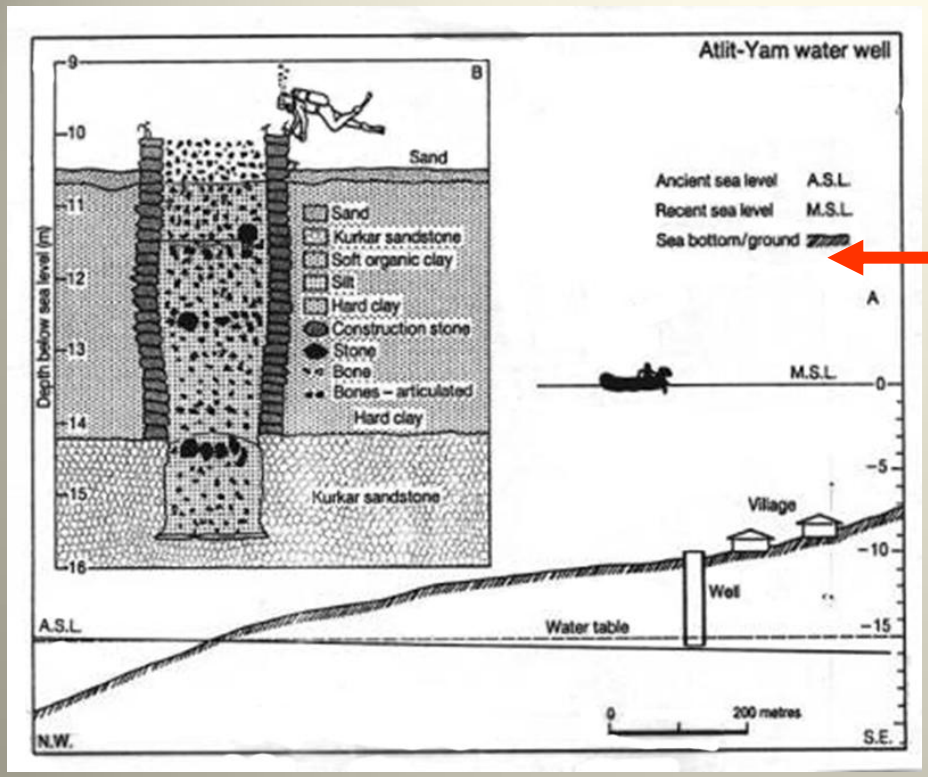
- Hewn in bedrock / stone construction
- Narrow opening and wide body
- Plastered from top to bottom
- Large storage capacity
- "Cannot export more water than it imports" (Avot de Rabbi Natan = Limited capacity)

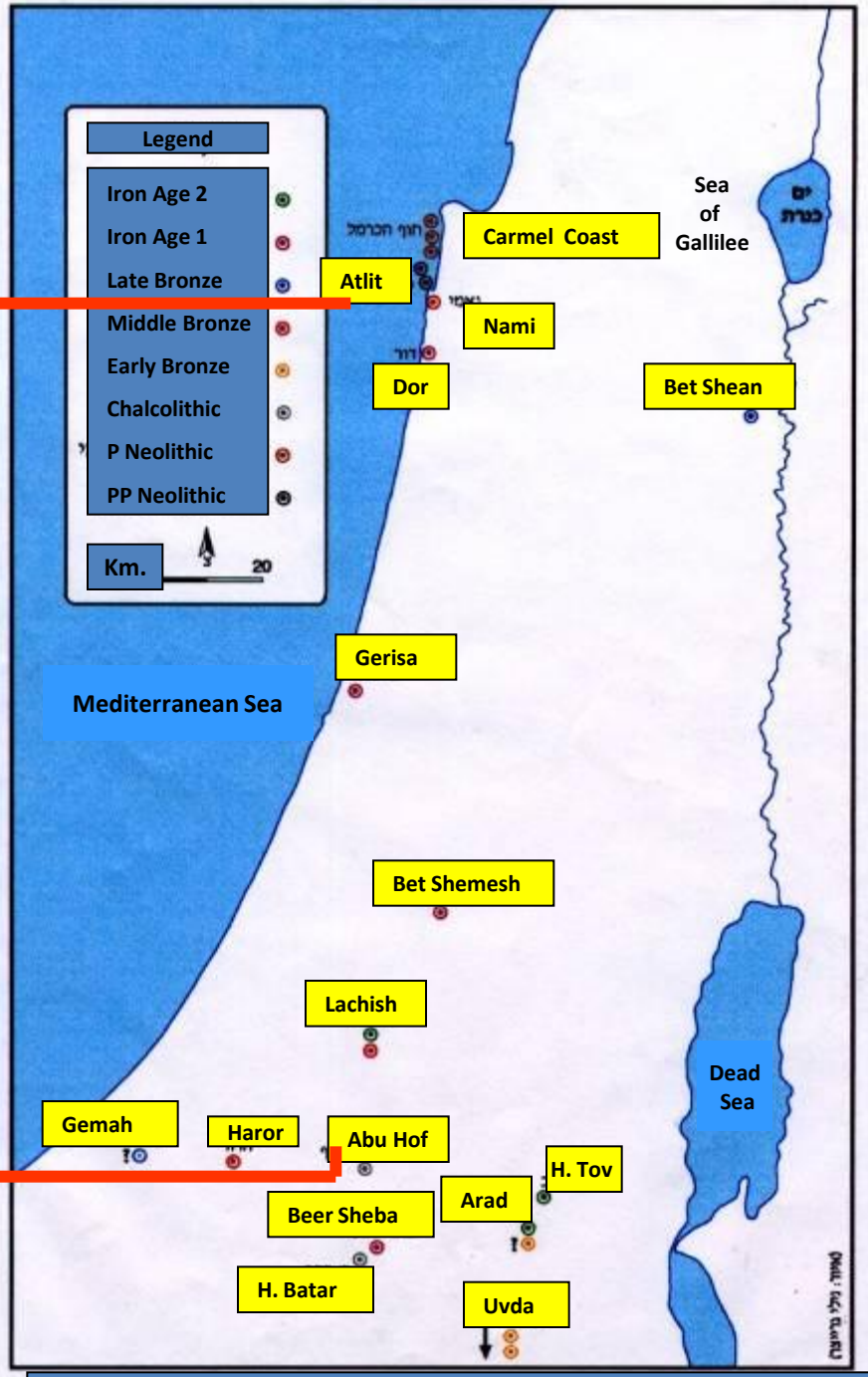
Wells

- Dug / hewn to the water table level
- Vertical and narrow
- No plaster
- No need for storage capacity
- "Water that runs by itself" (Avot de Rabbi Natan = Unlimited quantity of water)

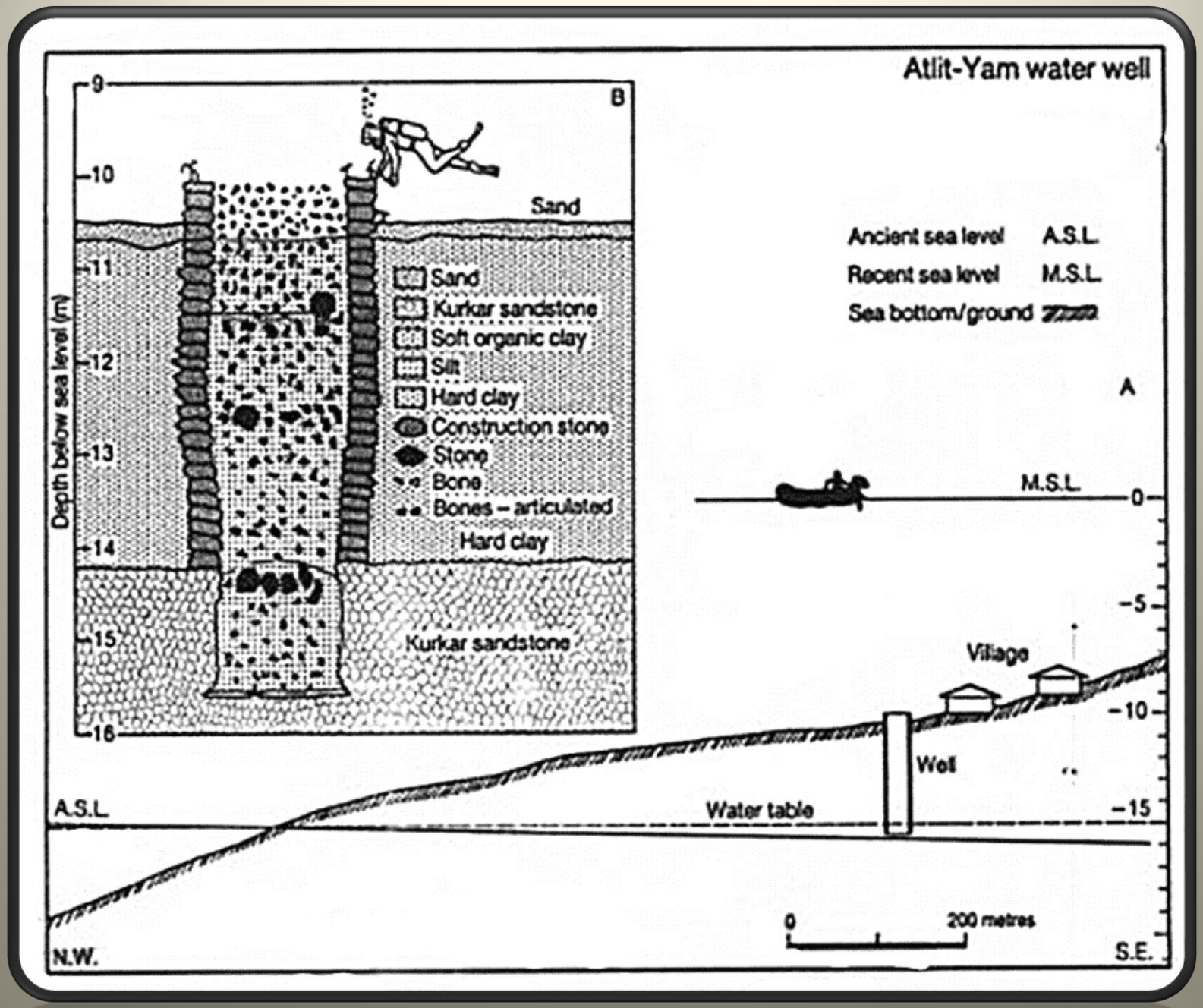
Wells

- Most ancient wells - Atlit-Yam, dated to 5900 BCE
- Deepest well - Tel Beer Sheba, 70 meters deep, dated to 1100 BCE
- Wells used throughout history until today
- Monumental water systems preferred in fortified cities
- Wells usually public, serving the entire community

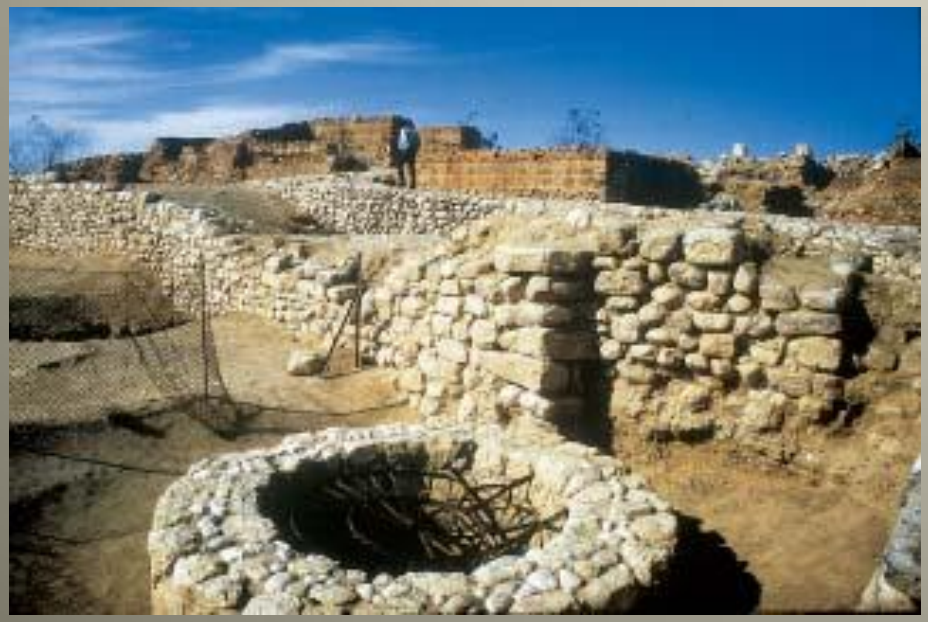




Wells from PPNe to Iron Age 2

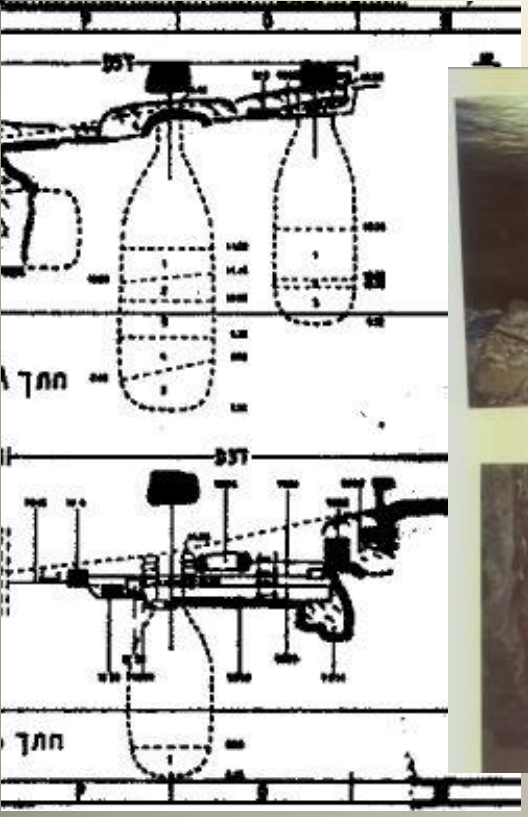

Atlit-Yam water well
B
9
10
11
12
13
14
15
16
Depth below sea level (m)
Sand
Sand
Kurkar sandstone
Soft organic clay
Silt
Hard clay
Construction stone
Stone
Bone
Bones – articulated
Hard clay
Kurkar sandstone
Ancient sea level A.S.L.
Recent sea level M.S.L.
Sea bottom/ground
A
M.S.L.
0
-5
-10
-15
Village
Well
A.S.L.
Water table
0
200 metres
N.W.
S.E.

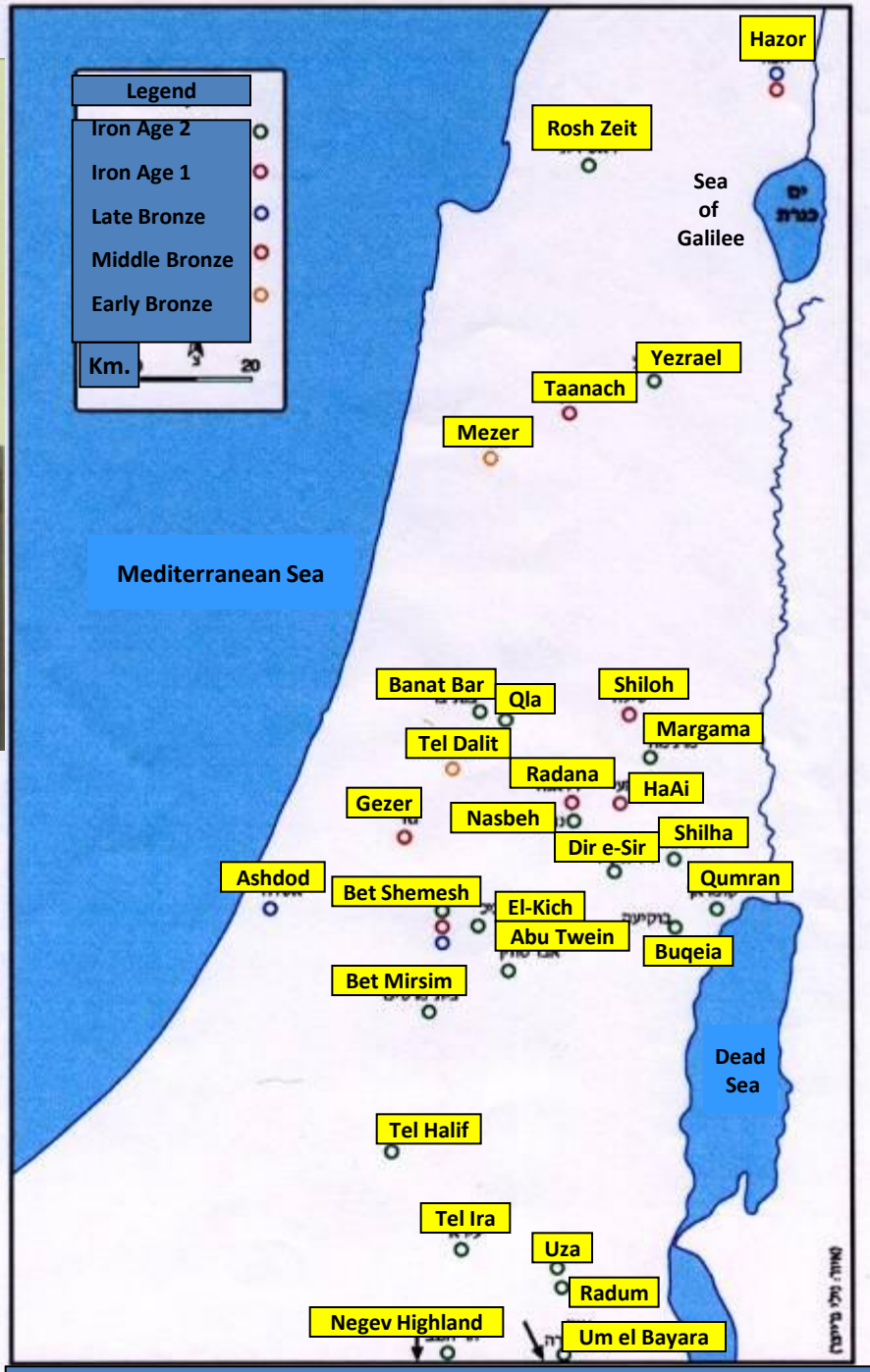
Beer-Sheba Well
Southern Israel
Deepest Well
70 m; 230 Ft.



Cisterns

- Beginning use - 3000 BCE
- First cisterns - small, hewn out of chalk, un-plastered
- First plastered cisterns - Hazor and Gezer, dating to 1800 BCE, bottle-shaped
- Plastered cisterns mainly bell-shaped
- Peak of cistern-use – Byzantine Period, 500 CE
- Used to this day
- Usually for private use





Cisterns from the Early Bronze to Iron age 2

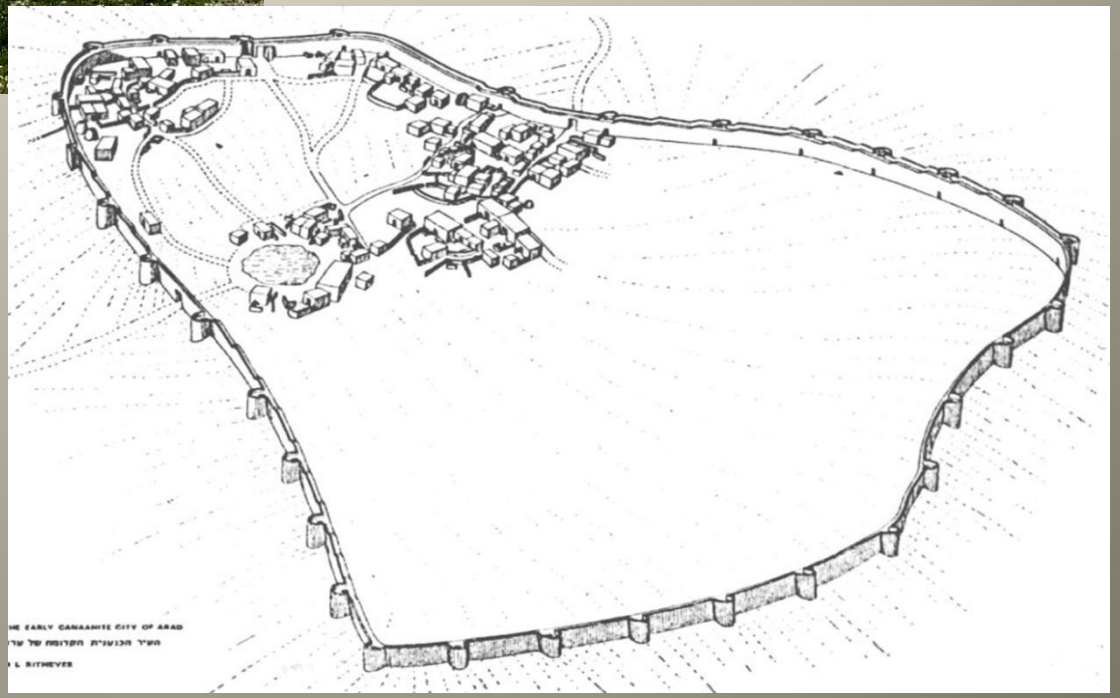
Qumran

Neqarot Cistern
Mt. Negev

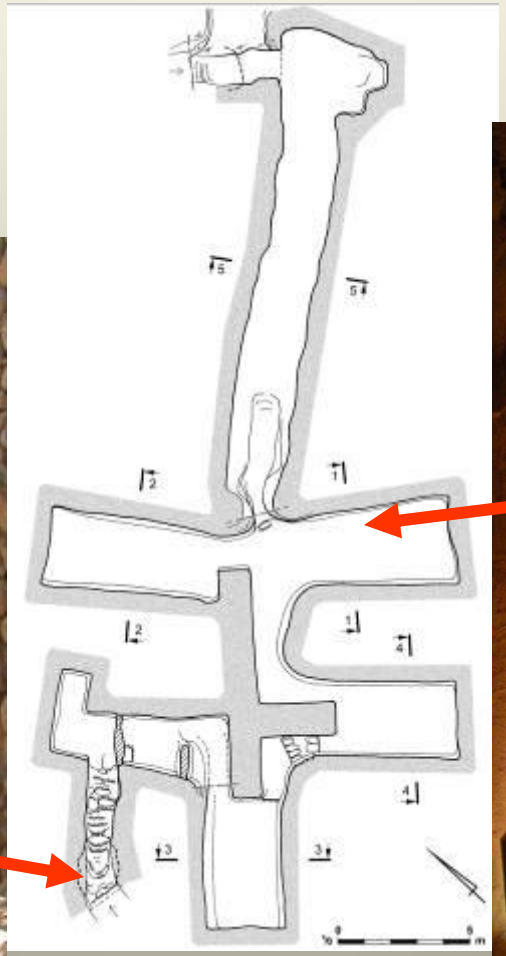
Reservoirs or Pools Collecting Runoff

- Reservoirs with a capacity greater than 150 cubic meters collecting runoff by channels (built or dug)
- Used in fortified cities during times of peace & siege
- First reservoirs (2500 BCE) at Arad & HaAi (Et-Tell) - mainly open, w/o plaster
- Hazor (Northern Israel) - a reservoir under the palace ca. 1300 BCE (LB Period)
- Well-known underground reservoirs, urban or royal (Judean Kingdom) - Tel Beer Sheba, Arad, Eitam, Bet Shemesh & Amman

Tel Arad
Central Reservoir



Beer Sheba Reservoir



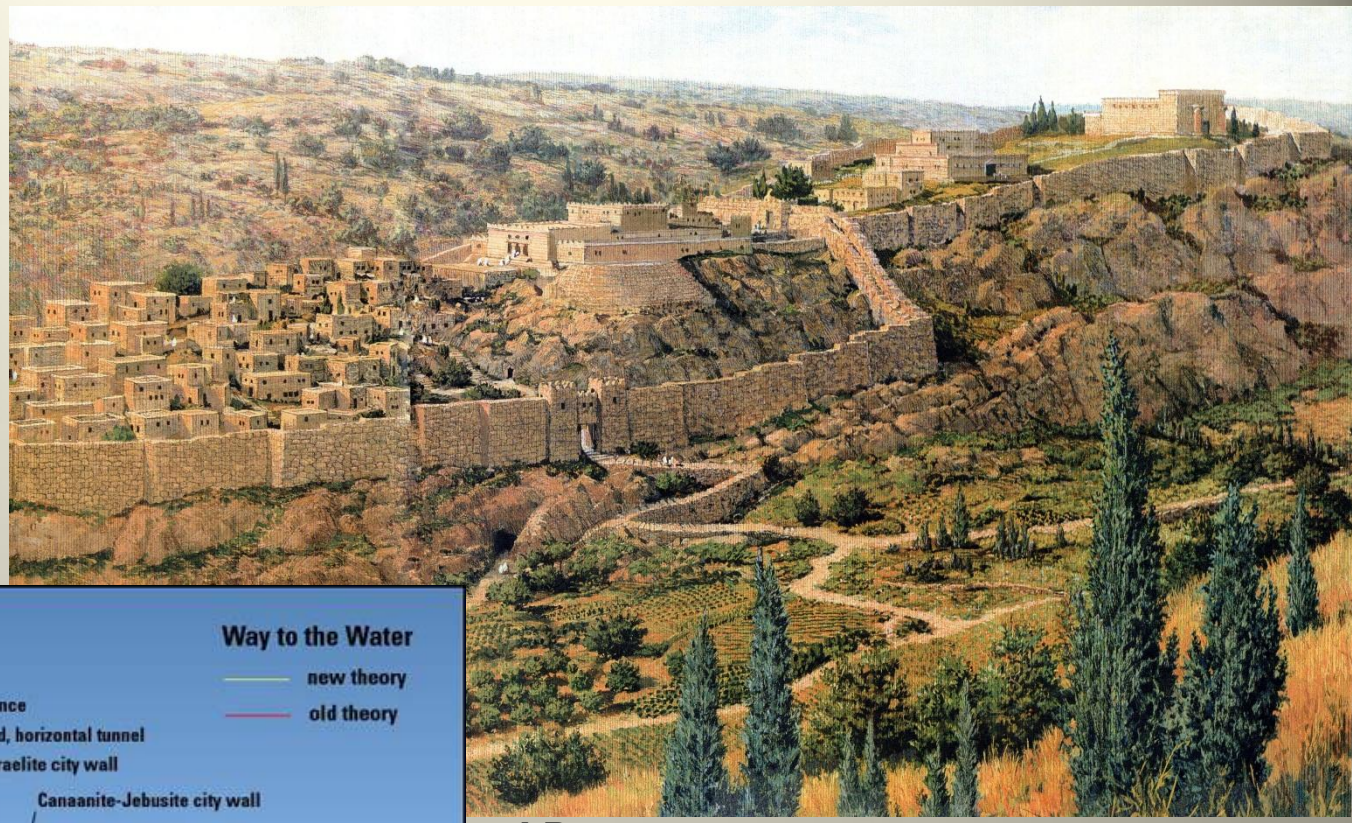
Typology of Water Shafts & Tunnels

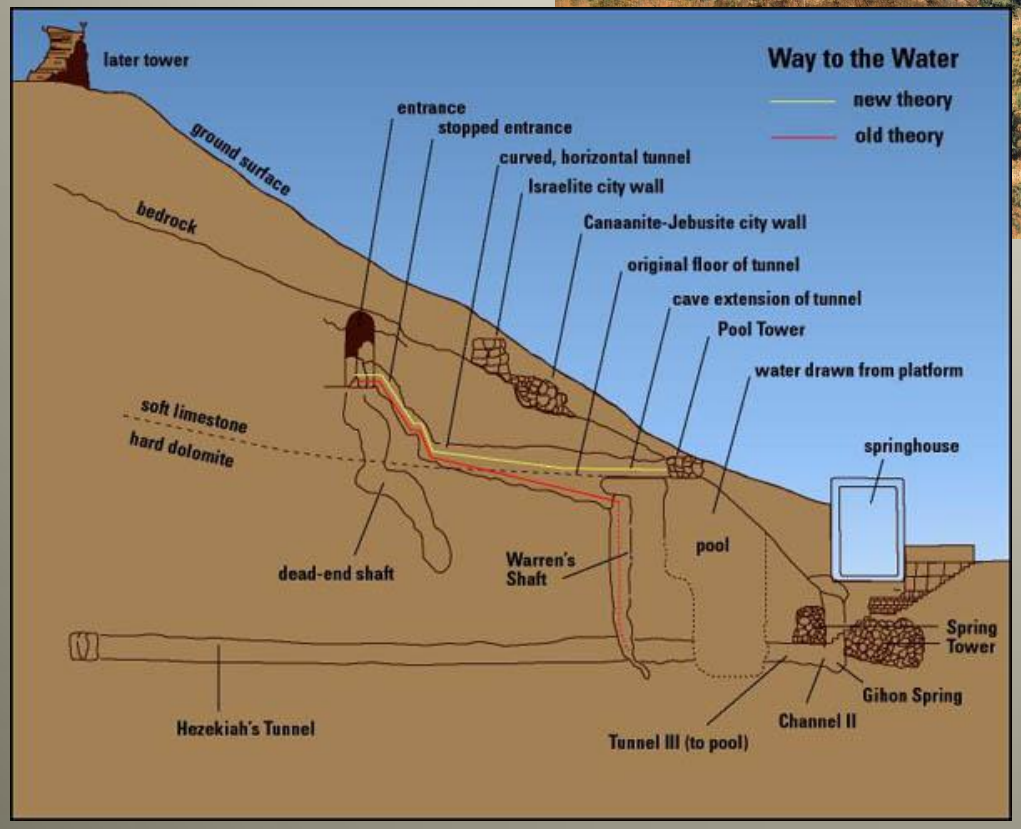
A	B	C	D	E
Shaft/ Tunnel to Exterior Spring	Shaft/ Tunnel to Water Table	Water Conducted to Bottom of Shaft/ Tunnel	Feeding Tunnel & Channels to Reservoirs	Exterior Approach to Water Source

Tunnels & Shafts to Inner Springs (w/in city walls)

- Used for a short period
- Fortified cities - built around a spring, ca. 1800 BCE = MB IIb
- Sites - Tel Dan, Kabri, Jericho
- Jerusalem - spring situated w/in the city walls & supplied by a hewn tunnel
- Inner springs - built by the government

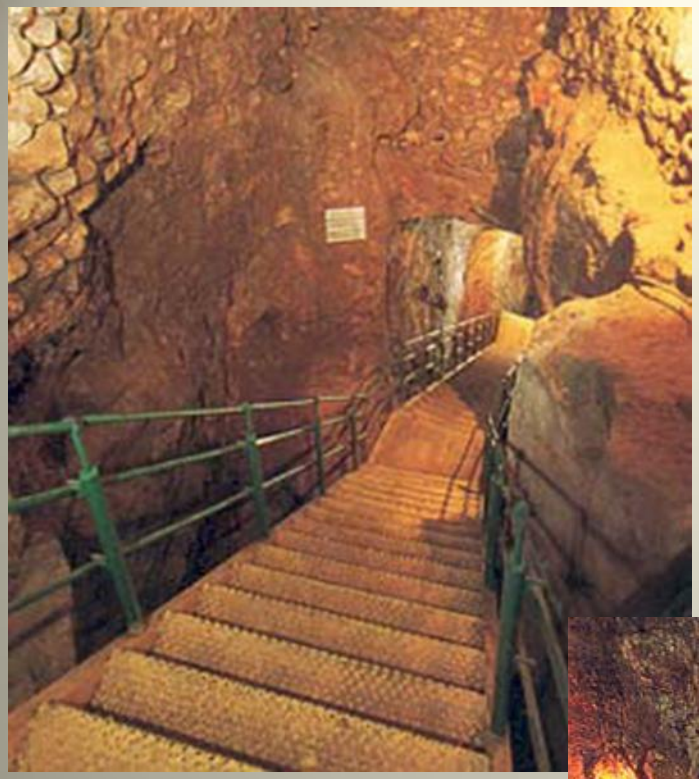
Jerusalem

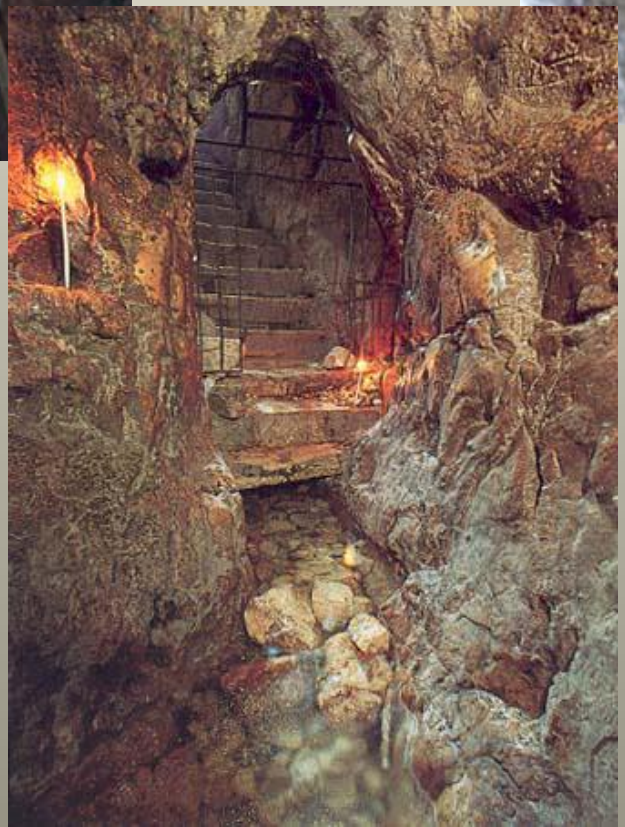




4 Parts:

1. **Tunnel which was cut to direct water from the plentiful Gihon Spring**
2. **Stepped tunnel - cut downward from the street level behind the city's defense wall**
3. **Almost horizontal tunnel ramp running out under the city wall to a point directly above the water chamber leading to #4**
4. **A shaft connected the end of this upper tunnel to the water chamber.**

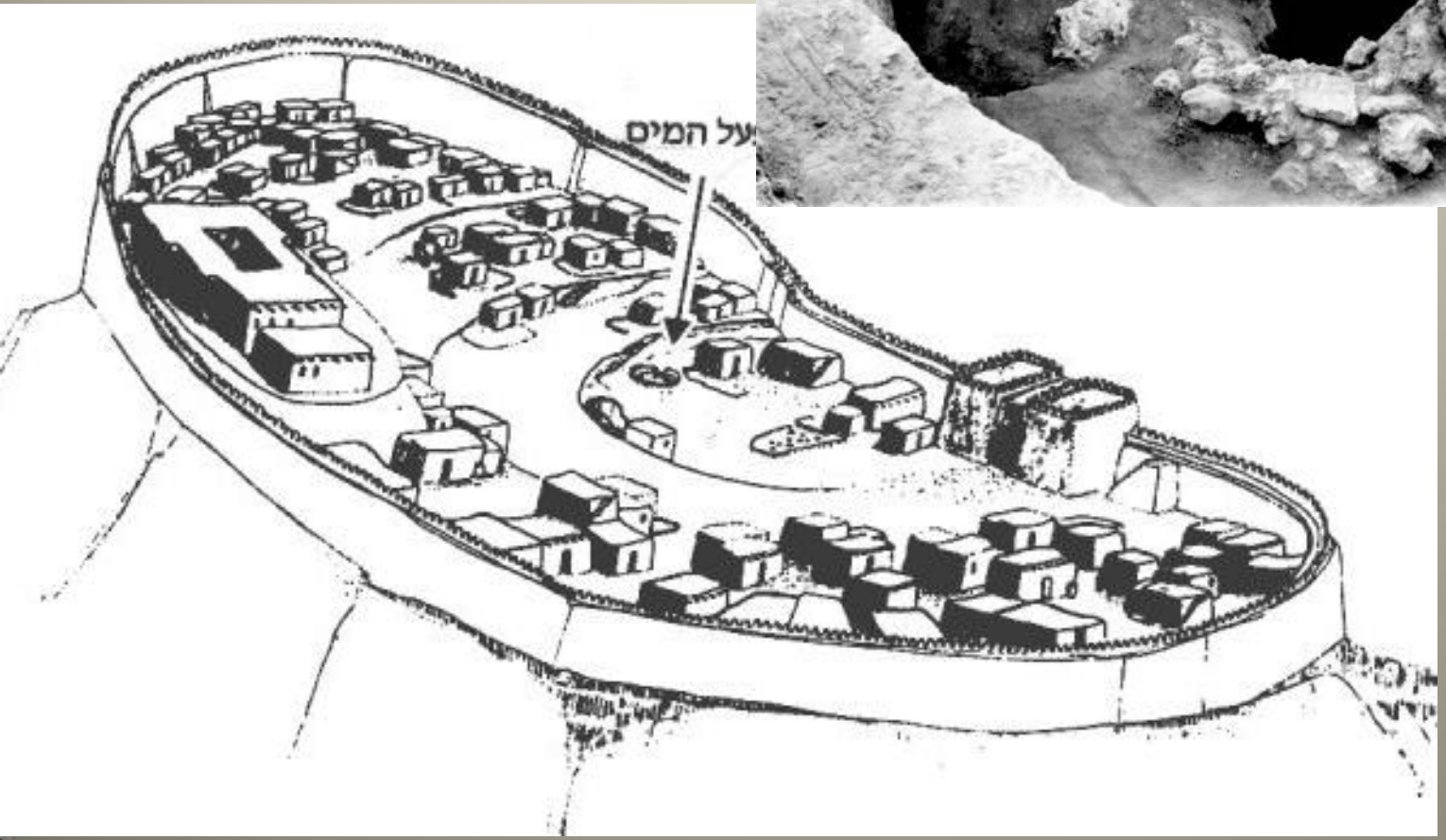




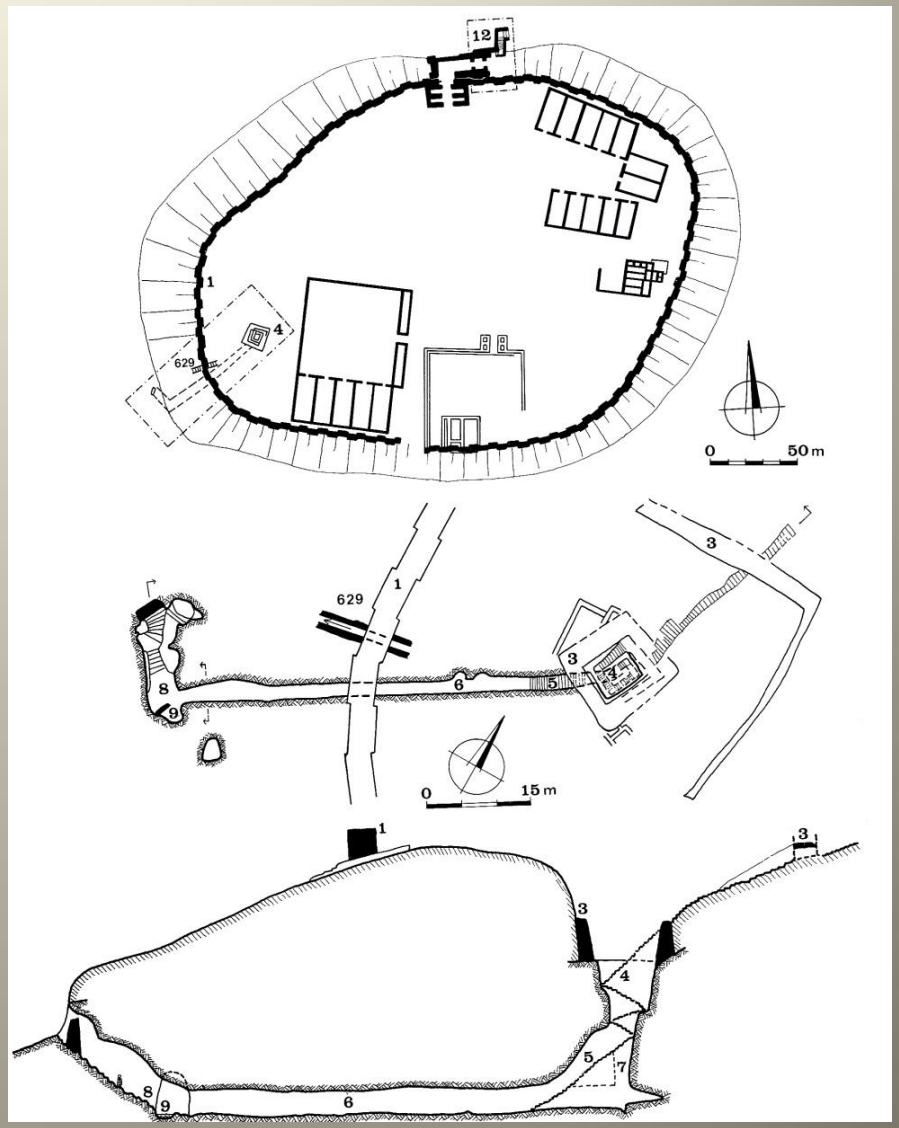
Underground Water Systems Hewn Down to Level of Water Table

- First appearance - Tel Gezer and Tel Gerisa, ca. 3800 BCE
- Mainly 1000 BCE - Megiddo, Hazor, Gibeon, Yebleam, Jokneam and Lachish(?)
- Hewn inside fortified cities - in time of siege
- Built by the government
- Disappeared - end of the Judean Kingdom

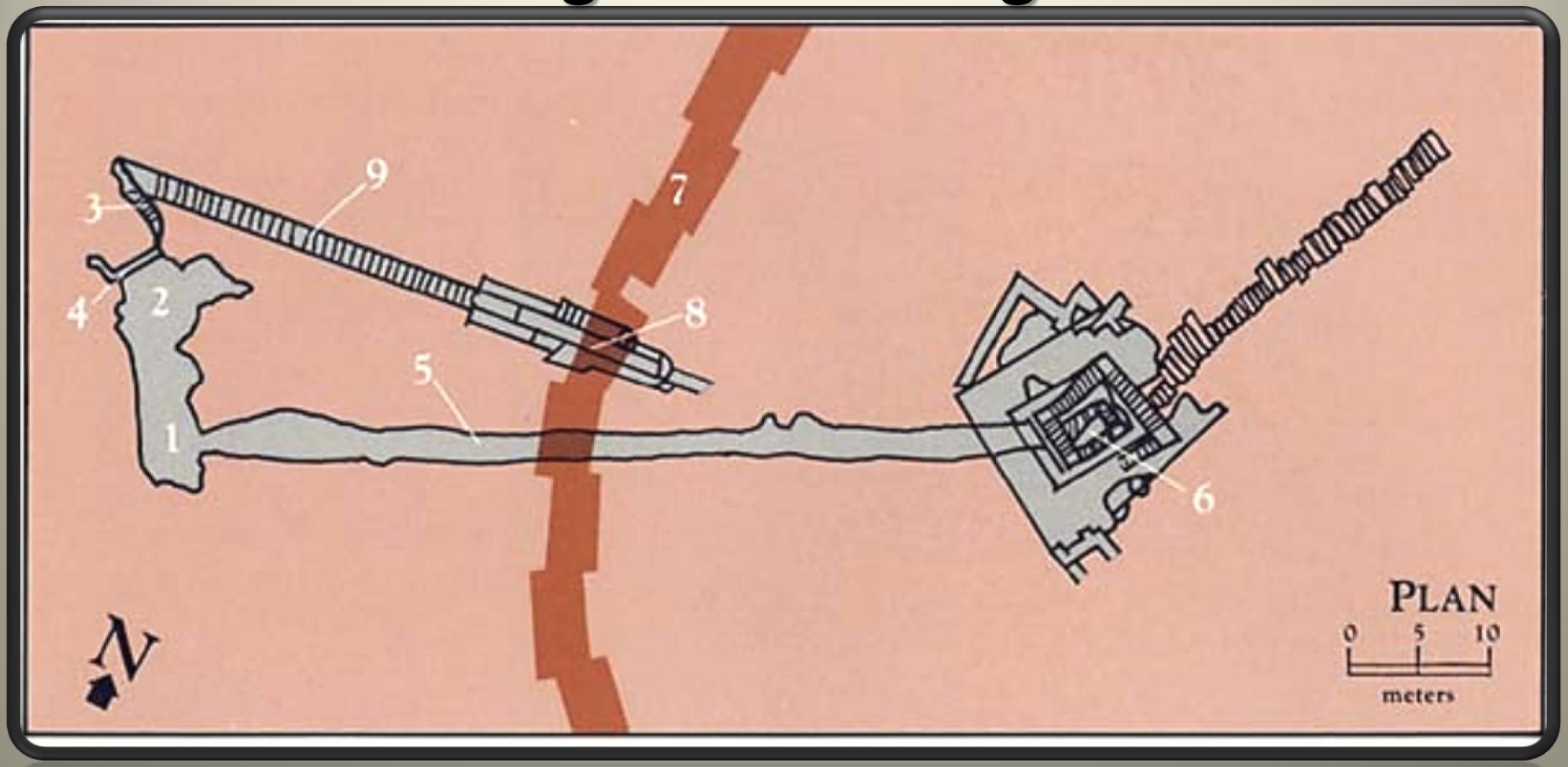
Tel Gerisa
1800 BCE
Tel Aviv



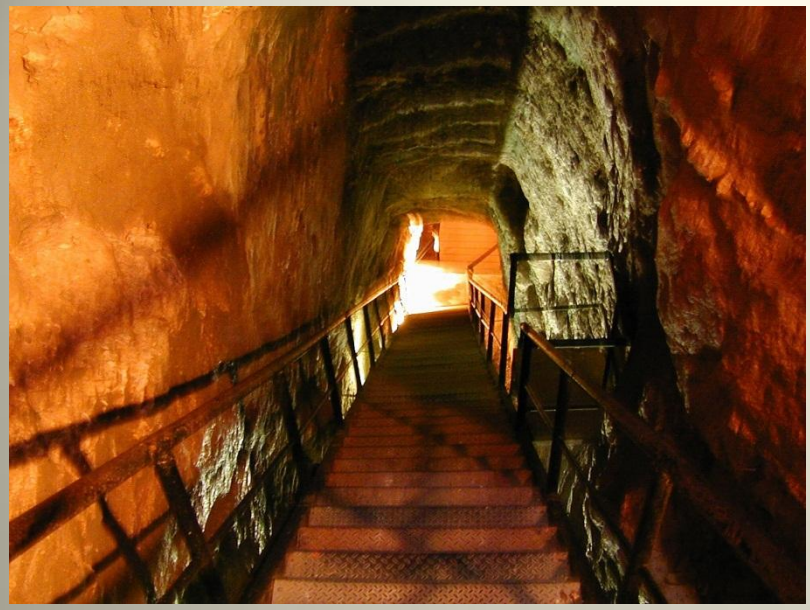
Megiddo

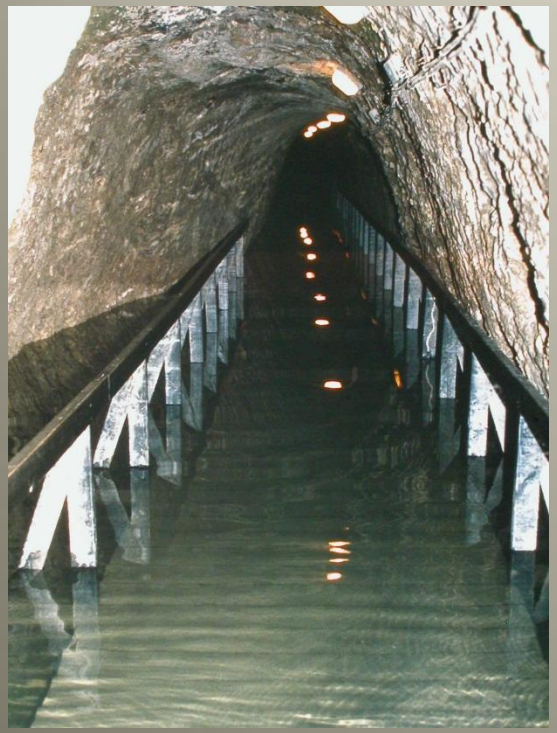


Megiddo Iron Age II



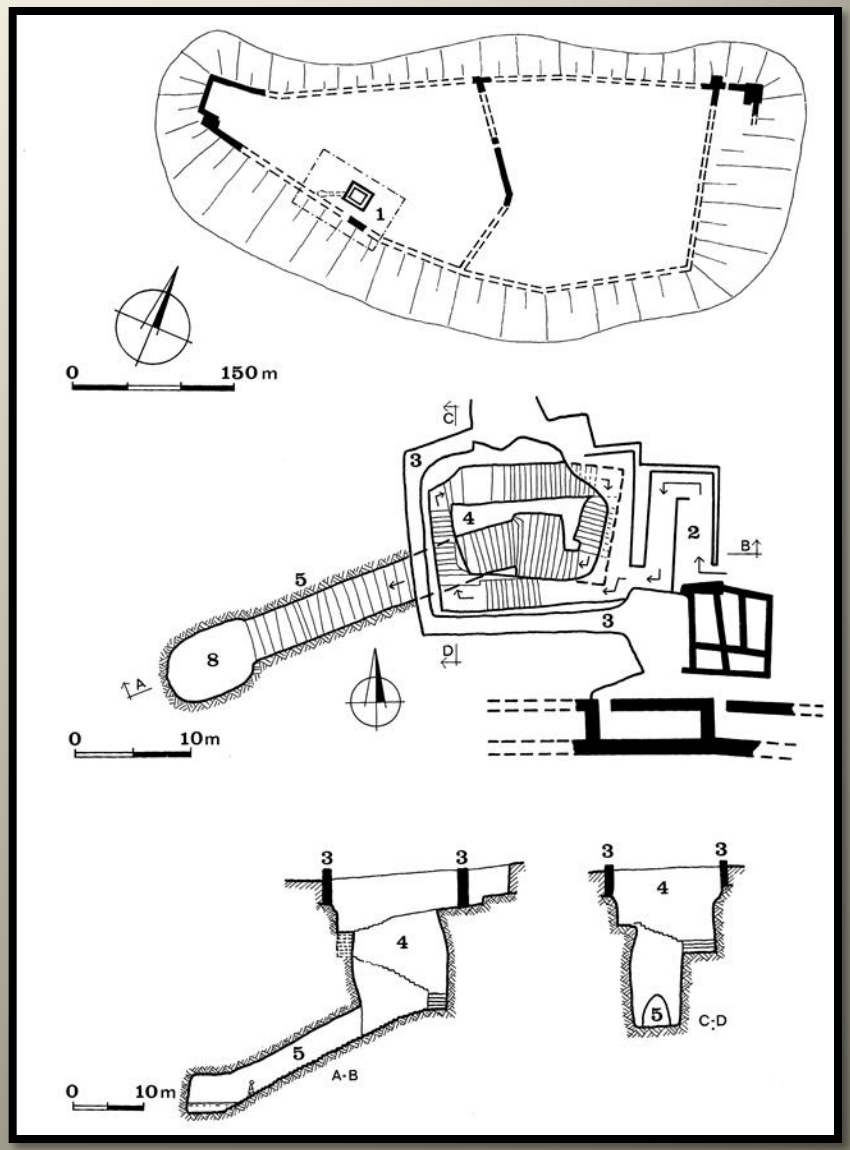
1. Spring
2. Spring chamber
3. Pre-10th cent B.C. stairs to spring chamber
4. 9th cent B.C. blocking wall at entrance to chamber
5. 9th cent B.C. tunnel
6. 9th cent B.C. stepped shaft
7. 9th cent B.C. inset offset wall
8. Solomonic (10th cent B.C.) gallery
9. Solomonic (10th cent B.C.) covered stairway

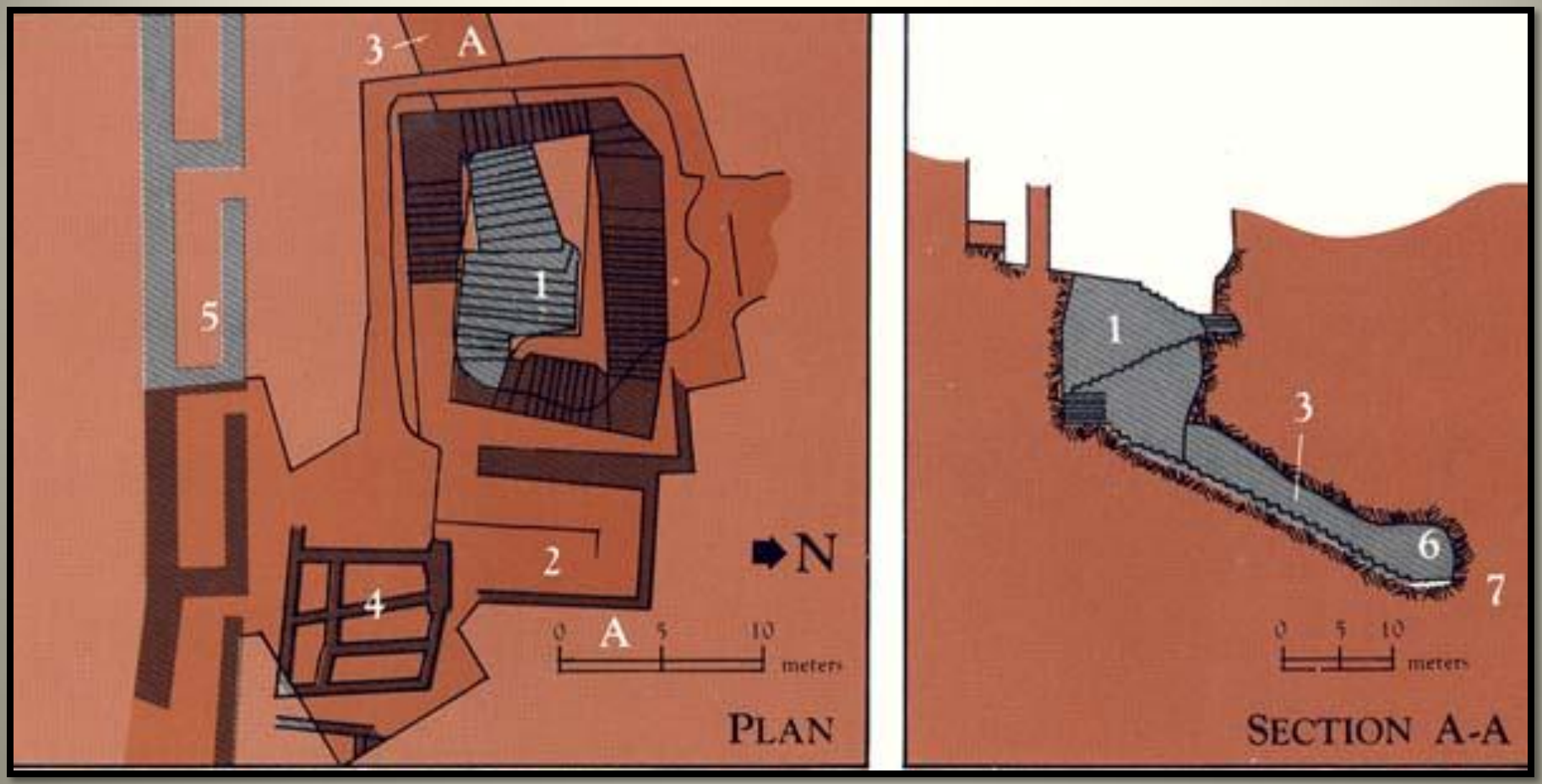




Stepped Tunnel=
Grade- 35°
L - 127 m, 416 ft.

Hazor
Northern Israel

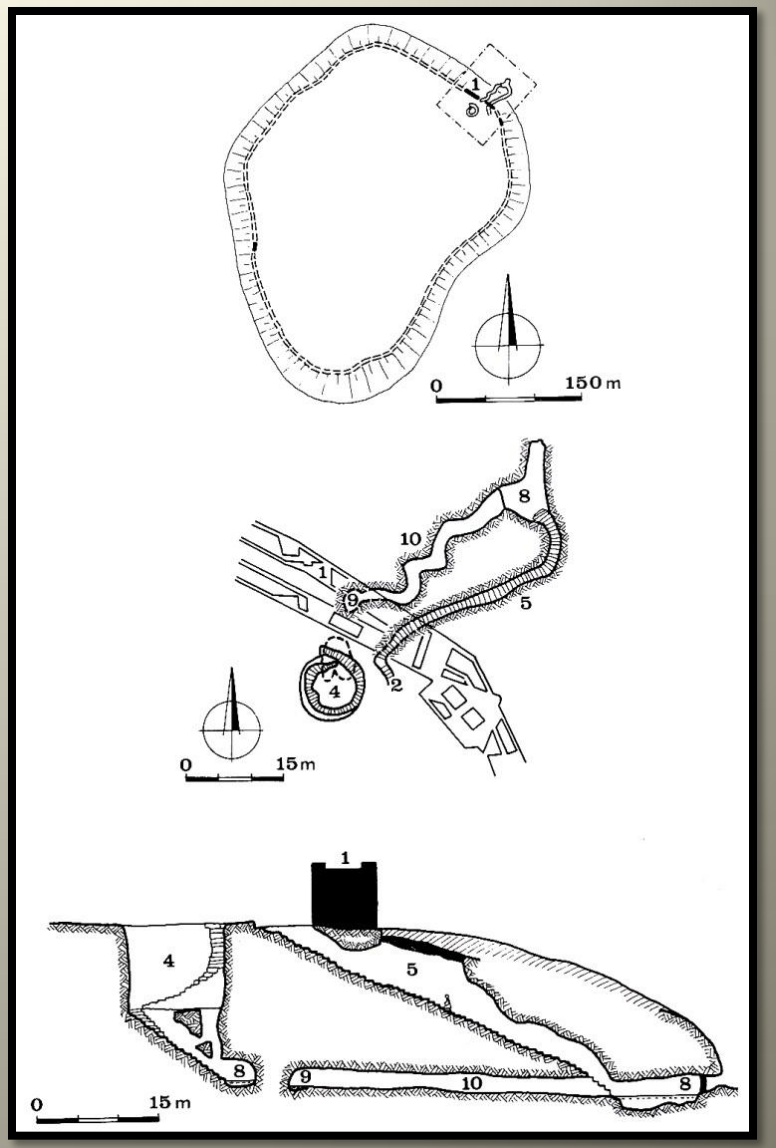


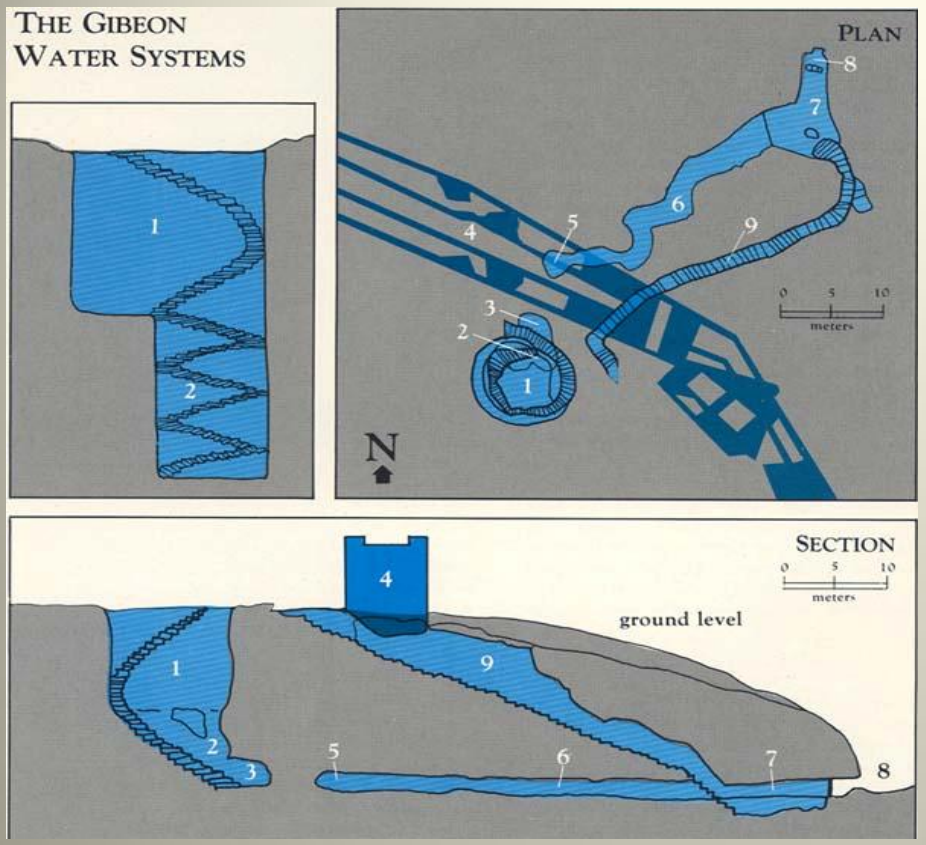


1. Rock-hewn shaft with steps
2. Entrance structure
3. Stepped (or sloping) tunnel leading to water table
4. 9th cent B.C. 4-room Israelite house
5. 10th cent B.C. Solomonic casemate wall
6. Chamber on water table
7. Pool on water table

Stepped Tunnel =
Gradient - 29°
Length - 80 m, 262 ft.

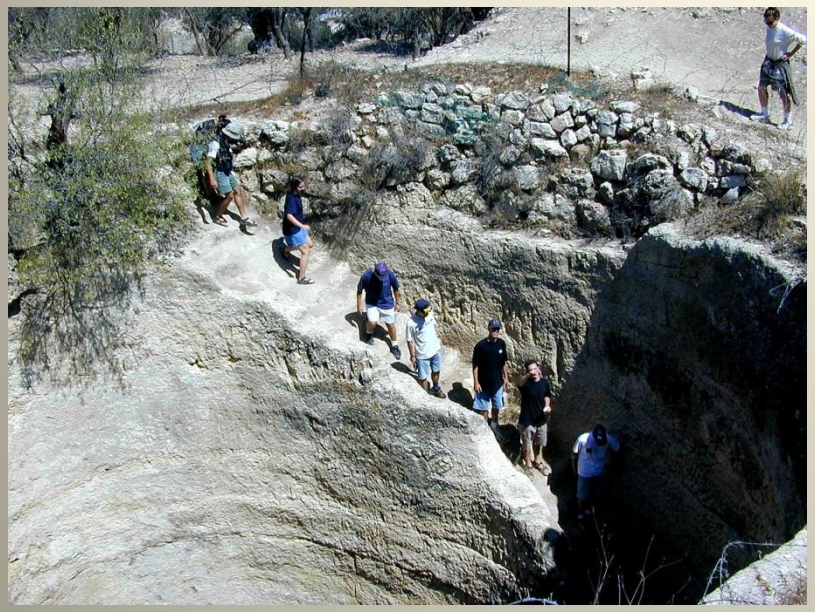
Gibeon Water Shaft & Tunnel





1. Pre-10th cent B.C. “pool”
2. Stepped shaft to water table
3. Chamber at water table
4. City wall constructed in 12th–10th centuries B.C.
5. Spring
6. Feeder tunnel to increase flow of spring to water chamber
7. Water chamber
8. Outside entrance to water chamber
9. Stepped (or sloping) tunnel from inside city to water chamber

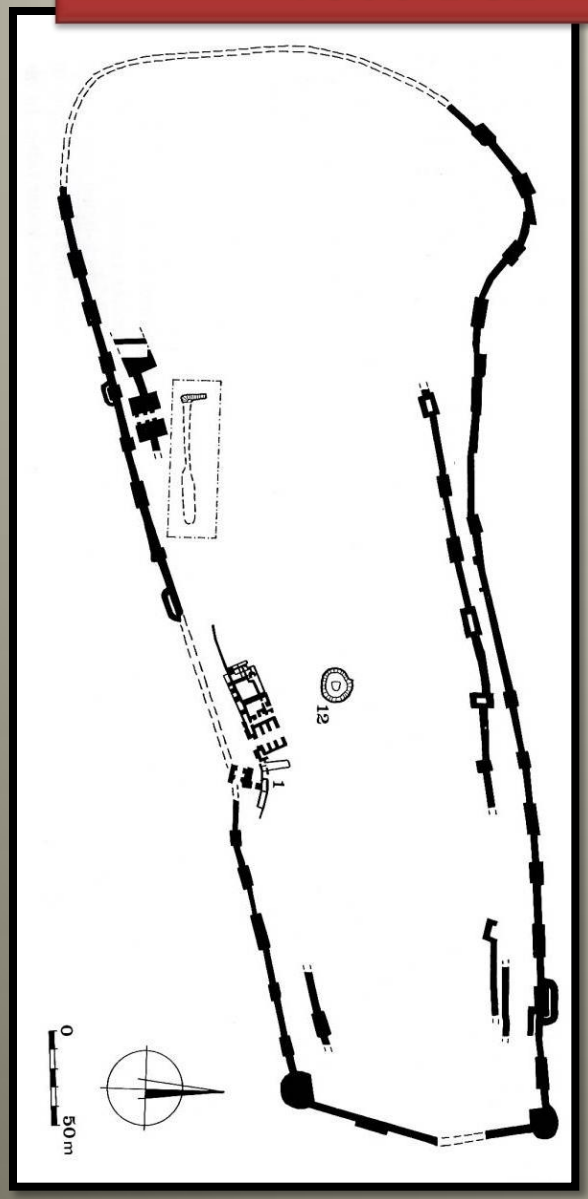
Water Shaft



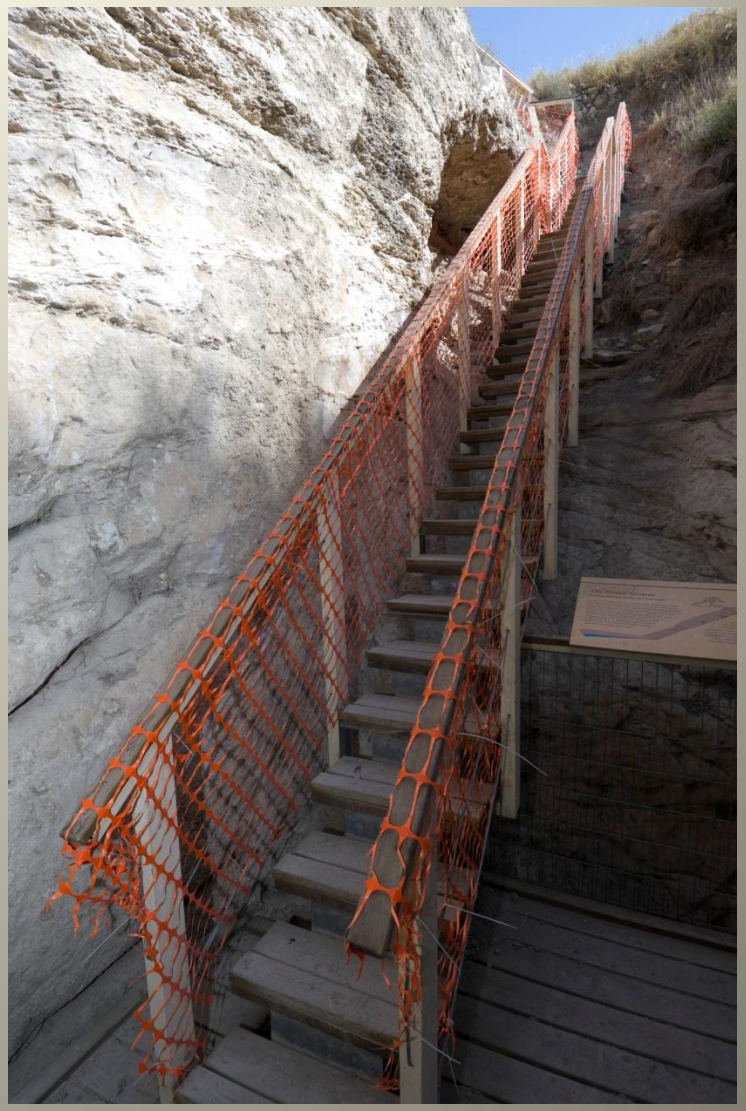
Gibeon Water Tunnel
Gradient = 43°
Length = 48 m, 157ft.

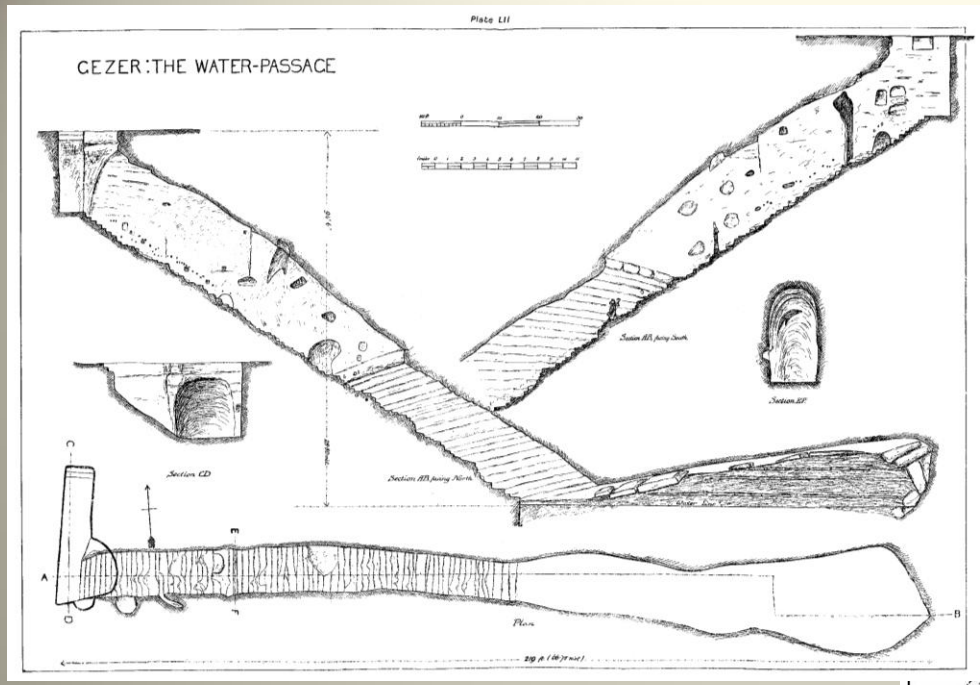
Water Chamber

Gezer
Middle Bronze Age
1800 BCE



Macalister's 1905 Dig





28.80 m. below surface

Entrance – Keyhole shaped, 10.5 m. deep, w/ steps

Tunnel – Gradient = 39°

- **Length 40m, 140 ft.,**
- **Height -7.5 m,**
- **Width - 4 m.**
- **Steps**

Drawing by Vincent

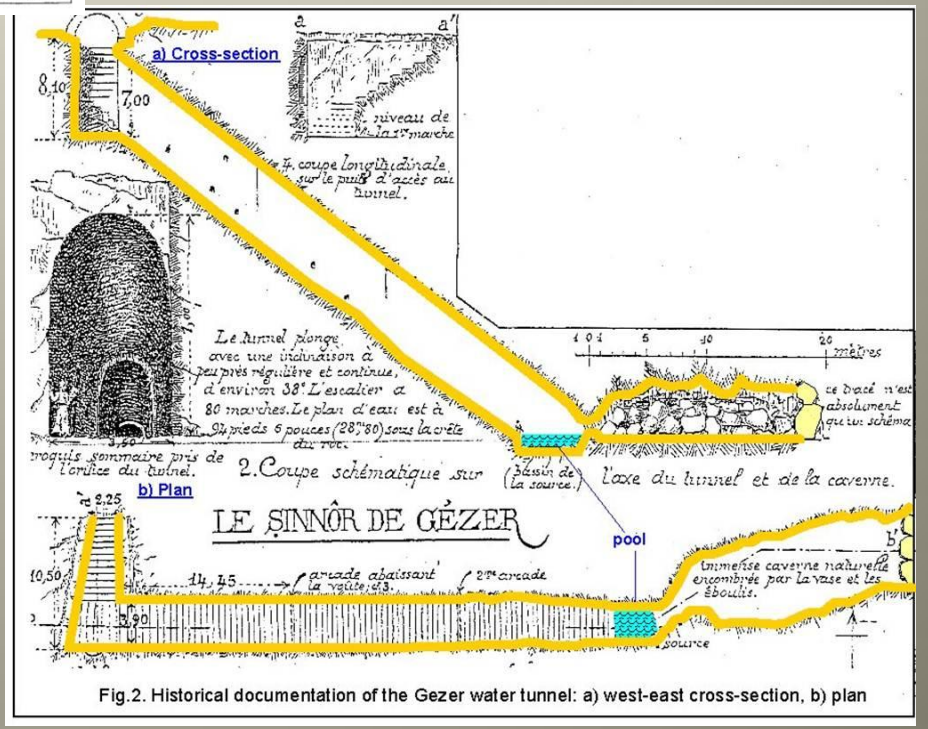
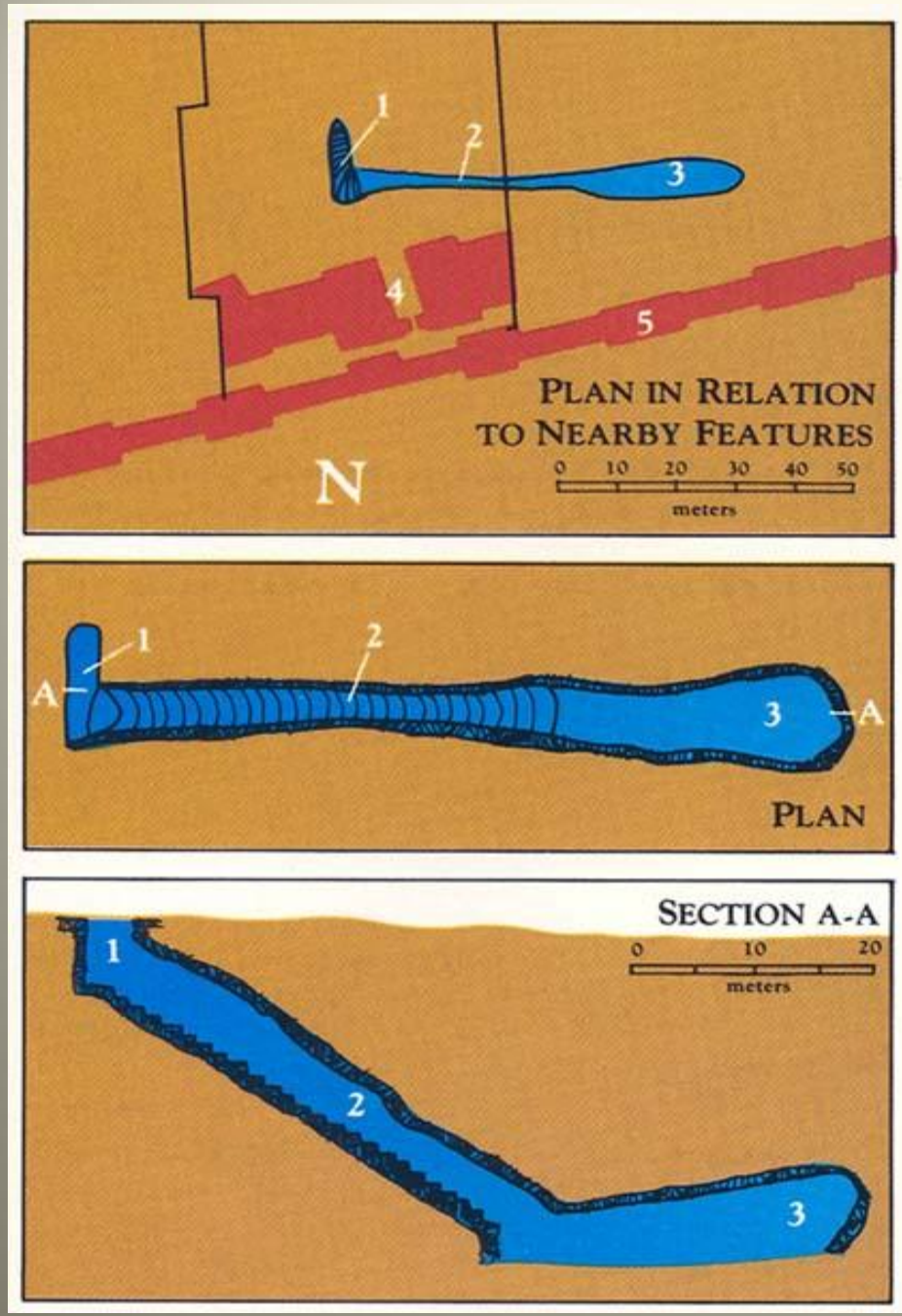


Fig.2. Historical documentation of the Gezer water tunnel: a) west-east cross-section, b) plan

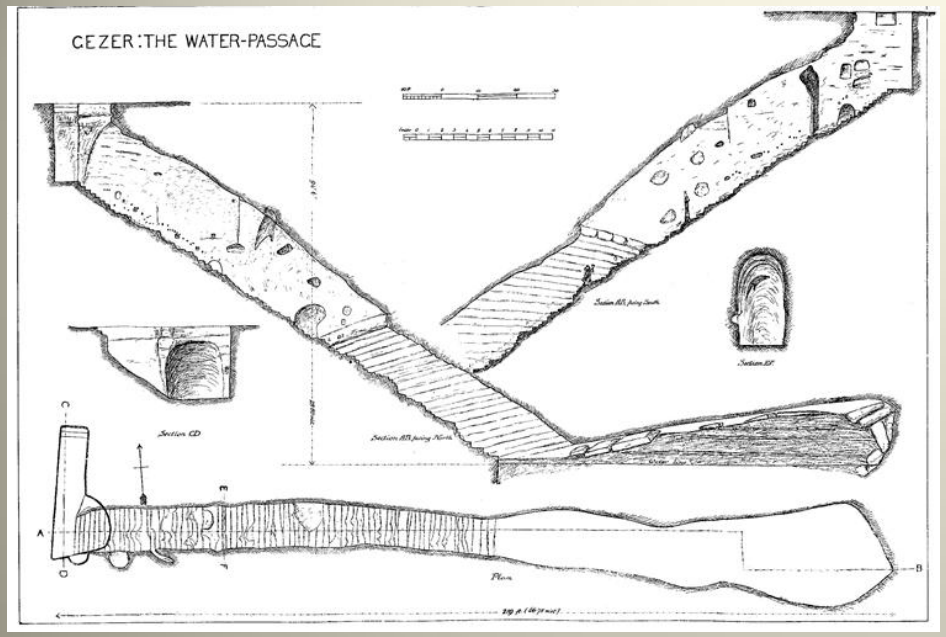


Gezer Shaft/Tunnel

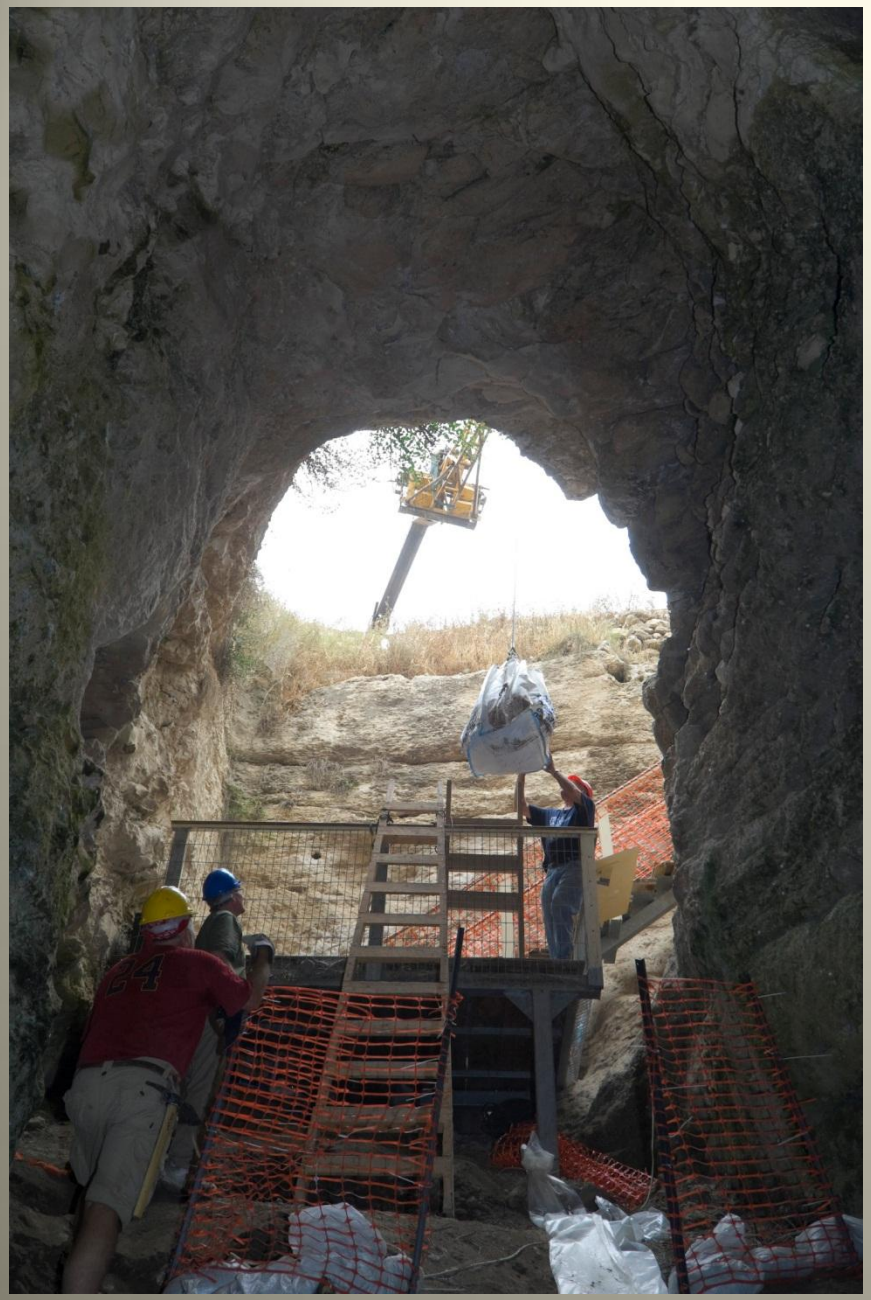
1. Rock-cut shaft
2. Stepped (or sloping) tunnel
3. Chamber on water table
4. Southern Gate in Middle Bronze wall
5. Middle or Late Bronze wall (initial phase built 2000-1500 BCE)

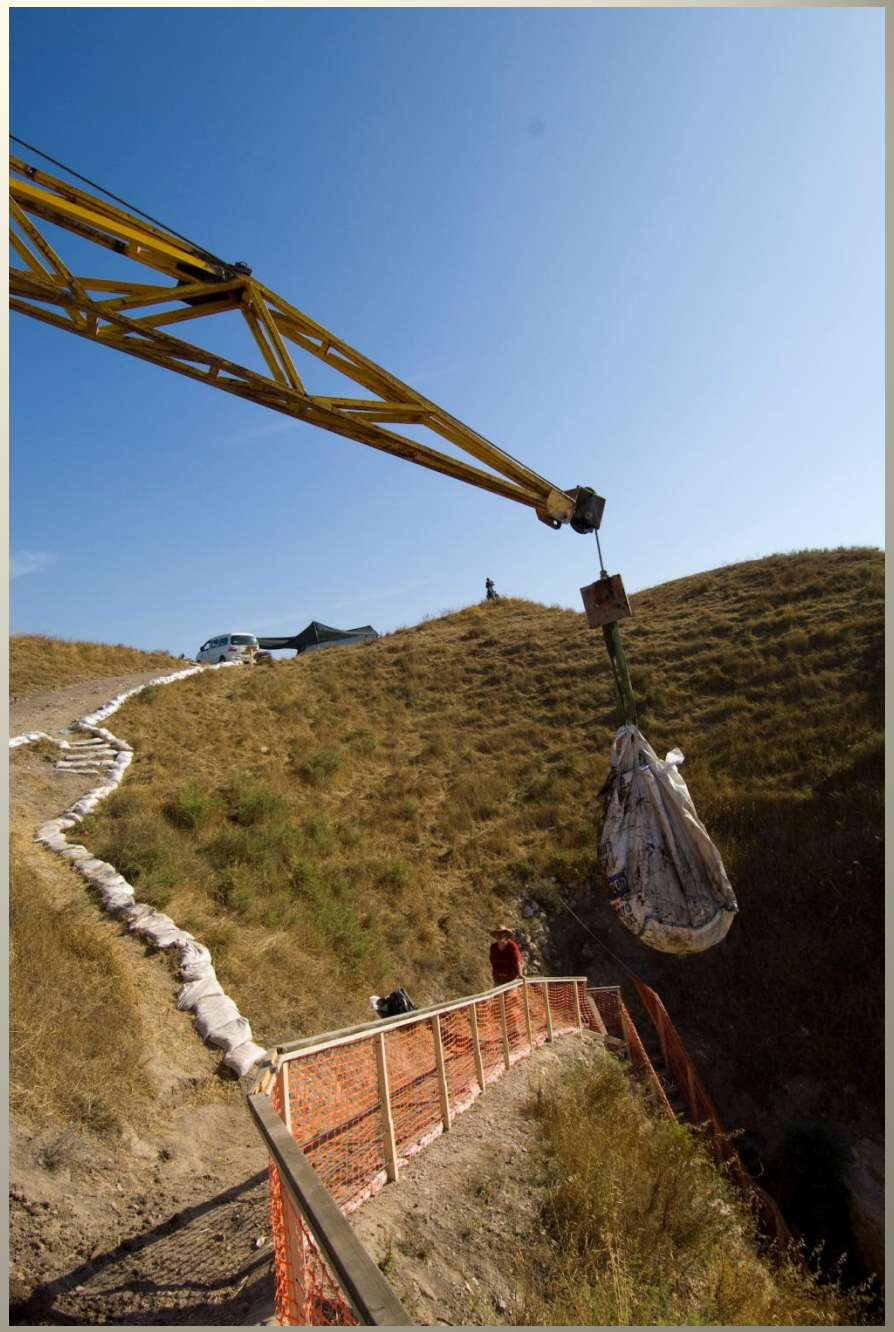
Gezer Tunnel

Architectural Features



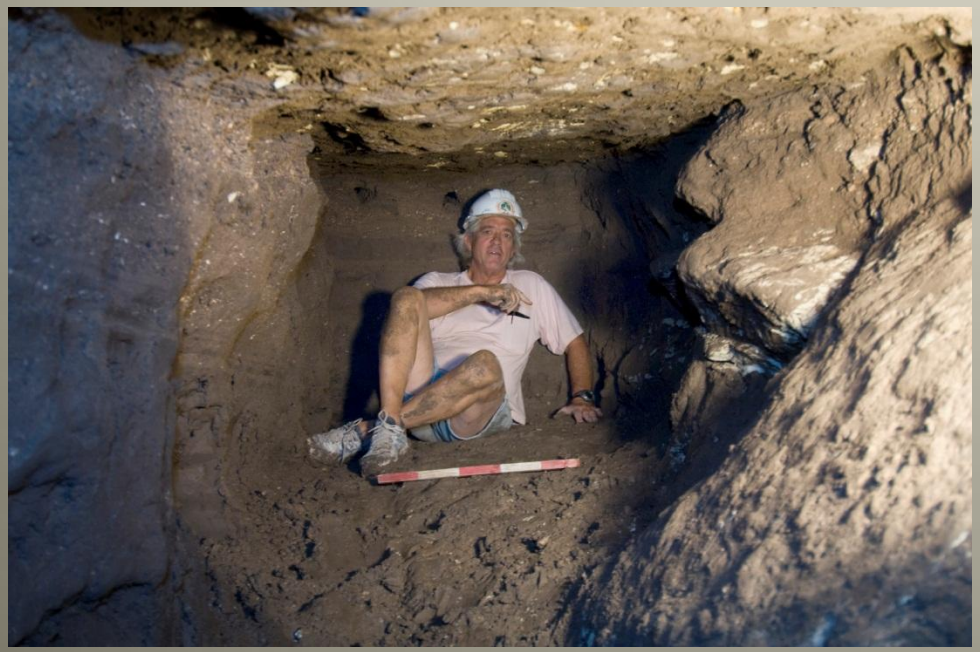
Daily Operation



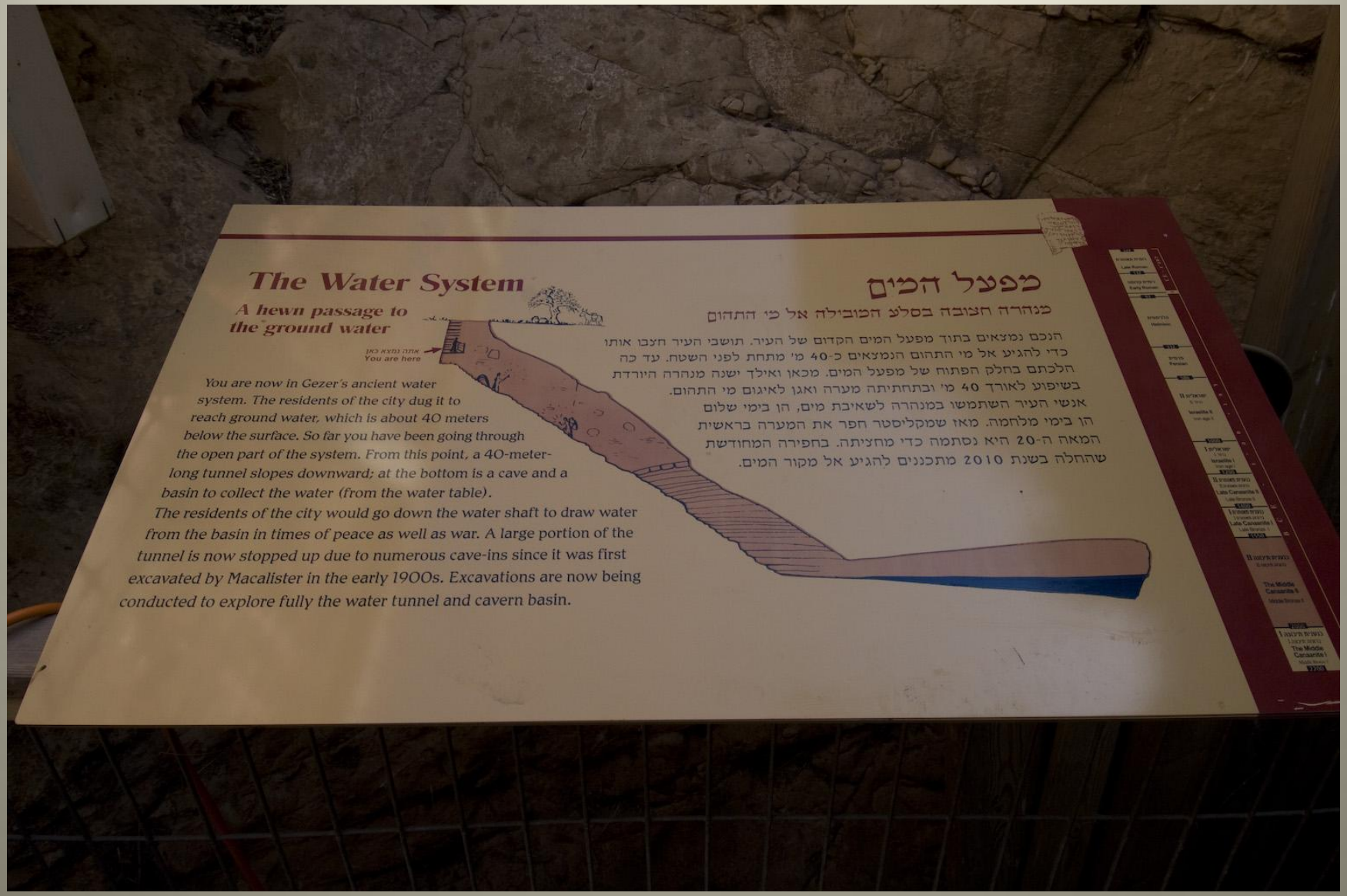


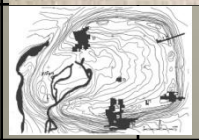
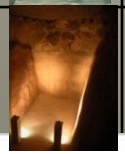
Steps

Entrance to Cavern



Goals for Summer 2012



	PPNe 6000 BCE	NE 5000 BCE	CL 4000 BCE	EB 2500 BCE	MB 1800 BCE	LB 1400 BCE	Iron 1 1100 BCE	Iron 2 800 BCE	Hell. 200 BCE	Rom. 200 CE	Byz. 500 CE	Med. 1200 CE
1 Well												
2 Nearby Spring												
3 Cistern												
4 Reserv. Pool Runoff												
5 Dam												
6 Inner Spring												
7 Unde. Water System												
8 Reser. Outer Source												
9. Aque-duct												

General Conclusions About Water Systems:

- Typology - gives only general picture on the subject in each region
- Certain developments can be traced throughout history
- Wells appeared first, leading to the development of underground, monumental water systems
- Cisterns next, leading to the development of underground reservoirs
- Research can be used for comparative analysis
- Research is just beginning and needs to be continued

www.nobts.edu/ArchaeologyCenter/
http://nobtsarchaeology.blogspot.com/