1	00:00:45:10	00:00:48:22	Annenberg Media
2	00:00:48:24	00:01:38:24	§
3	00:01:38:26	00:01:41:24	WATER HAS ALWAYS BEEN VITAL TO CIVILIZATION.
4	00:01:41:26	00:01:44:03	CITIES AND TOWNS ARE USUALLY BUILT
5	00:01:44:05	00:01:46:22	ALONG AN ABUNDANT SUPPLY OF FRESH WATER,
6	00:01:46:24	00:01:49:11	SUCH AS A RIVER OR A LAKE.
7	00:01:49:13	00:01:51:16	BUT LAKES AND RIVERS CAN'T SUPPLY
8	00:01:51:18	00:01:53:11	ALL THE WATER WE NEED,
9	00:01:53:13	00:01:56:01	SO WE'VE TAPPED INTO ANOTHER SOURCE--GROUNDWATER.
10	00:01:56:03	00:01:57:27	THE PRACTICE OF WATER DOWSING--
11	00:01:57:29	00:02:00:07	FINDING UNDERGROUND WATER USING FORKED STICKS--
12	00:02:00:09	00:02:02:22	HAS BEEN GOING ON FOR CENTURIES.
13	00:02:02:24	00:02:06:02	TYPICALLY, THE DOWSER GRASPS THE FORK OF THE STICK
14	00:02:06:04	00:02:08:17	AND POINTS THE OTHER END SKYWARD.
15	00:02:08:19	00:02:11:22	THEN, AS HE'S WALKING ALONG AND HAPPENS TO PASS OVER
16	00:02:11:24	00:02:13:21	A SUPPLY OF UNDERGROUND WATER,
17	00:02:13:23	00:02:16:12	THE END OF THE STICK, OR DIVINING ROD,
18	00:02:16:14	00:02:17:27	SUPPOSEDLY TWISTS DOWNWARD,
19	00:02:17:29	00:02:20:07	SHOWING WHERE TO DIG THE WELL.
20	00:02:20:09	00:02:22:27	IN REALITY, ALMOST ANYWHERE YOU POINT THE STICK,
21	00:02:22:29	00:02:24:12	YOU'D EVENTUALLY FIND WATER.
22	00:02:24:14	00:02:26:07	ALTHOUGH ITS DEPTH VARIES CONSIDERABLY
23	00:02:26:09	00:02:27:22	FROM PLACE TO PLACE,
24	00:02:27:24	00:02:30:01	WATER IS PRESENT BENEATH THE EARTH'S SURFACE
25	00:02:30:03	00:02:31:07	ALMOST EVERYWHERE,
26	00:02:31:09	00:02:33:05	EVEN UNDER THE DRIEST DESERTS.
27	00:02:33:07	00:02:35:22	MOST PEOPLE TEND TO TAKE GROUNDWATER FOR GRANTED,
28	00:02:35:24	00:02:38:02	BUT IT'S A TREMENDOUSLY VALUABLE RESOURCE
29	00:02:38:04	00:02:40:16	UPON WHICH MOST OF US DEPEND.
30	00:02:40:18	00:02:42:24	OVER 1/2 OF THE U.S. POPULATION
31	00:02:42:26	00:02:45:21	RELIES ON IT FOR ITS DRINKING-WATER SUPPLY.

32 00:02:45:23 00:02:48:20 EVEN MORE GROUNDWATER'S USED
FOR IRRIGATING AGRICULTURE,
33 00:02:48:22 00:02:51:20 AND ITS INDUSTRIAL USE
IS GROWING EVERY DAY.
34 00:02:51:22 00:02:53:04 GROUNDWATER IS VALUABLE
35 00:02:53:06 00:02:55:04 BECAUSE IT'S PLENTIFUL
AND CLEAN.
36 00:02:55:06 00:02:57:25 THERE'S ABOUT 50 TIMES
MORE WATER UNDERGROUND
37 00:02:57:27 00:03:00:15 THAN IN ALL
THE LAKES AND RIVERS
38 00:03:00:17 00:03:02:11 ON THE EARTH'S SURFACE
COMBINED.
39 00:03:02:13 00:03:05:00 IN MANY AREAS, ESPECIALLY
THOSE WITH DRY CLIMATES,
40 00:03:05:02 00:03:06:15 GROUNDWATER IS
THE MOST ABUNDANT
41 00:03:06:17 00:03:08:16 AND ECONOMICAL SOURCE
OF WATER AVAILABLE.
42 00:03:08:18 00:03:11:16 BECAUSE IT'S FILTERED AS IT
PASSES THROUGH THE SOIL,
43 00:03:11:18 00:03:13:05 GROUNDWATER IS USUALLY
LESS POLLUTED
44 00:03:13:07 00:03:14:20 THAN SURFACE WATER.
45 00:03:14:22 00:03:17:15 BUT THIS VALUABLE RESOURCE
IS NOW BEING THREATENED.
46 00:03:17:17 00:03:19:00 IN SOME PLACES,
47 00:03:19:02 00:03:20:15 GROUNDWATER
HAS BEEN CONTAMINATED
48 00:03:20:17 00:03:22:15 BY INDUSTRIAL
OR AGRICULTURAL POLLUTION.
49 00:03:22:17 00:03:24:10 IN OTHERS,
WELLS EXTRACT GROUNDWATER
50 00:03:24:12 00:03:26:19 FASTER THAN
IT CAN BE REPLENISHED.
51 00:03:26:21 00:03:28:05 ALREADY, THIS HAS CAUSED
52 00:03:28:07 00:03:30:00 SEVERE ECONOMIC
AND HEALTH PROBLEMS
53 00:03:30:02 00:03:32:10 IN SEVERAL AREAS
OF THE WORLD.
54 00:03:32:12 00:03:34:20 CONSEQUENTLY, THERE'S AN
INCREASINGLY IMPORTANT ROLE
55 00:03:34:22 00:03:37:11 FOR THE GEOLOGISTS WHO STUDY
WATER MOVEMENT UNDERGROUND
56 00:03:37:13 00:03:39:20 AND WHO CAN
ACCURATELY PREDICT
57 00:03:39:22 00:03:42:02 THE LOCATION AND QUANTITY
OF GROUNDWATER.
58 00:03:44:20 00:03:46:12 *"WATER, WATER EVERYWHERE,*
59 00:03:46:14 00:03:48:29 *YET NOT A DROP*
TO DRINK."
60 00:03:49:01 00:03:51:19 *SO WENT THE COMPLAINT*
OF THE ANCIENT MARINER
61 00:03:51:21 00:03:54:18 *AS HE LOOKED OUT*
OVER THE SALTY BRINE.
62 00:03:54:20 00:03:57:08 *ALTHOUGH THE EARTH*

IS SOMETIMES REFERRED TO

63 00:03:57:10 00:03:58:24 *AS THE WATER PLANET,*

64 00:03:58:26 00:04:01:23 *ONLY A TINY FRACTION OF THIS WATER*

65 00:04:01:25 00:04:04:23 *IS USABLE BY HUMAN BEINGS...*

66 00:04:04:25 00:04:07:04 *AND MOST OF THIS FRESH WATER*

67 00:04:07:06 00:04:08:18 *COMES NOT FROM ABOVE,*

68 00:04:08:20 00:04:11:18 *BUT FROM BENEATH THE EARTH'S SURFACE.*

69 00:04:11:20 00:04:15:03 *THIS GROUNDWATER ORIGINATES IN VARIOUS WAYS.*

70 00:04:15:05 00:04:17:17 *WATER PERCOLATES CONTINUOUSLY INTO THE EARTH*

71 00:04:17:19 00:04:20:02 *FROM LAKES AND RIVERS, FOR EXAMPLE.*

72 00:04:20:04 00:04:22:17 *MOST IMPORTANT OF ALL, HOWEVER,*

73 00:04:22:19 00:04:24:08 *IS RAINFALL.*

74 00:04:24:10 00:04:26:02 [THUNDER]

75 00:04:29:19 00:04:31:03 *IN SOME PLACES,*

76 00:04:31:05 00:04:33:24 *RAIN WATER READILY DISAPPEARS INTO THE GROUND.*

77 00:04:33:26 00:04:35:08 *OF COURSE,*

78 00:04:35:10 00:04:38:04 *WATER DOESN'T GET BENEATH THE LAND SURFACE*

79 00:04:38:06 00:04:41:04 *WITH EQUAL EASE EVERYWHERE ON THE GLOBE.*

80 00:04:41:06 00:04:44:03 *WHEN IT LANDS ON HARD BEDROCK*

81 00:04:44:05 00:04:45:25 *OR ASPHALT PAVEMENT,*

82 00:04:45:27 00:04:47:11 *IT SIMPLY RUNS OFF*

83 00:04:47:13 00:04:49:25 *TO FEED NEARBY STREAMS AND RIVERS.*

84 00:04:51:07 00:04:54:01 *BUT IF THERE ARE CRACKS OR FISSURES*

85 00:04:54:03 00:04:55:20 *IN THE SURFACE ROCK,*

86 00:04:55:22 00:04:59:07 *THE WATER CAN PASS THROUGH TO COLLECT UNDERGROUND.*

87 00:04:59:09 00:05:02:10 *EVEN HARD ROCKS, SUCH AS BASALT OR GRANITE,*

88 00:05:02:12 00:05:04:26 *USUALLY HAVE SOME FRACTURES IN THEM*

89 00:05:04:28 00:05:06:26 *THROUGH WHICH WATER CAN PERMEATE.*

90 00:05:10:09 00:05:11:22 *OTHER LAND SURFACES*

91 00:05:11:24 00:05:14:22 *CONSIST OF LESS SOLID AGGREGATES OF MATERIAL*

92 00:05:14:24 00:05:17:17 *SUCH AS SANDSTONE OR SEDIMENT*

93 00:05:17:19 00:05:19:00 *OR ORDINARY SOIL.*

94 00:05:19:02 00:05:22:00 *HERE THE WATER CAN WORK ITS WAY*

95 00:05:22:02 00:05:24:07 *DOWN THROUGH THE GAPS, OR INTERSTICES,*

96 00:05:24:09 00:05:26:20 *BETWEEN THE INDIVIDUAL BITS OF MATTER.*

97 00:05:28:16 00:05:32:11 *ALTHOUGH PERMEABLE ROCK WILL LET THE WATER THROUGH,*

98 00:05:32:13 00:05:34:11 *IT STILL MAY NOT BE*

99 00:05:34:13 00:05:36:07 *A GOOD SOURCE OF GROUNDWATER.*

100 00:05:36:09 00:05:38:29 *FOR A ROCK TO CONTAIN ABUNDANT GROUNDWATER,*

101 00:05:39:01 00:05:42:14 *IT ALSO NEEDS TO HAVE A LOT OF OPEN SPACES,*

102 00:05:42:16 00:05:43:22 *OR PORES.*

103 00:05:43:24 00:05:45:25 *THE CAPACITY TO TRANSMIT WATER*

104 00:05:45:27 00:05:47:28 *IS CALLED PERMEABILITY,*

105 00:05:48:00 00:05:50:15 *AND THE CAPACITY TO STORE WATER*

106 00:05:50:17 00:05:52:04 *IS CALLED POROSITY.*

107 00:05:52:06 00:05:53:18 *THE IDEAL ROCK MATERIAL*

108 00:05:53:20 00:05:56:14 *FOR THE ACCUMULATION OF GROUNDWATER*

109 00:05:56:16 00:05:59:07 *IS BOTH POROUS AND PERMEABLE.*

110 00:06:01:01 00:06:04:13 *THIS KIND OF MATERIAL IS KNOWN AS AN AQUIFER--*

111 00:06:04:15 00:06:06:28 *FROM THE LATIN FOR "WATER-BEARING."*

112 00:06:09:02 00:06:12:08 *SANDSTONE IS A GOOD EXAMPLE OF AN AQUIFER.*

113 00:06:15:13 00:06:18:04 *CLAY, ON THE OTHER HAND, IS A MATERIAL*

114 00:06:18:06 00:06:21:15 *THAT TENDS TO EXCLUDE THE FLOW OF GROUNDWATER.*

115 00:06:21:17 00:06:22:28 *IT IS AN AQUICLUDE,*

116 00:06:23:00 00:06:24:29 *THE OPPOSITE OF AN AQUIFER.*

117 00:06:27:10 00:06:29:04 *AS CLAY ABSORBS LIQUID,*

118 00:06:29:06 00:06:30:28 *ITS INDIVIDUAL GRAINS*

119 00:06:31:00 00:06:33:08 *SWELL UP WHILE BECOMING SATURATED*

120 00:06:33:10 00:06:36:14 *AND CLOSE THE CHANNELS BETWEEN ADJOINING PORES,*

121 00:06:36:16 00:06:40:00 *THUS BLOCKING THE PASSAGE OF GROUNDWATER.*

122 00:06:40:02 00:06:42:13 *WHILE GROUNDWATER HAS THE EFFECT*

123 00:06:42:15 00:06:44:13 *OF MAKING CLAY LAYERS SWELL,*

124 00:06:44:15 00:06:47:12 *IT CAN EAT AWAY OTHER ROCK TYPES.*

125 00:06:50:24 00:06:53:02 *THE MOST VIVID EXAMPLE OF THIS*

126 00:06:53:04 00:06:54:27 *IS THE FORMATION OF CAVES.*

127 00:06:54:29 00:06:58:13 *INFILTRATING GROUNDWATER IS ALWAYS SLIGHTLY ACIDIC*

128 00:06:58:15 00:07:01:27 *BECAUSE IT HAS REACTED WITH CARBON DIOXIDE IN THE AIR,*
129 00:07:01:29 00:07:04:07 *THUS FORMING CARBONIC ACID.*
130 00:07:04:09 00:07:07:26 *THIS ACID GRADUALLY DISSOLVES LIMESTONE,*
131 00:07:07:28 00:07:10:03 *ESPECIALLY ALONG JOINTS.*
132 00:07:10:05 00:07:12:27 *IF THE GROUNDWATER EVENTUALLY DRAINS OFF,*
133 00:07:12:29 00:07:16:16 *IT WILL LEAVE BEHIND AIR-FILLED CAVERNS.*
134 00:07:22:09 00:07:23:22 *COLUMNS OF ROCK*
135 00:07:23:24 00:07:26:00 *BUILD UP INSIDE THESE CAVERNS.*
136 00:07:32:15 00:07:34:01 *THESE FORMATIONS ARE CREATED*
137 00:07:34:03 00:07:37:29 *BY DROPLETS OF GROUNDWATER SEEPING INTO THE CAVES.*
138 00:07:43:07 00:07:45:25 *AS EACH DROP CLINGS TO THE CEILING*
139 00:07:45:27 00:07:47:25 *FOR A BRIEF MOMENT,*
140 00:07:47:27 00:07:49:10 *ENOUGH EVAPORATION TAKES PLACE*
141 00:07:49:12 00:07:51:11 *TO PRECIPITATE A MINUTE AMOUNT*
142 00:07:51:13 00:07:53:01 *OF CALCIUM CARBONATE.*
143 00:07:55:12 00:07:56:28 *OVER CENTURIES,*
144 00:07:57:00 00:07:59:29 *UNTOLD MILLIONS OF SUCH MICROSCOPIC GRAINS OF ROCK*
145 00:08:00:03 00:08:02:14 *WILL FORM STALACTITES ABOVE.*
146 00:08:04:22 00:08:07:04 *AND FROM THE BUILD-UP OF DROPLETS*
147 00:08:07:06 00:08:09:04 *THAT REACH THE FLOOR BELOW,*
148 00:08:09:06 00:08:10:26 *STALAGMITES WILL FORM.*
149 00:08:14:22 00:08:18:21 *IN PLACES WHERE CAVES ARE STILL FLOODED,*
150 00:08:18:23 00:08:21:29 *GEOLOGISTS CAN TRACE THE FLOW OF GROUNDWATER*
151 00:08:22:01 00:08:24:19 *BY RELEASING NONTOXIC DYES...*
152 00:08:27:13 00:08:28:25 *THAT WILL ULTIMATELY REAPPEAR*
153 00:08:28:27 00:08:30:28 *AT THE EARTH'S SURFACE*
154 00:08:31:00 00:08:33:21 *IN THE FORM OF SPRINGS AND RIVERS.*
155 00:08:33:23 00:08:36:21 *ONE REASON GEOLOGISTS STUDY GROUNDWATER*
156 00:08:36:23 00:08:39:00 *IS TO LEARN HOW IT MOVES*
157 00:08:39:02 00:08:40:14 *BENEATH THE EARTH'S SURFACE.*
158 00:08:41:28 00:08:44:23 *THE AREA IN WHICH THE WATER ACCUMULATES*
159 00:08:44:25 00:08:48:08 *IS KNOWN*

AS THE SATURATED ZONE,

160 00:08:48:10 00:08:52:03 *AND THE LAYER ABOVE IT--*
THE UNSATURATED ZONE.

161 00:08:52:05 00:08:55:08 *WHEN A WELL IS DUG*
INTO THE SATURATED ZONE,

162 00:08:55:10 00:08:58:13 *THE GROUNDWATER WILL FILL*
THE LOWER PART OF THE WELL.

163 00:08:58:15 00:09:00:28 *THE WATER LEVEL*
INSIDE THE WELL

164 00:09:01:00 00:09:05:00 *MARKS THE UPPER SURFACE*
OF THE SATURATED ZONE.

165 00:09:05:02 00:09:09:08 *THIS SURFACE IS CALLED*
THE WATER TABLE.

166 00:09:09:10 00:09:12:08 *WHERE THE LAND SURFACE*
IS FLAT,

167 00:09:12:10 00:09:14:08 *THE WATER TABLE*
BENEATH IT

168 00:09:14:10 00:09:16:26 *IS ALSO FLAT.*

169 00:09:16:28 00:09:19:09 *BUT WHERE*
THE LAND IS HILLY,

170 00:09:19:11 00:09:22:08 *THE WATER TABLE WILL ALSO*
HAVE AN IRREGULAR SURFACE

171 00:09:22:10 00:09:25:08 *WITH HIGH AND LOW PARTS*
ROUGHLY CORRESPONDING

172 00:09:25:10 00:09:27:04 *TO THE OVERLYING*
TOPOGRAPHY.

173 00:09:29:25 00:09:32:09 *IN VALLEYS,*
THE ZONE OF SATURATION

174 00:09:32:11 00:09:35:02 *MAY RISE TO MEET*
THE EARTH'S SURFACE

175 00:09:35:04 00:09:37:08 *AT RIVER*
AND LAKE BEDS.

176 00:09:37:10 00:09:39:29 *WHEN THE RIVERS*
AND LAKES ARE FULL,

177 00:09:40:01 00:09:42:06 *A CONTINUOUS SUPPLY*
OF NEW GROUNDWATER

178 00:09:42:08 00:09:44:06 *RECHARGES*
THE ZONE OF SATURATION,

179 00:09:44:08 00:09:46:20 *AND WATER FLOWS*
FROM THE SURFACE

180 00:09:46:22 00:09:48:09 *INTO THE GROUND.*

181 00:09:50:00 00:09:52:22 *HOWEVER, DURING*
THE DRY SUMMER MONTHS

182 00:09:52:24 00:09:55:06 *WHEN SURFACE*
WATER LEVELS ARE LOW,

183 00:09:55:08 00:09:58:06 *GROUNDWATER MAY FLOW*
IN THE OPPOSITE DIRECTION,

184 00:09:58:08 00:10:00:06 *PROVIDING*
THE RIVERS AND LAKES

185 00:10:00:08 00:10:02:21 *WITH THEIR ONLY*
SUPPLY OF WATER

186 00:10:02:23 00:10:04:21 *IN THE ABSENCE OF RAIN.*

187 00:10:04:23 00:10:07:20 *THIS PHENOMENON*
IS CALLED EFFLUENCE.

188 00:10:10:16 00:10:13:06 *WHERE GROUNDWATER FLOWS OUT*
THROUGH AN OPENING

189 00:10:13:08 00:10:14:20 *TO THE SURFACE--*
190 00:10:14:22 00:10:17:21 *AS, FOR EXAMPLE,*
ALONG A JOINT OR A FAULT--
191 00:10:17:23 00:10:19:05 *SPRINGS FORM.*
192 00:10:19:07 00:10:21:21 *MOST SPRINGS*
FLOW YEAR-ROUND,
193 00:10:21:23 00:10:24:16 *EVEN THROUGH THE LONG*
HOT MONTHS OF SUMMER
194 00:10:24:18 00:10:27:16 *WHEN THEY MIGHT BE EXPECTED*
TO DRY UP.
195 00:10:27:18 00:10:29:06 *THIS IS BECAUSE*
196 00:10:29:08 00:10:32:12 *THE WATER THAT COMES OUT*
OF THE GROUND IN THE SUMMER
197 00:10:32:14 00:10:34:11 *MAY WELL HAVE*
STARTED ITS JOURNEY
198 00:10:34:13 00:10:35:26 *THE PREVIOUS WINTER.*
199 00:10:38:28 00:10:41:07 *GETTING WATER*
OUT OF THE GROUND
200 00:10:41:09 00:10:43:07 *REQUIRES WORKING*
AGAINST GRAVITY
201 00:10:43:09 00:10:45:08 *AND PUMPING*
THE WATER UP.
202 00:10:49:13 00:10:50:26 *BUT IN SOME WELLS,*
203 00:10:50:28 00:10:52:21 *THE GROUNDWATER*
WILL MOVE UPWARD
204 00:10:52:23 00:10:54:06 *OF ITS OWN ACCORD*
205 00:10:54:08 00:10:56:07 *IN APPARENT DEFIANCE*
OF GRAVITY.
206 00:10:56:09 00:10:59:00 *THESE ARE CALLED*
ARTESIAN WELLS.
207 00:11:01:08 00:11:04:06 *TO UNDERSTAND HOW*
THESE VALUABLE WELLS WORK,
208 00:11:04:08 00:11:06:03 *A CLASSIFICATION*
OF AQUIFERS
209 00:11:06:05 00:11:09:02 *INTO TWO TYPES--*
OPEN AND CLOSED--
210 00:11:09:04 00:11:10:22 *IS USEFUL.*
211 00:11:10:24 00:11:12:26 *IN AN OPEN AQUIFER,*
212 00:11:12:28 00:11:14:26 *A STRATUM*
OF PERMEABLE ROCK
213 00:11:14:28 00:11:16:29 *OVERLIES THE WATER TABLE,*
214 00:11:17:01 00:11:19:21 *SO THAT THE PRESSURE*
OF THE WATER--
215 00:11:19:23 00:11:22:06 *IN OTHER WORDS,*
THE HYDROSTATIC PRESSURE--
216 00:11:22:08 00:11:25:02 *AT THE TOP OF THE ZONE*
OF SATURATION
217 00:11:25:04 00:11:26:26 *IS QUITE LOW,*
218 00:11:26:28 00:11:30:06 *TOO LOW FOR THE WATER*
TO RISE UP UNASSISTED
219 00:11:30:08 00:11:31:21 *TO THE LAND SURFACE.*
220 00:11:33:14 00:11:35:27 *THE OTHER MAIN TYPE*
OF AQUIFER,
221 00:11:35:29 00:11:37:21 *THE CLOSED AQUIFER,*
222 00:11:37:23 00:11:41:18 *IS OVERLAIN BY A LAYER*
OF IMPERMEABLE ROCK--

223 00:11:41:20 00:11:43:04 *AN AQUICLUDE.*
224 00:11:43:06 00:11:46:04 *WHERE SUCH AN AQUIFER IS INCLINED*
225 00:11:46:06 00:11:49:05 *WITH ITS HIGHEST LEVEL EXPOSED AT THE SURFACE,*
226 00:11:49:07 00:11:51:20 *WATER CAN ENTER DIRECTLY INTO IT*
227 00:11:51:22 00:11:54:19 *IN WHAT IS KNOWN AS THE RECHARGE AREA.*
228 00:11:56:06 00:11:58:03 *THE WEIGHT OF THE WATER*
229 00:11:58:05 00:11:59:18 *ENTERING THE INCLINED AQUIFER*
230 00:11:59:20 00:12:01:04 *VIA THE RECHARGE AREA,*
231 00:12:01:06 00:12:03:03 *COMBINED WITH THE CONFINING EFFECT*
232 00:12:03:05 00:12:06:20 *OF THE LAYER OF IMPERMEABLE ROCK ABOVE,*
233 00:12:06:22 00:12:10:19 *CAUSES HYDROSTATIC PRESSURE TO BUILD UP.*
234 00:12:10:21 00:12:14:24 *IF A WELL IS DUG IN THE APPROPRIATE PLACE,*
235 00:12:14:26 00:12:17:04 *THIS PRESSURE IS OFTEN STRONG ENOUGH*
236 00:12:17:06 00:12:20:05 *TO DRIVE WATER UP TO THE SURFACE*
237 00:12:20:07 00:12:22:04 *AGAINST THE PULL OF GRAVITY.*
238 00:12:28:16 00:12:30:13 *ONE WAY TO BETTER UNDERSTAND*
239 00:12:30:15 00:12:33:16 *HOW HYDROSTATIC PRESSURE CAN MAKE WATER FLOW UPWARD*
240 00:12:33:18 00:12:35:28 *IS TO TRY A SIMPLE EXPERIMENT*
241 00:12:36:00 00:12:37:13 *WITH A HOSE.*
242 00:12:37:15 00:12:40:05 *WHEN WATER IS POURED INTO THE HIGHER END,*
243 00:12:40:07 00:12:42:18 *ITS WEIGHT DRIVES THE WATER UP*
244 00:12:42:20 00:12:45:12 *AND OUT THE LOWER END OF THE HOSE,*
245 00:12:45:14 00:12:47:08 *EVEN THOUGH THE LOWER END*
246 00:12:47:10 00:12:50:07 *IS ABOVE THE SAGGING MIDDLE OF THE HOSE.*
247 00:12:52:04 00:12:54:12 *ONE OF THE MOST SIGNIFICANT AQUIFERS*
248 00:12:54:14 00:12:55:27 *IN THE UNITED STATES*
249 00:12:55:29 00:12:58:12 *LIES JUST SOUTH OF LOS ANGELES*
250 00:12:58:14 00:12:59:28 *IN ORANGE COUNTY,*
251 00:13:00:01 00:13:02:23 *WHERE IT SUPPLIES WATER FOR TWO MILLION PEOPLE.*
252 00:13:02:25 00:13:05:16 *THE TOTAL POTENTIAL CAPACITY OF THIS AQUIFER*
253 00:13:05:18 00:13:07:02 *IS ESTIMATED*
254 00:13:07:04 00:13:10:02 *AT BETWEEN 10*

AND 30 MILLION ACRE-FEET.

255 00:13:10:04 00:13:12:22 *THIS EQUALS*
THE TOTAL VOLUME OF WATER
256 00:13:12:24 00:13:14:06 *THAT LIES BENEATH*
257 00:13:14:08 00:13:16:12 *THE ENTIRE*
STATE OF CALIFORNIA.
258 00:13:16:14 00:13:18:27 *THIS IS*
ALL THE MORE SURPRISING
259 00:13:18:29 00:13:20:22 *BECAUSE*
BEFORE ITS SETTLEMENT,
260 00:13:20:24 00:13:22:06 *LOW RAINFALL*
261 00:13:22:08 00:13:25:22 *MADE MOST OF THIS REGION*
A VIRTUAL DESERT.
262 00:13:25:24 00:13:28:21 THE COASTAL PLAIN
OF SOUTHERN CALIFORNIA,
263 00:13:28:23 00:13:31:22 OF WHICH ORANGE COUNTY
IS A PART,
264 00:13:31:24 00:13:35:02 IS PARTICULARLY WELL SUITED
FOR, UH, GROUNDWATER STORAGE.
265 00:13:35:04 00:13:38:01 IT HAS SEVERAL THINGS
GOING FOR IT.
266 00:13:38:03 00:13:41:00 A--IT'S VERY DEEP,
267 00:13:41:02 00:13:43:00 SOME 4,000 FEET DEEP,
268 00:13:43:02 00:13:44:14 UH, TO, UH...
269 00:13:44:16 00:13:46:00 ALL CONTAINING
FRESH WATER,
270 00:13:46:02 00:13:50:01 OF WHICH WE ONLY USE
ABOUT THE UPPER 1,500 FEET.
271 00:13:50:03 00:13:55:00 IT HAS A, UH...
SURFACE WATER SUPPLY.
272 00:13:55:02 00:13:59:15 IT'S THE ONLY
PERENNIAL STREAM
IN SOUTHERN CALIFORNIA.
273 00:13:59:17 00:14:02:15 THE--THIS STREAM
IS FED BY--
274 00:14:02:17 00:14:04:02 BY SNOW MELT
275 00:14:04:04 00:14:07:09 IN A VERY LARGE
MOUNTAIN RANGE BEHIND US.
276 00:14:07:11 00:14:09:10 AGAIN, IN A DESERT AREA,
277 00:14:09:12 00:14:12:24 WE HAVE SNOW THAT FEEDS
A PERENNIAL RIVER SYSTEM
278 00:14:12:26 00:14:16:00 WHICH PROVIDES
CONTINUOUS WATER SUPPLY.
279 00:14:16:02 00:14:19:01 ANOTHER FACTOR THAT
HELPS OUT A GREAT DEAL
280 00:14:19:03 00:14:22:18 IN MAINTAINING
THE FLOW OF THE WATER
DOWN THIS RIVER
281 00:14:22:20 00:14:25:00 IS THE FACT
THAT WE HAVE
282 00:14:25:02 00:14:27:00 CONSIDERABLE RESIDENTIAL
AND COMMERCIAL DEVELOPMENT
283 00:14:27:02 00:14:29:14 UPSTREAM OF US,
284 00:14:29:16 00:14:32:14 WHICH, UH,
PROVIDES US WATERS
285 00:14:32:16 00:14:34:29 OF WASTE-WATER ORIGIN.

286 00:14:35:01 00:14:36:16 THAT MEANS THE WATER
287 00:14:36:18 00:14:39:16 HAS GONE THROUGH
A TREATMENT PLANT
ONCE UPSTREAM
288 00:14:39:18 00:14:43:14 AND HAS GONE THROUGH
A SERIES OF BIOLOGICAL
CLEANSING ACTIVITY,
289 00:14:43:16 00:14:47:13 WHICH PROVIDES US
WITH A VERY SUITABLE
SUPPLY OF WATER
290 00:14:47:15 00:14:50:27 TO GO INTO
OUR GROUNDWATER BASIN.
291 00:14:50:29 00:14:53:28 SO WE'RE BLESSED
WITH VERY PERMEABLE SOILS,
292 00:14:54:00 00:14:55:29 A VERY LARGE
STORAGE CAPACITY,
293 00:14:56:01 00:14:58:22 AND A STEADY SUPPLY
OF WATER.
294 00:15:00:01 00:15:01:09 *PART OF THE SUCCESS*
295 00:15:01:11 00:15:03:13 *OF THE ORANGE COUNTY*
WATER DISTRICT
296 00:15:03:15 00:15:05:19 *CAN BE TRACED*
TO MEASURES TAKEN
297 00:15:05:21 00:15:08:05 *TO RECHARGE*
THE LOCAL AQUIFER.
298 00:15:09:20 00:15:12:23 ONE OF THE WAYS
WE MANAGE THE
GROUNDWATER BASIN
299 00:15:12:25 00:15:16:17 IS BY ENSURING THAT
WE PUT AS MUCH WATER
BACK INTO THE GROUND
300 00:15:16:19 00:15:19:13 AS WE TAKE OUT
THROUGH A SERIES
OF EXTRACTION WELLS.
301 00:15:19:15 00:15:22:08 THIS IS DONE
THROUGH OUR
RECHARGE FACILITIES,
302 00:15:22:10 00:15:24:28 MUCH LIKE
THE ONE SHOWN
IN THE BACKGROUND.
303 00:15:25:00 00:15:27:03 THESE RECHARGE
BASINS CONSIST
PRIMARILY
304 00:15:27:05 00:15:31:08 OF OLD GRAVEL PITS
AND ALSO WHAT'S
IN THE CHANNEL.
305 00:15:31:10 00:15:34:05 THE OFF-CHANNEL
OR OLD GRAVEL PITS
306 00:15:34:07 00:15:35:28 CAPTURE WATER
FROM THE RIVER
307 00:15:36:00 00:15:38:13 AND DIVERT IT
INTO THESE BASINS
308 00:15:38:15 00:15:41:06 WHERE IT EFFECTIVELY
PERCOLATES INTO
THE GROUNDWATER.
309 00:15:41:08 00:15:43:16 ALL OF THESE BASINS

ARE UNDERLINED

310 00:15:43:18 00:15:45:17 BY POROUS,
HIGH-PERMEABLE
SEDIMENTS

311 00:15:45:19 00:15:48:16 THAT ARE IN
CONNECTION WITH THE
UNDERLYING AQUIFERS

312 00:15:48:18 00:15:51:26 WHICH EXTEND
DOWN INTO THE LOWER
PART OF THE BASIN.

313 00:15:51:28 00:15:55:11 THEREFORE, WATER
IS ABLE TO PERCOLATE
THROUGH THESE BASINS

314 00:15:55:13 00:15:58:26 INTO THE AQUIFERS
AND EFFECTIVELY
RECHARGE

315 00:15:58:28 00:16:01:25 THE WHOLE
ORANGE COUNTY
GROUNDWATER BASIN.

316 00:16:03:15 00:16:06:27 *GROUNDWATER MANAGEMENT*
REQUIRES A GREAT DEAL OF CARE,

317 00:16:06:29 00:16:10:17 *NOT ONLY BECAUSE THE WATER*
ITSELF IS SO VITAL,

318 00:16:10:19 00:16:12:17 *BUT BECAUSE*
A DIMINISHED SUPPLY

319 00:16:12:19 00:16:15:10 *COULD CAUSE THE GROUND*
ABOVE TO SUBSIDE,

320 00:16:15:12 00:16:16:26 *AND THIS, IN TURN,*

321 00:16:16:28 00:16:19:10 *COULD TRIGGER*
A MULTITUDE OF PROBLEMS.

322 00:16:21:24 00:16:24:11 AS WATER INFILTRATES
INTO AN AQUIFER,

323 00:16:24:13 00:16:26:26 THE PERMEABLE ROCK
SOAKS UP THE WATER

324 00:16:26:28 00:16:29:03 LIKE A SPONGE
UNTIL IT'S SATURATED.

325 00:16:29:05 00:16:30:26 THE WEIGHT
OF THIS SATURATED ZONE

326 00:16:30:28 00:16:32:08 GENERATES
AN AQUIFER PRESSURE

327 00:16:32:10 00:16:34:11 THAT FORCES
ROCK PARTICLES APART.

328 00:16:34:13 00:16:37:12 THIS PRESSURE ALSO HELPS TO
HOLD UP THE GROUND SURFACE,

329 00:16:37:14 00:16:39:00 EVEN INFLATING IT SLIGHTLY.

330 00:16:39:02 00:16:40:16 WHEN GROUNDWATER
IS WITHDRAWN,

331 00:16:40:18 00:16:41:28 THE PRESSURE DECREASES,

332 00:16:42:00 00:16:44:19 AND THE PARTICLES PACK
MORE TIGHTLY TOGETHER.

333 00:16:44:21 00:16:46:13 IF THE RATE
OF WATER WITHDRAWAL

334 00:16:46:15 00:16:48:09 EXCEEDS THE RATE
OF INFILTRATION,

335 00:16:48:11 00:16:50:24 THE OVERLYING GROUND SURFACE
WILL OFTEN SUBSIDE.

336 00:16:50:26 00:16:52:29 GROUND SUBSIDENCE
CAN BE DRAMATIC
337 00:16:53:01 00:16:54:14 AND HAVE
DISASTROUS CONSEQUENCES
338 00:16:54:16 00:16:57:04 IN AREAS OF HIGH
GROUNDWATER WITHDRAWAL.
339 00:16:57:06 00:16:59:03 IN HOUSTON, TEXAS,
FOR EXAMPLE,
340 00:16:59:05 00:17:00:14 3 METERS OF SUBSIDENCE
341 00:17:00:16 00:17:03:00 HAS OCCURRED OVER 40 YEARS
OF OVERPUMPING,
342 00:17:03:02 00:17:05:03 RESULTING IN TENS
OF MILLIONS OF DOLLARS
343 00:17:05:05 00:17:06:16 OF PROPERTY DAMAGE
344 00:17:06:18 00:17:08:24 AND THE LOSS OF 80 SQUARE
KILOMETERS OF LAND.
345 00:17:08:26 00:17:10:08 ONE SUBURB, CRYSTAL COVE,
346 00:17:10:10 00:17:13:04 HAD TO BE ABANDONED COMPLETELY
BECAUSE OF FLOODING.
347 00:17:13:06 00:17:14:25 IN ITALY,
GROUNDWATER WITHDRAWAL
348 00:17:14:27 00:17:17:29 HAS CAUSED THE LEAN
IN THE TOWER OF PISA
349 00:17:18:01 00:17:19:24 AND CONTRIBUTES
TO CONTINUED FLOODING
350 00:17:19:26 00:17:21:29 IN THE CANAL CITY OF VENICE.
351 00:17:23:07 00:17:24:25 *SOMETIMES,*
GROUNDWATER WITHDRAWAL
352 00:17:24:27 00:17:26:24 *CAN CAUSE THE GROUND*
TO COLLAPSE
353 00:17:26:26 00:17:29:19 *LIKE SAND GOING THROUGH*
THE NECK OF AN HOURGLASS,
354 00:17:29:21 00:17:32:24 *RESULTING IN SINKHOLES*
LIKE THESE.
355 00:17:35:11 00:17:36:26 *IN OTHER REGIONS,*
356 00:17:36:28 00:17:40:20 *THE SURFACE OF THE EARTH*
IS TORN BY GIANT CRACKS.
357 00:17:40:22 00:17:42:02 *IN COASTAL REGIONS,*
358 00:17:42:04 00:17:44:01 *THE EXCESSIVE WITHDRAWAL*
OF GROUNDWATER
359 00:17:44:03 00:17:47:25 *CAN CAUSE OTHER PROBLEMS*
IN ADDITION TO SUBSIDENCE.
360 00:17:50:14 00:17:53:12 *BENEATH LAND,*
GROUNDWATER IS FRESH,
361 00:17:53:14 00:17:56:16 *BUT UNDERNEATH*
THE SEA FLOOR, IT IS SALTY.
362 00:17:56:18 00:18:00:03 *SINCE FRESH WATER IS*
LESS DENSE THAN SEA WATER,
363 00:18:00:05 00:18:03:03 *FRESH GROUNDWATER*
JUST INLAND FROM THE COAST
364 00:18:03:05 00:18:06:27 *WILL TEND TO FLOAT ON TOP*
OF A SALT WATER BASE.
365 00:18:06:29 00:18:09:02 *IF FRESH WATER*
IS PUMPED OUT
366 00:18:09:04 00:18:11:12 *FASTER THAN IT CAN BE*
NATURALLY REPLENISHED,

367 00:18:11:14 00:18:14:13 *SEA WATER WILL FLOW IN TO REPLACE IT.*

368 00:18:14:15 00:18:18:07 *AS A RESULT, THE WELL WATER BECOMES INCREASINGLY SALTY,*

369 00:18:18:09 00:18:20:12 *MAKING IT USELESS FOR DRINKING*

370 00:18:20:14 00:18:22:22 *AND POISONOUS FOR IRRIGATION.*

371 00:18:29:09 00:18:32:03 *OTHER GROUNDWATER POLLUTION PROBLEMS ALSO EXIST,*

372 00:18:32:05 00:18:35:13 *INVOLVING CONTAMINATION FROM MANY SOURCES*

373 00:18:35:15 00:18:37:10 *SUCH AS FACTORIES,*

374 00:18:37:12 00:18:40:22 *FARMS, SEPTIC TANKS,*

375 00:18:40:24 00:18:42:08 *GARBAGE DUMPS,*

376 00:18:42:10 00:18:45:06 *AND LESS OFTEN, RADIOACTIVE WASTE DEPOSITORIES.*

377 00:18:49:14 00:18:52:23 *HEADLINES LIKE THESE ABOUT TOXIC DRINKING WATER*

378 00:18:52:25 00:18:55:19 *HAVE BEEN ALL TOO COMMON IN RECENT YEARS.*

379 00:18:58:11 00:19:01:10 *ONE WAY IN WHICH WE POLLUTE GROUNDWATER*

380 00:19:01:12 00:19:02:24 *IS THROUGH BADLY DESIGNED*

381 00:19:02:26 00:19:06:11 *OR IMPROPERLY MAINTAINED LANDFILLS.*

382 00:19:06:13 00:19:09:10 *WHEN RAIN LEACHES THE POLLUTANTS FROM A LANDFILL*

383 00:19:09:12 00:19:11:20 *INTO THE SATURATED ZONE,*

384 00:19:11:22 00:19:14:19 *A PLUME OF POLLUTED WASTE SPREADS OUT*

385 00:19:14:21 00:19:17:05 *IN THE DIRECTION OF GROUNDWATER FLOW.*

386 00:19:17:07 00:19:19:11 *FORTUNATELY, ENGINEERS ARE NOW DEVELOPING*

387 00:19:19:13 00:19:20:29 *MORE EFFECTIVE TECHNIQUES*

388 00:19:21:01 00:19:23:16 *TO MINIMIZE THE IMPACT OF LANDFILLS*

389 00:19:23:18 00:19:25:25 *ON GROUNDWATER QUALITY.*

390 00:19:25:27 00:19:28:20 *ONE OF THE TECHNIQUES THAT HAS BEEN DEVELOPED*

391 00:19:28:22 00:19:31:06 *IS A LANDFILL LINER SYSTEM.*

392 00:19:31:08 00:19:34:00 *ITS MULTIPLE LAYERS ACT AS A BARRIER*

393 00:19:34:02 00:19:36:29 *BETWEEN THE GARBAGE AND THE SURROUNDING ENVIRONMENT.*

394 00:19:37:01 00:19:39:16 *THE BASE OF THE LINER SYSTEM*

395 00:19:39:18 00:19:42:13 *IS SIMPLY A LAYER OF IMPERMEABLE CLAY*

396 00:19:42:15 00:19:44:18 *WHICH IS SPREAD AROUND THE LANDFILL*

397 00:19:44:20 00:19:46:29 *AND COMPACTED BY HEAVY EQUIPMENT.*

398 00:19:47:01 00:19:48:14 *WHILE THE CLAY ITSELF*

399 00:19:48:16 00:19:51:03 *MIGHT BE ADEQUATE*

TO PREVENT THE SEEPAGE

400 00:19:51:05 00:19:52:22 *OF POLLUTED WATER,*
OR LEACHATE,

401 00:19:52:24 00:19:54:09 *OUT OF THE LANDFILL,*

402 00:19:54:11 00:19:56:23 *EXTRA PRECAUTIONS*
ARE TAKEN.

403 00:19:56:25 00:19:59:18 *A SYNTHETIC,*
HIGH-DENSITY PLASTIC LINER

404 00:19:59:20 00:20:02:17 *IS PLACED*
ON TOP OF THE CLAY.

405 00:20:05:04 00:20:08:18 *NEXT, A HALF METER OR SO*
OF PERMEABLE SAND,

406 00:20:08:20 00:20:10:09 *ALONG WITH DRAINAGE PIPES,*

407 00:20:10:11 00:20:13:18 *IS LAID ACROSS THE PLASTIC.*

408 00:20:13:20 00:20:15:18 *HERE, THE LEACHATE*
ACCUMULATES

409 00:20:15:20 00:20:18:18 *AND FLOWS OUT*
FROM BENEATH THE LANDFILL

410 00:20:18:20 00:20:20:28 *FOR SAFE DISPOSAL*
ELSEWHERE.

411 00:20:23:15 00:20:24:28 *AT SOME LANDFILLS,*

412 00:20:25:00 00:20:27:18 *THE METHANE GAS*
PRODUCED BY DECAYING WASTE

413 00:20:27:20 00:20:32:03 *IS COLLECTED AND BURNED*
TO GENERATE ELECTRICITY.

414 00:20:32:05 00:20:35:02 *AND SO, A COMPOSITE*
LANDFILL LINER

415 00:20:35:04 00:20:37:08 *CAN SERVE A DUAL PURPOSE--*

416 00:20:37:10 00:20:39:08 *PROTECTING*
GROUNDWATER QUALITY

417 00:20:39:10 00:20:42:12 *AND PROVIDING AN ADDITIONAL*
SOURCE OF ELECTRICITY.

418 00:20:46:05 00:20:48:03 *THE GREAT IRONY*
ABOUT GROUNDWATER

419 00:20:48:05 00:20:50:17 *IS HOW LITTLE ATTENTION*
IT OFTEN GETS

420 00:20:50:19 00:20:53:04 *IN DISCUSSIONS*
ABOUT DWINDLING RESOURCES.

421 00:20:53:06 00:20:55:19 *WE WORRY*
ABOUT RUNNING OUT OF OIL,

422 00:20:55:21 00:20:58:03 *AND THERE'S NO QUESTION*
IT'S OF GREAT IMPORTANCE

423 00:20:58:05 00:20:59:28 *TO OUR GLOBAL ECONOMY.*

424 00:21:00:00 00:21:02:18 *BUT WHEN ALL*
IS SAID AND DONE,

425 00:21:02:20 00:21:06:03 *LIFE COULD GO ON,*
EVEN WITHOUT HYDROCARBONS.

426 00:21:06:05 00:21:07:18 *THERE ARE, AFTER ALL,*

427 00:21:07:20 00:21:09:22 *ALTERNATIVE SOURCES*
OF ENERGY.

428 00:21:11:21 00:21:13:27 *BUT WHEN IT COMES TO WATER,*

429 00:21:13:29 00:21:16:09 *THERE IS NO SUBSTITUTE.*

430 00:21:16:11 00:21:20:12 *WITHOUT WATER, LIFE*
IS SIMPLY NOT POSSIBLE.

431 00:21:23:07 00:21:24:29 *FORTUNATELY,*
GROUNDWATER RESOURCES

432	00:21:25:01	00:21:27:28	*ARE NOT AS LIMITED* *OR IRREPLACEABLE,*
433	00:21:28:00	00:21:29:12	*FOR GROUNDWATER*
434	00:21:29:14	00:21:31:12	*IS MORE RAPIDLY* *REPLENISHED BY NATURE*
435	00:21:31:14	00:21:33:08	*THAN IS OIL.*
436	00:21:33:10	00:21:36:18	*BUT THE TIME SCALE* *OF NATURAL REPLENISHMENT*
437	00:21:36:20	00:21:38:03	*IS VERY LONG,*
438	00:21:38:05	00:21:40:22	*AT LEAST* *BY HUMAN STANDARDS.*
439	00:21:40:24	00:21:43:01	*AT THE CURRENT LEVEL* *OF INFILTRATION,*
440	00:21:43:03	00:21:45:00	*IT WOULD TAKE* *THOUSANDS OF YEARS*
441	00:21:45:02	00:21:46:15	*TO RESTORE* *THE WATER SUPPLY*
442	00:21:46:17	00:21:49:02	*THAT HAS BEEN PUMPED* *FROM BENEATH MANY CITIES*
443	00:21:49:04	00:21:51:25	*IN BUT A FRACTION* *OF THAT TIME.*
444	00:21:53:06	00:21:55:15	*IN ADDITION TO ENSURING* *ADEQUATE SUPPLY,*
445	00:21:55:17	00:21:57:12	*PROTECTING* *THE QUALITY OF WATER*
446	00:21:57:14	00:21:59:29	*IS ALSO* *OF UTMOST IMPORTANCE.*
447	00:22:00:03	00:22:03:02	*AGAIN, ORANGE COUNTY* *IS AN EXCELLENT EXAMPLE*
448	00:22:03:04	00:22:06:05	*OF HOW GEOLOGISTS* *GO ABOUT DOING THIS.*
449	00:22:08:03	00:22:11:01	THERE ARE TWO ASPECTS TO WATER QUALITY.
450	00:22:11:03	00:22:15:00	FIRST OF ALL IS-- WE'RE IN A COASTAL BASIN.
451	00:22:15:02	00:22:17:00	WE'RE NEXT TO THE OCEAN.
452	00:22:17:02	00:22:20:17	IF WE DRAW THE BASIN DOWN,
453	00:22:20:19	00:22:24:16	SALT WATER WOULD FLOW IN TO TAKE THE FRESH WATER'S PLACE
454	00:22:24:18	00:22:27:16	AND THUS SEVERELY DAMAGE THE BASIN.
455	00:22:27:18	00:22:30:12	THE OTHER ASPECT IS POLLUTION.
456	00:22:30:14	00:22:33:12	IN THE CASE OF SALT WATER INTRUSION,
457	00:22:33:14	00:22:37:26	WE HAVE BUILT INJECTION WELLS ALONG THE COAST,
458	00:22:37:28	00:22:41:09	AND WE ARE EITHER PUTTING IMPORTED WATER IN THEM,
459	00:22:41:11	00:22:44:29	OR WE'RE PUTTING RECLAIMED WASTE WATER
460	00:22:45:01	00:22:48:10	THAT'S PRODUCED AT OUR WATER FACTORY 21.
461	00:22:49:21	00:22:51:14	*THE ORANGE COUNTY*

INJECTION WELLS

462 00:22:51:16 00:22:54:15 *ACT AS A HYDRAULIC BARRIER*
ALONG THE COAST

463 00:22:54:17 00:22:56:14 *WHICH KEEPS*
THE SALT WATER OUT

464 00:22:56:16 00:22:59:24 *EVEN IF THE LEVEL OF THE*
GROUNDWATER IN THE BASIN

465 00:22:59:26 00:23:01:08 *IS DRASTICALLY LOWERED.*

466 00:23:03:05 00:23:07:25 IN POLLUTION, WE HAVE
AN INDUSTRIAL BASE
IN ORANGE COUNTY

467 00:23:07:27 00:23:10:00 AND MUCH OF
SOUTHERN CALIFORNIA.

468 00:23:10:02 00:23:13:00 THERE IS MORE CIRCUIT BOARD
MANUFACTURING DONE

469 00:23:13:02 00:23:15:14 PER SQUARE MILE
IN ORANGE COUNTY

470 00:23:15:16 00:23:17:29 THAN ANYPLACE ELSE
IN THE WORLD.

471 00:23:18:01 00:23:19:14 SO WE HAVE THINGS

472 00:23:19:16 00:23:22:29 THAT POTENTIALLY
COULD GET INTO OUR
GROUNDWATER BASIN--

473 00:23:23:01 00:23:26:15 SOLVENTS, HEAVY METALS,
ET CETERA,

474 00:23:26:17 00:23:30:15 BUT WE HAVE
A VERY DETAILED
SOURCE CONTROL PROGRAM

475 00:23:30:17 00:23:33:14 THAT'S MANAGED
BY OUR SANITATION
DISTRICTS HERE

476 00:23:33:16 00:23:37:13 THAT DON'T ALLOW
DISCHARGES OF THAT MATERIAL

477 00:23:37:15 00:23:40:12 EITHER INTO OUR BASINS

478 00:23:40:14 00:23:42:12 OR INTO
THE WASTE WATER STREAM

479 00:23:42:14 00:23:45:28 THAT EVENTUALLY GETS INTO
OUR INJECTION BARRIER.

480 00:23:46:00 00:23:48:20 *BECAUSE WATER QUALITY*
IS SUCH A VITAL PART

481 00:23:48:22 00:23:50:07 *OF GROUNDWATER MANAGEMENT,*

482 00:23:50:09 00:23:52:21 *IT IS ESSENTIAL*
TO MONITOR THE WATER

483 00:23:52:23 00:23:55:13 *BOTH ABOVE*
AND BELOW THE SURFACE.

484 00:23:59:14 00:24:03:28 TRADITIONALLY,
WE'VE SAMPLED OUR
GROUNDWATER BASIN

485 00:24:04:00 00:24:05:27 AT THE PRODUCTION WELL,

486 00:24:05:29 00:24:07:22 AND WE STILL DO THAT

487 00:24:07:24 00:24:10:22 BECAUSE THE NEXT STEP
IS YOUR FAUCET,

488 00:24:10:24 00:24:15:12 AND WE'RE VERY
CONCERNED ABOUT WHAT
REACHES THE FAUCET.

489 00:24:15:14 00:24:17:28 BUT IT WOULD ALSO

BE NICE TO KNOW
490 00:24:18:00 00:24:22:28 IF THERE IS SOMETHING
COMING DOWN THE AQUIFER
THAT WE DON'T KNOW ABOUT
491 00:24:23:00 00:24:27:26 AND FIND IT
BEFORE IT REACHES
THE PRODUCTION WELL.
492 00:24:29:08 00:24:32:18 SO, WHAT WE'VE DONE
AT ORANGE COUNTY
IS DEVELOPED
493 00:24:32:20 00:24:35:28 A VERY SOPHISTICATED
GROUNDWATER MONITORING PROGRAM
494 00:24:36:00 00:24:39:13 WHICH USES
SURFACE WATER SAMPLING,
495 00:24:39:15 00:24:41:10 PRODUCTION WELL SAMPLING,
496 00:24:41:12 00:24:45:10 AND DEDICATED
MONITORING WELL SAMPLING.
497 00:24:45:12 00:24:50:00 OUR MONITORING WELLS
ARE DRILLED TO A DEPTH
OF ABOUT 1,500 FEET
498 00:24:50:02 00:24:53:29 AND ISOLATE AND TAP
UP TO 18 ZONES
499 00:24:54:01 00:24:56:29 THAT WE CAN MONITOR
INDIVIDUALLY,
500 00:24:57:01 00:25:00:10 SO THAT IF A CONTAMINANT
IS COMING TOWARDS US--
501 00:25:00:12 00:25:02:20 TOWARDS A PRODUCTION WELL--
502 00:25:02:22 00:25:06:00 WE CAN FIND IT BEFORE
IT BECOMES A PROBLEM
503 00:25:06:02 00:25:08:09 AND INSTITUTE A MITIGATION.
504 00:25:10:19 00:25:12:20 *THE MONITORING WELLS*
PROVIDE A PICTURE
505 00:25:12:22 00:25:16:10 *NOT ONLY OF WHEN AND WHERE*
CONTAMINATION IS OCCURRING,
506 00:25:16:12 00:25:18:16 *BUT ALSO OF*
THE GEOLOGICAL STRUCTURE
507 00:25:18:18 00:25:20:10 *OF THE GROUNDWATER BASIN.*
508 00:25:20:12 00:25:21:27 *AS A WELL IS DRILLED,*
509 00:25:21:29 00:25:26:02 *SAMPLES OF THE ROCK*
ARE COLLECTED AND ANALYZED.
510 00:25:26:04 00:25:29:11 *FROM THESE DATA,*
THE SUBSTRUCTURE IS MAPPED
511 00:25:29:13 00:25:30:29 *AND COMPUTER MODELS CREATED*
512 00:25:31:01 00:25:35:05 *TO PREDICT HOW GROUNDWATER*
FLOWS THROUGH THE BASIN.
513 00:25:37:02 00:25:39:09 *THIS INFORMATION*
IS EXTREMELY IMPORTANT
514 00:25:39:11 00:25:42:08 *BECAUSE IT HELPS*
WATER DISTRICT PERSONNEL
515 00:25:42:10 00:25:46:03 *PLAN HOW TO EFFECTIVELY CONTAIN*
GROUNDWATER POLLUTANTS.
516 00:25:47:15 00:25:49:28 WE DON'T WAIT
FOR REGULATORY AGENCIES
517 00:25:50:00 00:25:54:08 SUCH AS THE STATE
OR THE EPA TO COME TO US
518 00:25:54:10 00:25:56:08 AND TELL US

WE'VE GOT A PROBLEM.
519 00:25:56:10 00:25:57:23 IT'S TOO LATE THEN.
520 00:25:57:25 00:26:00:13 WE'RE LOOKING AT MANAGING
OUR OWN GROUNDWATER BASIN
521 00:26:00:15 00:26:03:07 AS THOUGH WE HAD
TO DRINK THE WATER,
522 00:26:03:09 00:26:04:21 AND WE DO.
523 00:26:14:00 00:26:15:13 LIFE DEMANDS WATER,
524 00:26:15:15 00:26:16:25 AND GROUNDWATER
525 00:26:16:27 00:26:19:03 IS AN IMMENSELY
IMPORTANT NATURAL RESOURCE.
526 00:26:19:05 00:26:21:18 GROUNDWATER IS RECHARGED
BY THE INFILTRATION
527 00:26:21:20 00:26:24:18 OF RAIN AND SNOW
AND SURFACE WATER
528 00:26:24:20 00:26:27:08 INTO THE FRACTURES
AND PORES IN ROCKS.
529 00:26:27:10 00:26:29:23 ROCKS THAT ARE BOTH
HIGHLY POROUS AND PERMEABLE
530 00:26:29:25 00:26:32:08 MAKE THE BEST-QUALITY
AQUIFERS AND WILL CONTAIN
531 00:26:32:10 00:26:34:19 THE MOST ABUNDANT
GROUNDWATER SUPPLIES.
532 00:26:34:21 00:26:37:09 AQUIFERS ARE VITAL
TO THE WATER SUPPLIES
533 00:26:37:11 00:26:38:28 OF BOTH CITIES AND FARMS,
534 00:26:39:00 00:26:40:08 BUT MANY ARE THREATENED
535 00:26:40:10 00:26:42:16 BY PROBLEMS THAT NEED
TO BE ADDRESSED NOW
536 00:26:42:18 00:26:44:21 IF THESE AQUIFERS
ARE TO BE USED
537 00:26:44:23 00:26:46:02 BY FUTURE GENERATIONS.
538 00:26:46:04 00:26:48:16 THEY ARE IN DANGER
OF BEING DEPLETED
539 00:26:48:18 00:26:51:11 NOT ONLY BY A RAPIDLY RISING
DEMAND FOR WATER,
540 00:26:51:13 00:26:54:06 BUT ALSO BY WASTEFUL
WATER USE PRACTICES.
541 00:26:54:08 00:26:57:01 LARGE-SCALE LAND SUBSIDENCE
IS A DRAMATIC REMINDER
542 00:26:57:03 00:26:58:16 THAT THE PROBLEM
OF OVERPUMPING
543 00:26:58:18 00:27:00:27 HAS BEEN POORLY ADDRESSED
IN THE PAST.
544 00:27:00:29 00:27:03:05 AQUIFERS ARE ALSO
IN DANGER OF POLLUTION,
545 00:27:03:07 00:27:04:19 A PROBLEM CLOSELY ASSOCIATED
546 00:27:04:21 00:27:07:02 WITH OUR MOUNTING
WASTE DISPOSAL NEEDS
547 00:27:07:04 00:27:09:01 AND ALSO
THE INCREASING TOXICITY
548 00:27:09:03 00:27:10:19 OF OUR WASTE PRODUCTS.
549 00:27:10:21 00:27:12:01 BUT THE GROUNDWATER PICTURE
550 00:27:12:03 00:27:14:00 ISN'T AS BLEAK
AS IT MAY SEEM.
551 00:27:14:02 00:27:15:16 IN RECENT YEARS,

552 00:27:15:18 00:27:17:12 EARTH SCIENTISTS HAVE GAINED
A MUCH CLEARER VIEW
553 00:27:17:14 00:27:19:00 OF HOW AQUIFERS
ARE MAINTAINED
554 00:27:19:02 00:27:21:20 AND THE WAY THAT WATER
BEHAVES UNDERGROUND.
555 00:27:21:22 00:27:24:21 THIS KNOWLEDGE IS BEING USED
TO LOCATE NEW AQUIFERS
556 00:27:24:23 00:27:26:03 AND TO DEVELOP STRATEGIES
557 00:27:26:05 00:27:28:11 FOR DEALING WITH
GROUNDWATER-RELATED PROBLEMS.
558 00:27:28:13 00:27:31:22 SOME AQUIFERS ARE BEING
RECHARGED ARTIFICIALLY.
559 00:27:31:24 00:27:35:00 THIS PROTECTS WATER QUALITY
AND PREVENTS SUBSIDENCE
560 00:27:35:02 00:27:38:06 WHILE ASSURING COMMUNITIES
OF AN ADEQUATE WATER SUPPLY.
561 00:27:38:08 00:27:40:19 HYDROGEOLOGISTS
USING COMPUTER MODELS
562 00:27:40:21 00:27:43:03 ARE WORKING TO TRACK
AND PREDICT
563 00:27:43:05 00:27:45:15 THE MOVEMENT
OF GROUNDWATER CONTAMINATION
564 00:27:45:17 00:27:48:05 AND ARE ACTIVELY INVOLVED
IN DEVELOPING METHODS
565 00:27:48:07 00:27:49:29 FOR ISOLATING
AND REMOVING CONTAMINANTS
566 00:27:50:01 00:27:51:27 FROM THE GROUNDWATER
DIRECTLY.
567 00:27:51:29 00:27:53:28 ALTHOUGH THE GOLDEN AGE
OF HYDROGEOLOGY
568 00:27:54:00 00:27:55:12 IS WELL UNDER WAY,
569 00:27:55:14 00:27:57:19 THERE'S STILL MUCH WORK
TO BE DONE.
570 00:27:57:21 00:27:59:04 HYDROGEOLOGISTS
WILL CONTINUE
571 00:27:59:06 00:28:00:19 TO PLAY A CRITICAL ROLE
572 00:28:00:21 00:28:02:24 IN MAINTAINING
GROUNDWATER RESOURCES
573 00:28:02:26 00:28:04:20 NOT ONLY FOR OURSELVES,
574 00:28:04:22 00:28:06:20 BUT FOR FUTURE GENERATIONS.
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