Evaluation and Mitigation of Pollutant Transport in Agricultural Sandy Soils

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USDA/ARS - Prosser, WA

Ashok K. Alva

INTEGRATED CROPPING SYSTEMS FOR IRRIGATED FARMING

Variable rate irrigation, nutrients and chemicals

Spatial variability yield monitoring

N uptake, fate and budget

Management of potatoes and rotational crops

Optimize farm profitability and environmental sustainability

Develop decision support system

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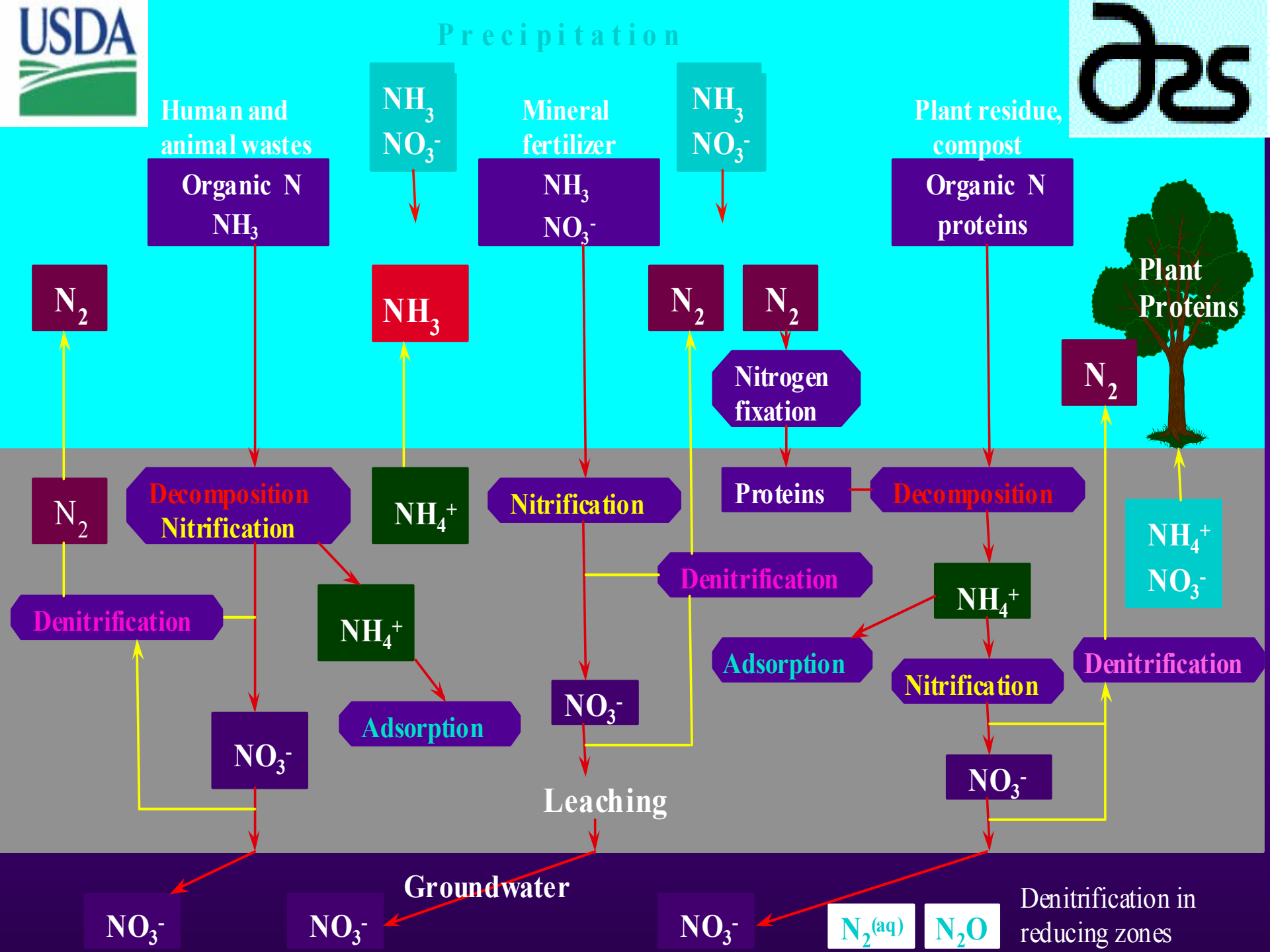
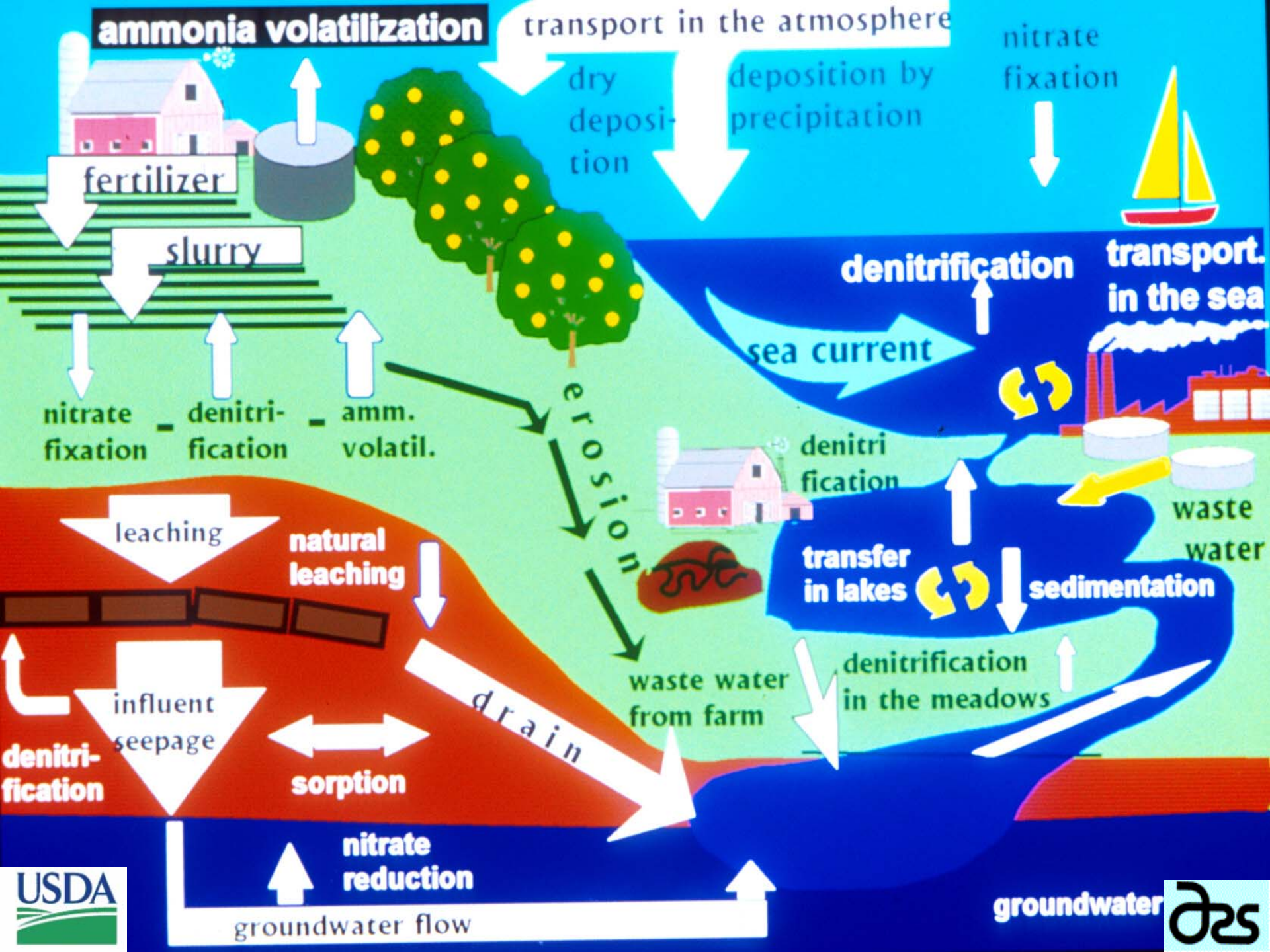

Precipitation
Human and animal wastes
Organic N
NH3
NH3
NO3-
Mineral fertilizer
NH3
NO3-
NH3
NO3-
Plant residue, compost
Organic N
proteins
Plant Proteins
N2
N2
NH3
N2
N2
N2
Nitrogen fixation
Decomposition
Nitrification
NH4+
Nitrification
Proteins
Decomposition
NH4+
NO3-
Denitrification
Denitrification
NH4+
Adsorption
Adsorption
Nitrification
Denitrification
NO3-
NO3-
NO3-
Leaching
Groundwater
NO3-
NO3-
NO3-
N2(aq)
N2O
Denitrification in reducing zones


ammonia volatilization
transport in the atmosphere
dry deposition
deposition by precipitation
nitrate fixation
fertilizer
slurry
nitrate fixation
denitrification
amm. volatil.
erosion
denitrification
transport in the sea
sea current
denitrification
waste water
transfer in lakes
sedimentation
leaching
natural leaching
waste water from farm
denitrification in the meadows
influent seepage
drain
denitrification
sorption
nitrate reduction
groundwater flow
groundwater
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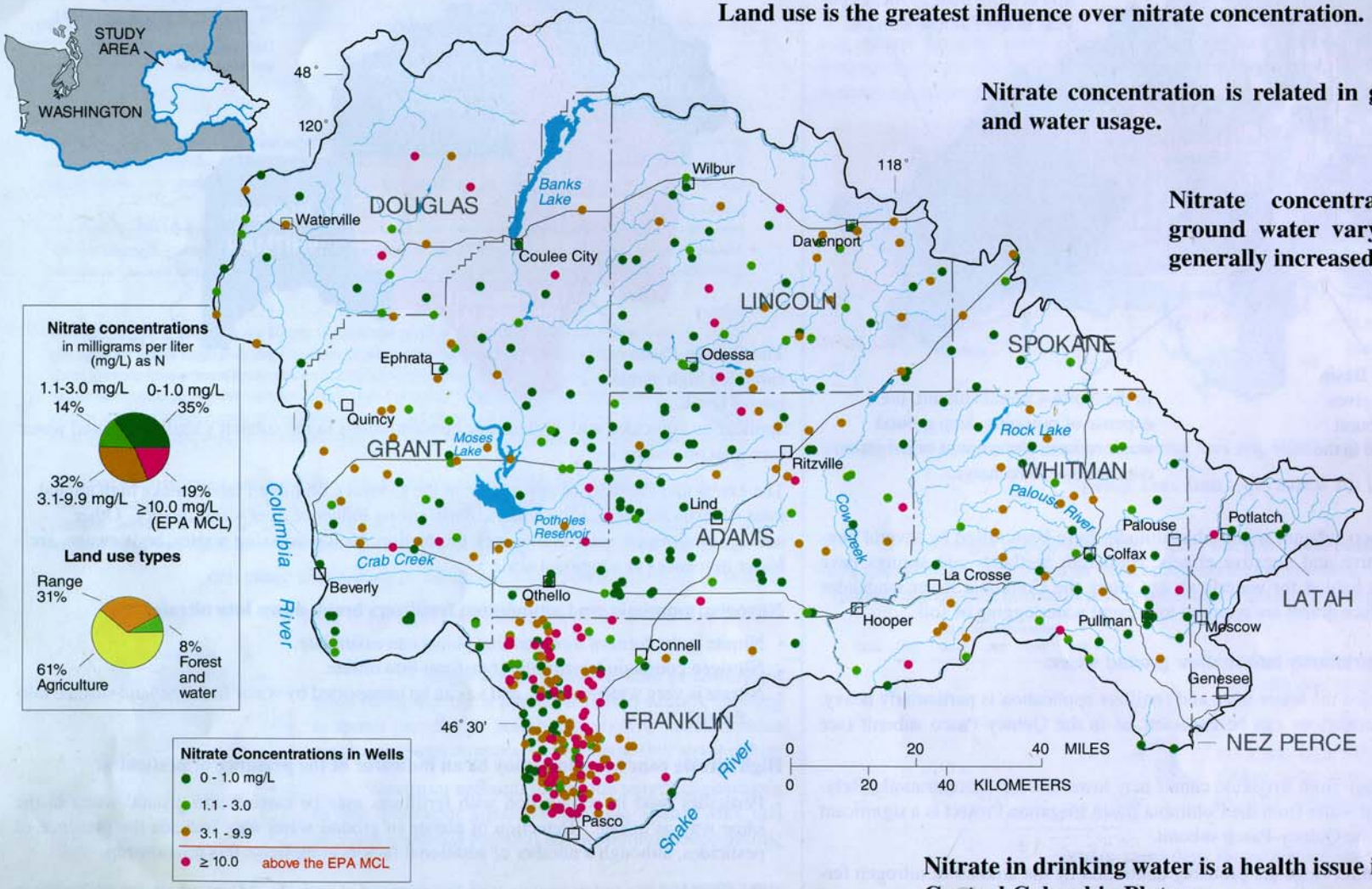
U.S. Geological Survey

Nitrate Concentrations in Ground Water of the Central Columbia Plateau

Open-File Report 95-445
Sarah J. Ryker and Joseph L. Jones

U S
G S

The U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program is designed to assess the status of and trends in the quality of the Nation's water resources, and to gain a better understanding of the natural and human factors that affect water quality. The Central Columbia Plateau is one of 60 NAWQA study units (major river basins and parts of aquifer systems) located throughout the Nation. In the Central Columbia Plateau, nitrate concentrations for 19% of the 573 wells shown below exceed the U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) for drinking water. These concentrations include USGS samples from 1942-94, although 93% of the data are from 1980-94. Where more than one analysis was available for a well, this document refers to the mean concentration as the nitrate concentration for the well.



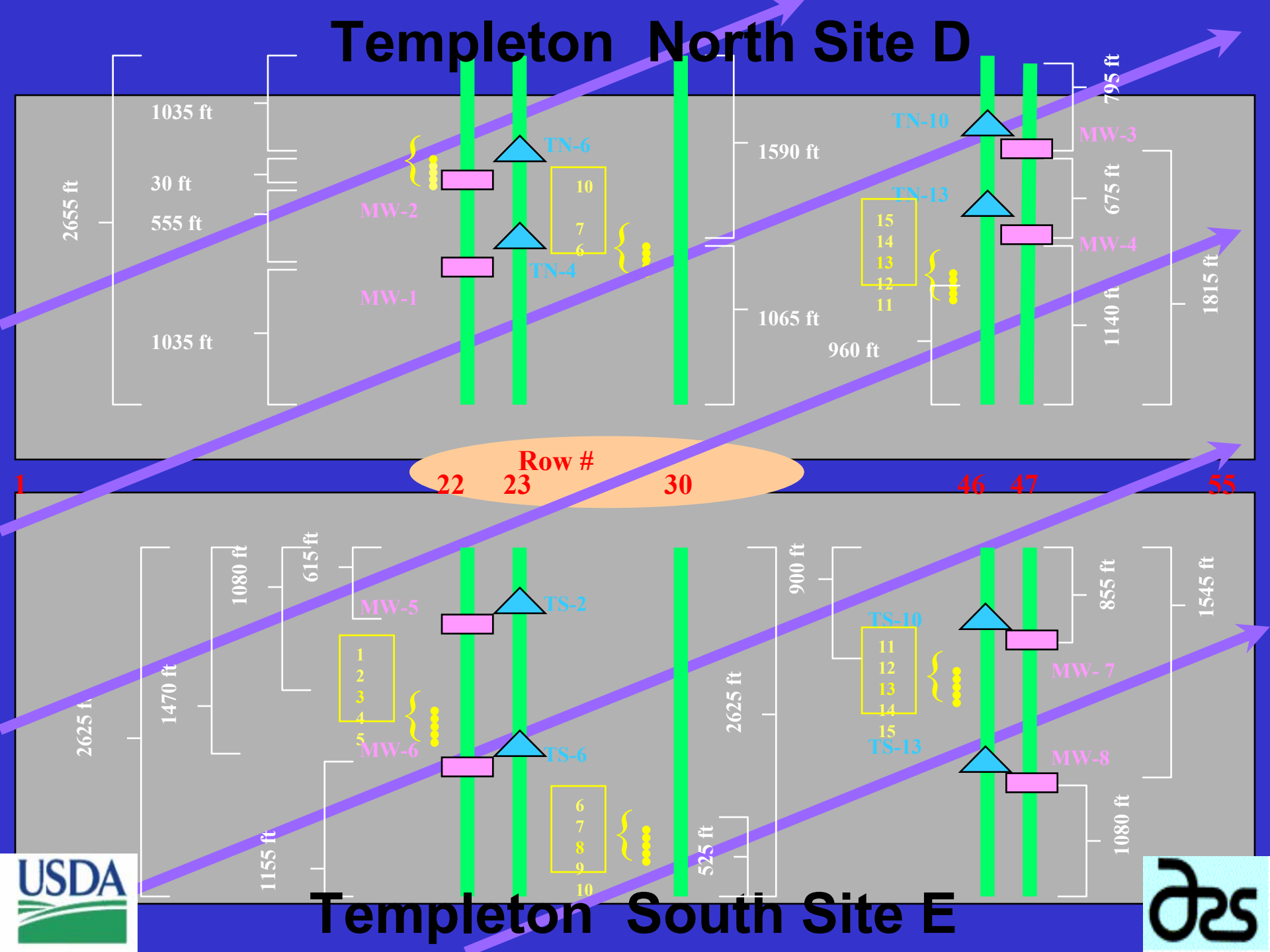
Land use is the greatest influence over nitrate concentration.

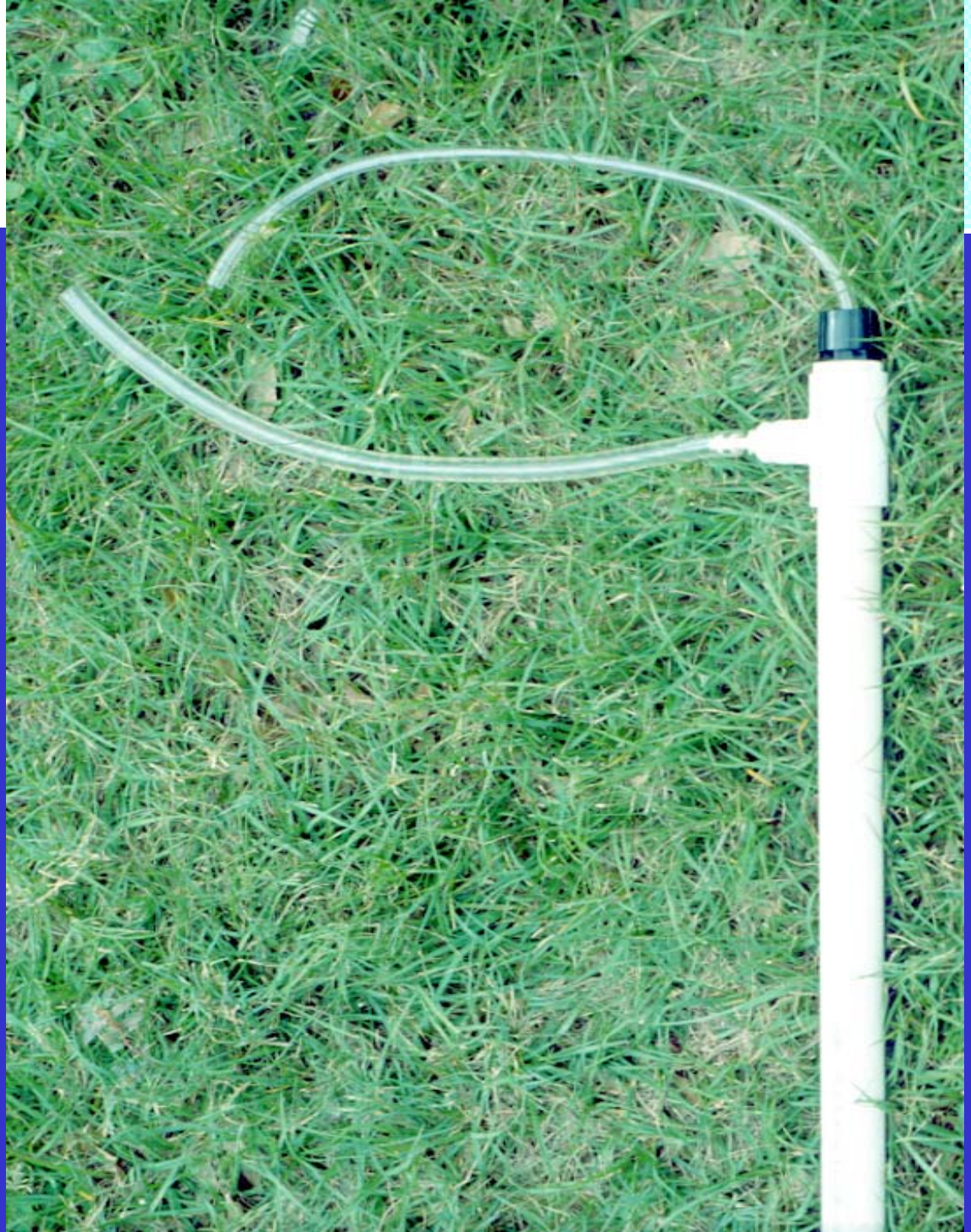
Nitrate concentration is related in general to fertilizer and water usage.

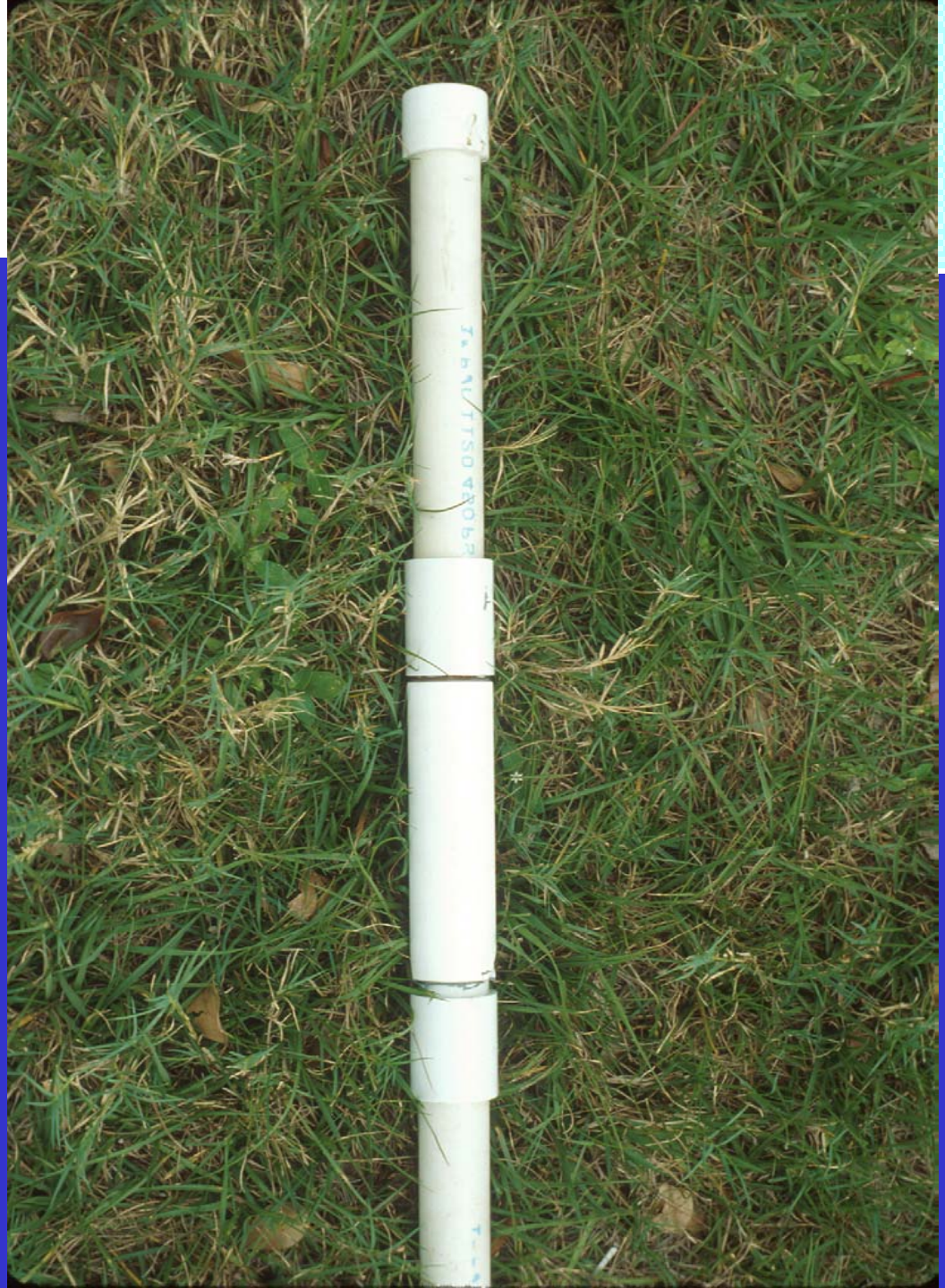
Nitrate concentrations in shallow ground water vary greatly, but have generally increased since the 1950's.

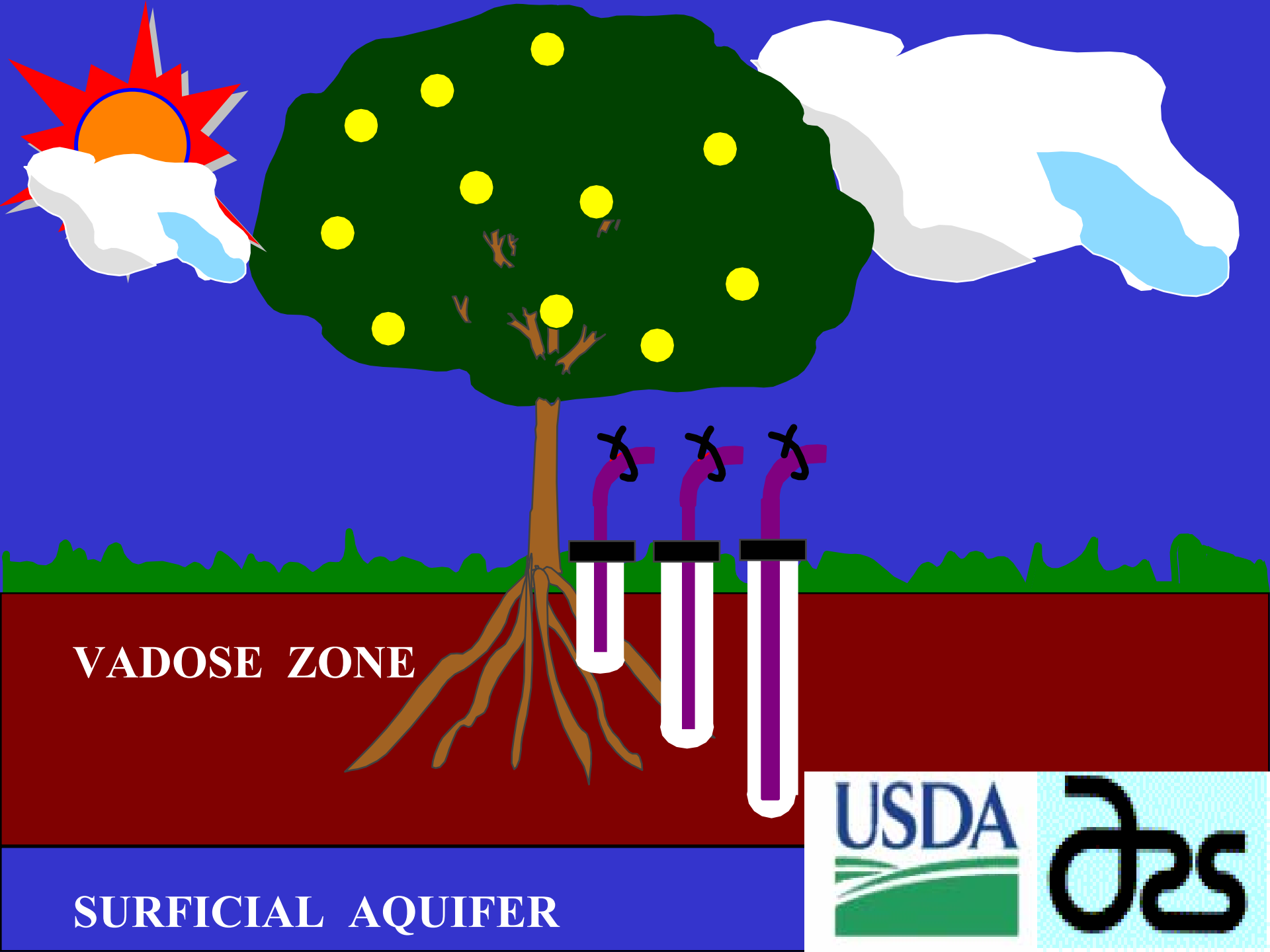
Nitrate in drinking water is a health issue in parts of the Central Columbia Plateau.

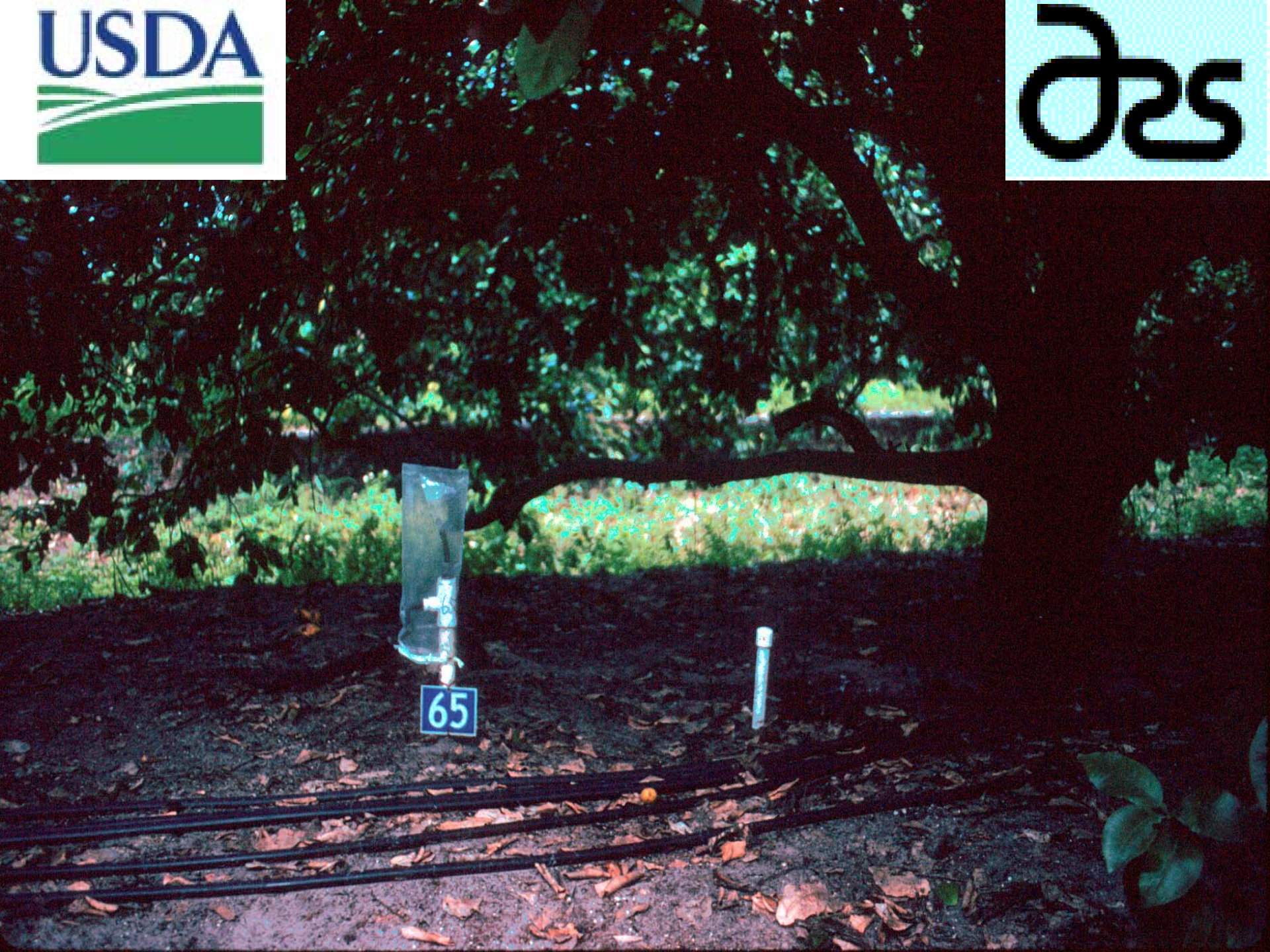
Data from Jones and Wagner, 1995.


Templeton North Site D
1035 ft
30 ft
555 ft
1035 ft
2655 ft
MW-2
MW-1
TN-6
TN-4
10
7
6
1590 ft
1065 ft
TN-10
TN-13
15
14
13
12
11
960 ft
MW-3
MW-4
795 ft
675 ft
1140 ft
1815 ft
Row #
1
22
23
30
46
47
55
2625 ft
1470 ft
1080 ft
615 ft
MW-5
MW-6
1
2
3
4
5
TS-2
TS-6
6
7
8
9
10
1155 ft
2625 ft
525 ft
900 ft
TS-10
TS-13
11
12
13
14
15
MW- 7
MW-8
855 ft
1080 ft
1545 ft
Templeton South Site E
USDA
ARS

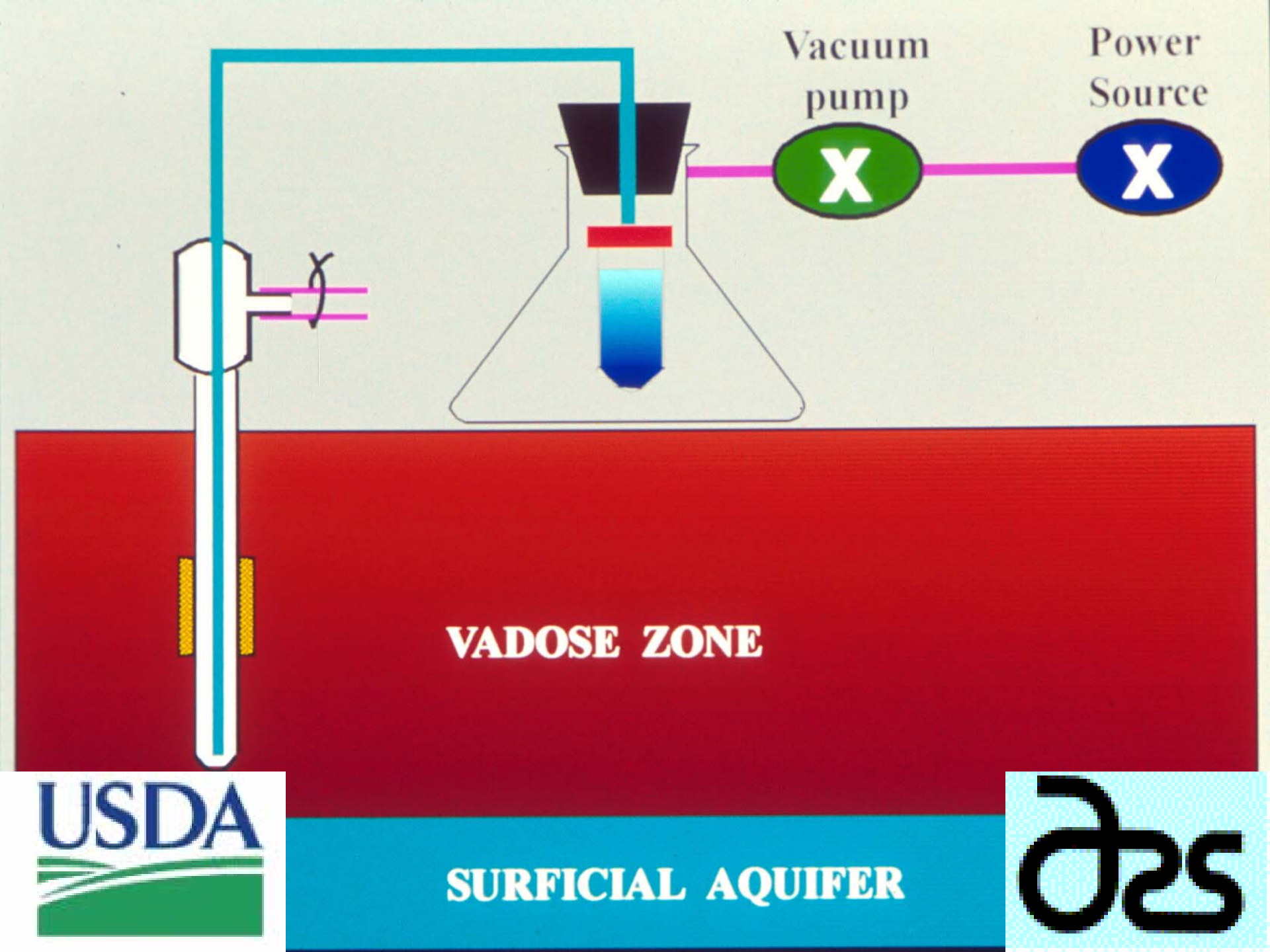


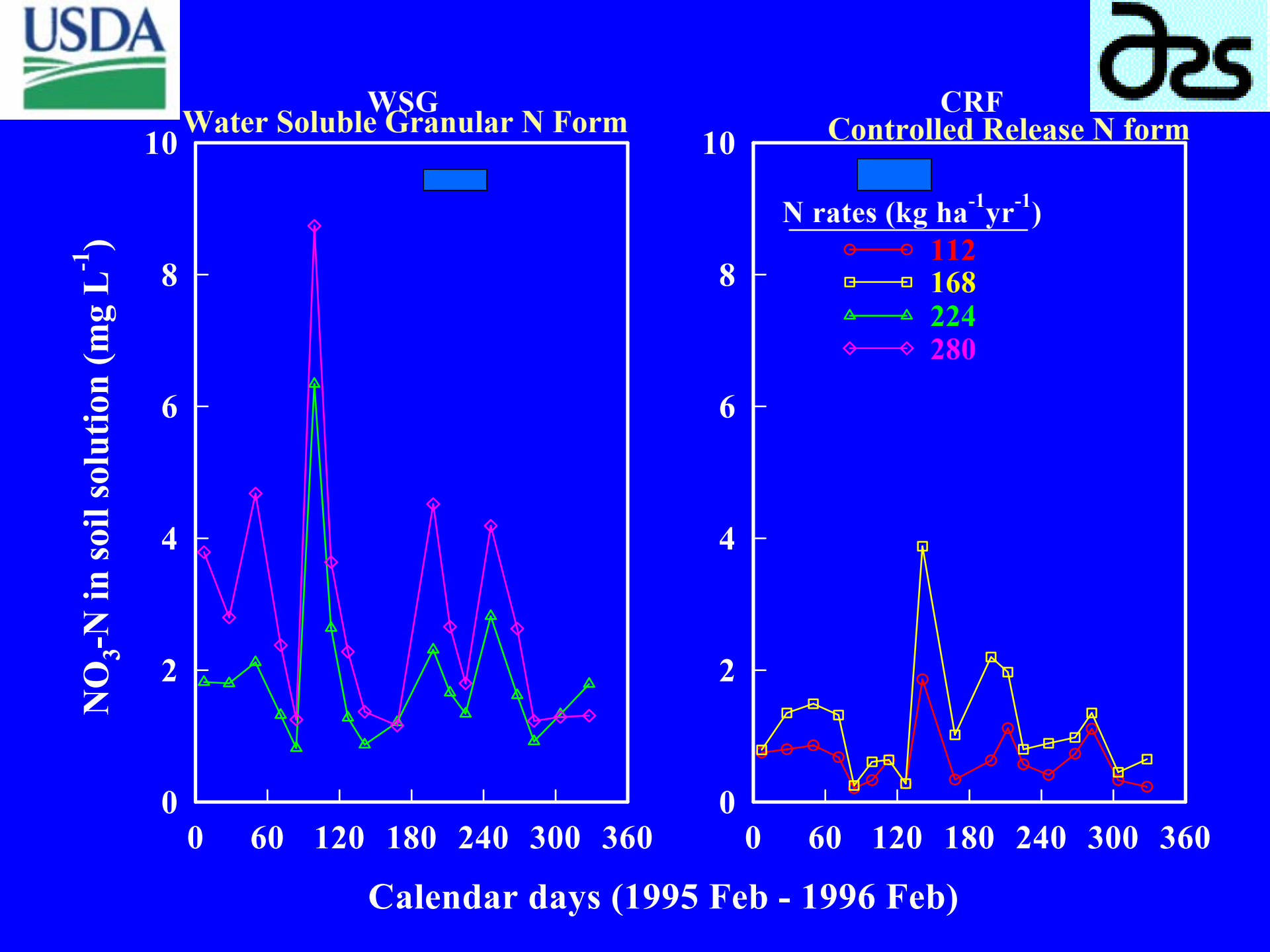


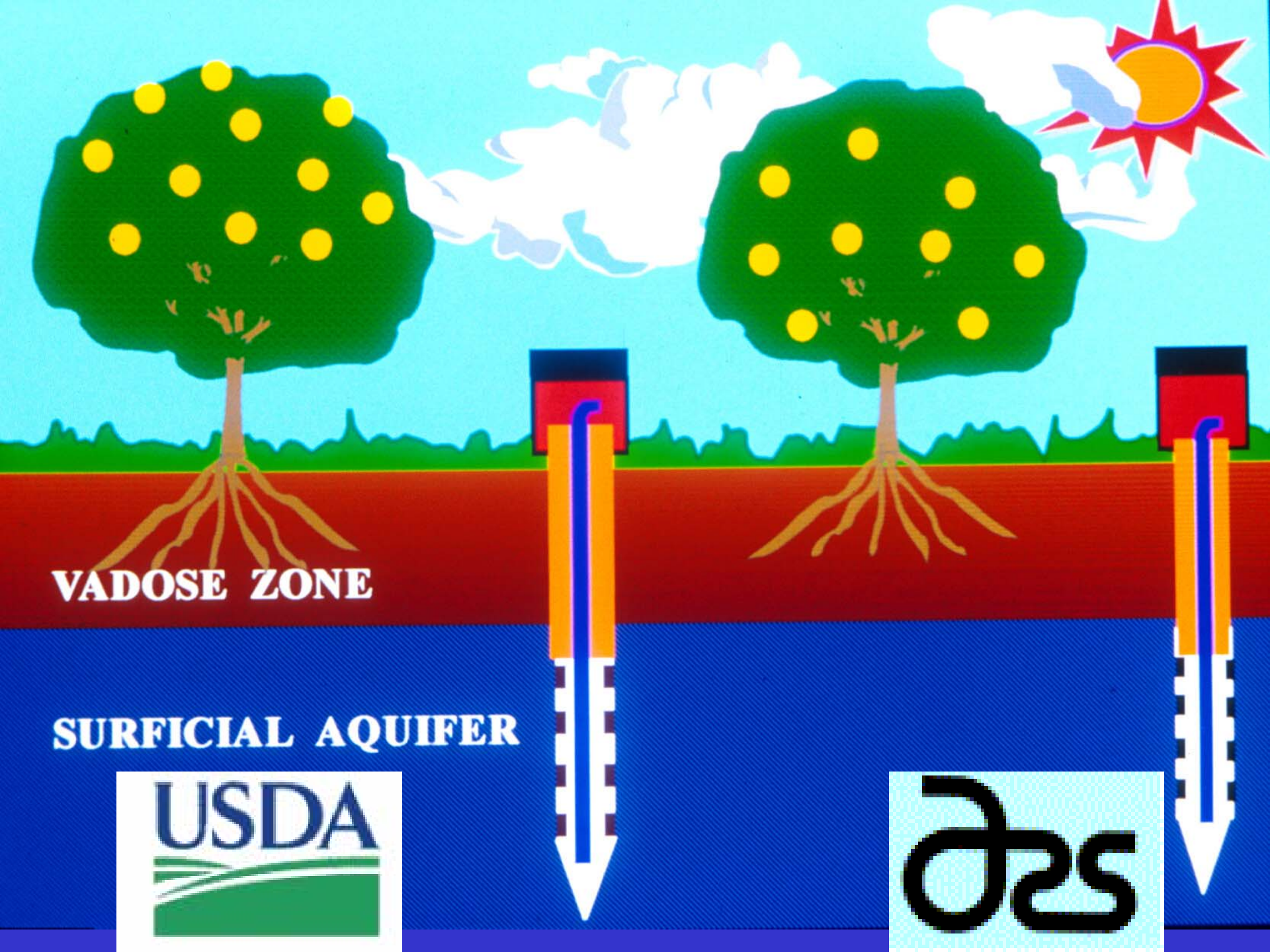

VADOSE ZONE
SURFICIAL AQUIFER
USDA
ars

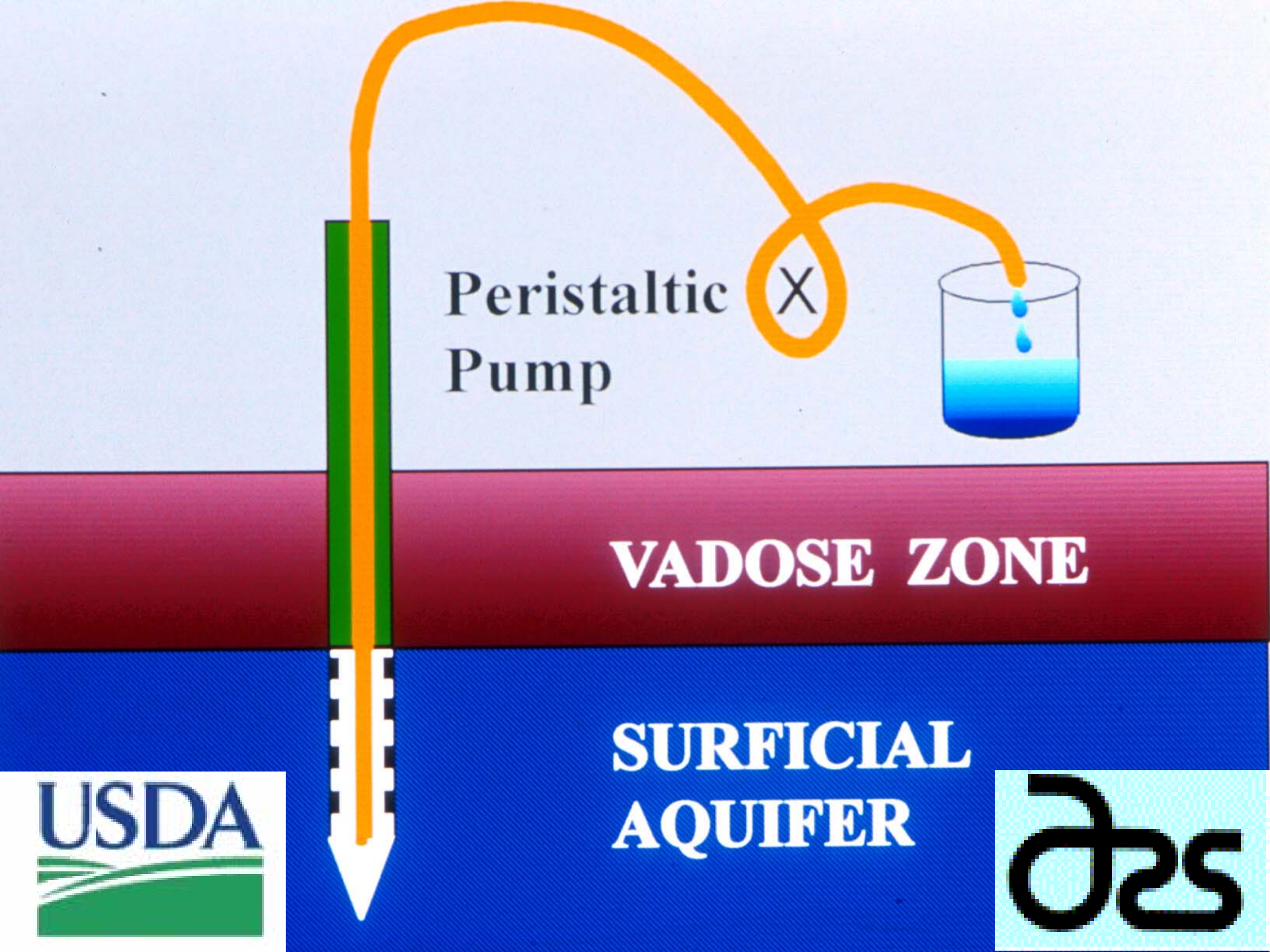

USDA
65

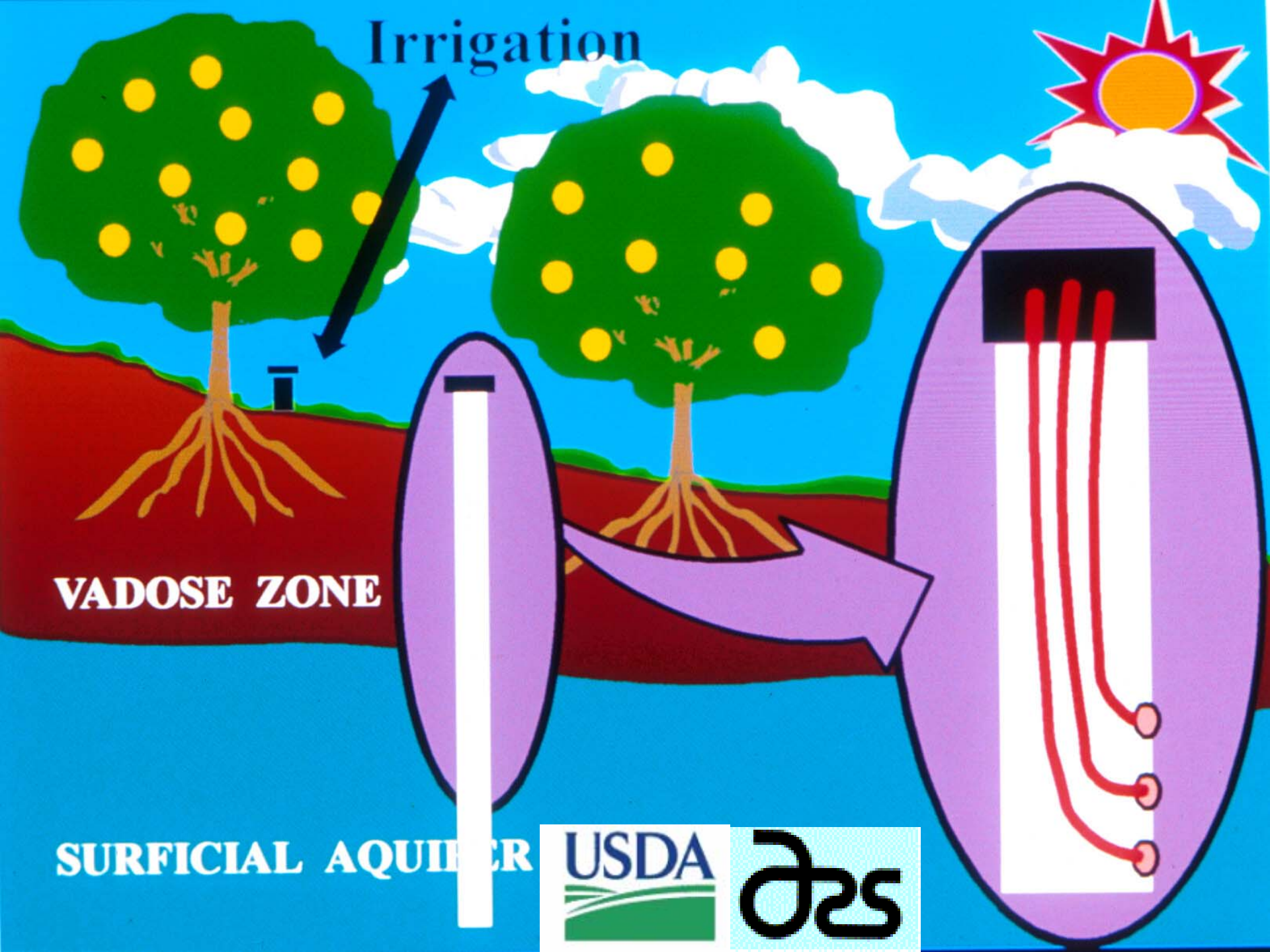
WATER
FURROW
VADOSE ZONE
HARD PAN
VADOSE ZONE
SURFICIAL AQUIFER
USDA
ars

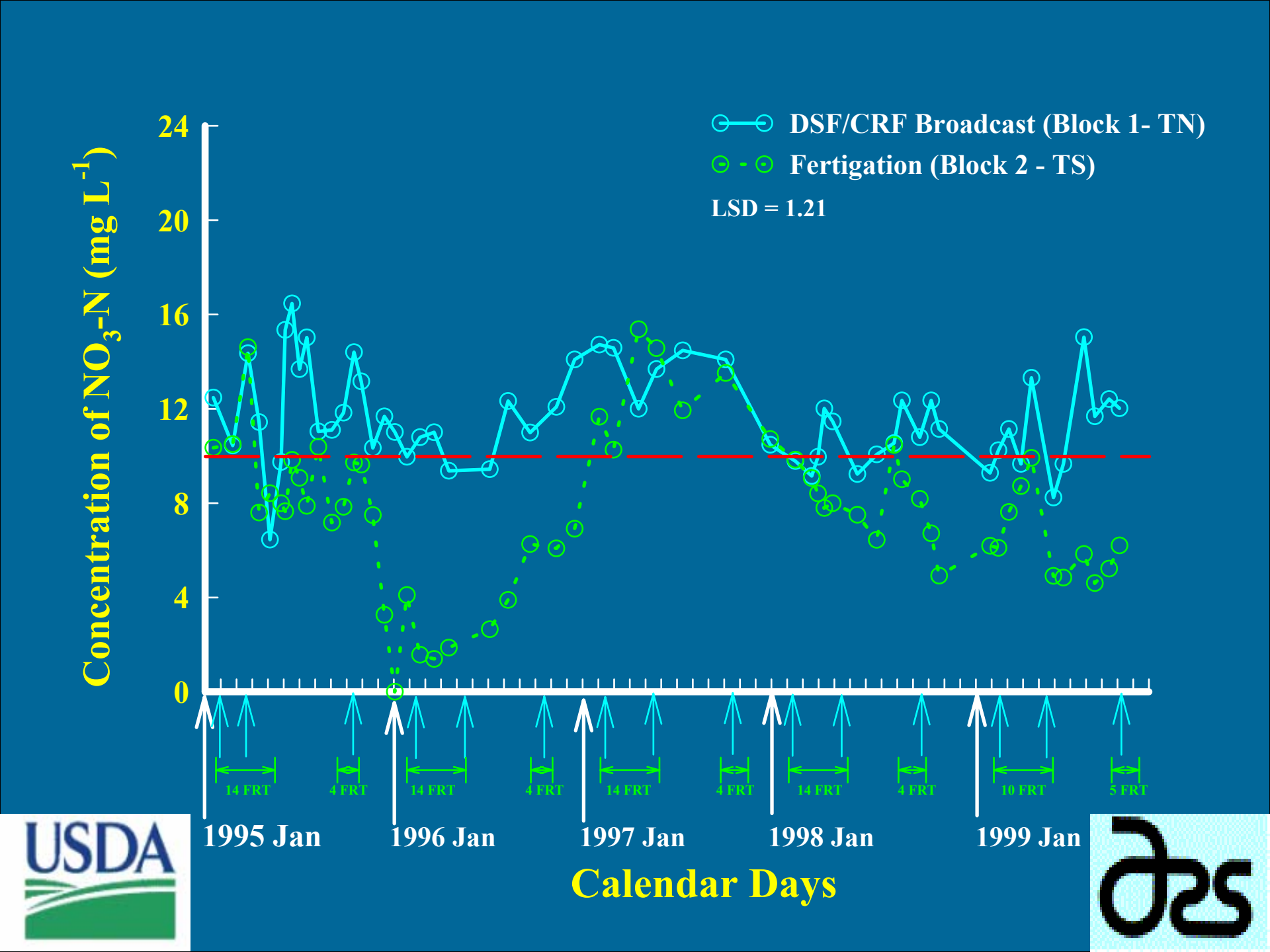

Vacuum
pump
Power
Source
VADOSE ZONE
SURFICIAL AQUIFER

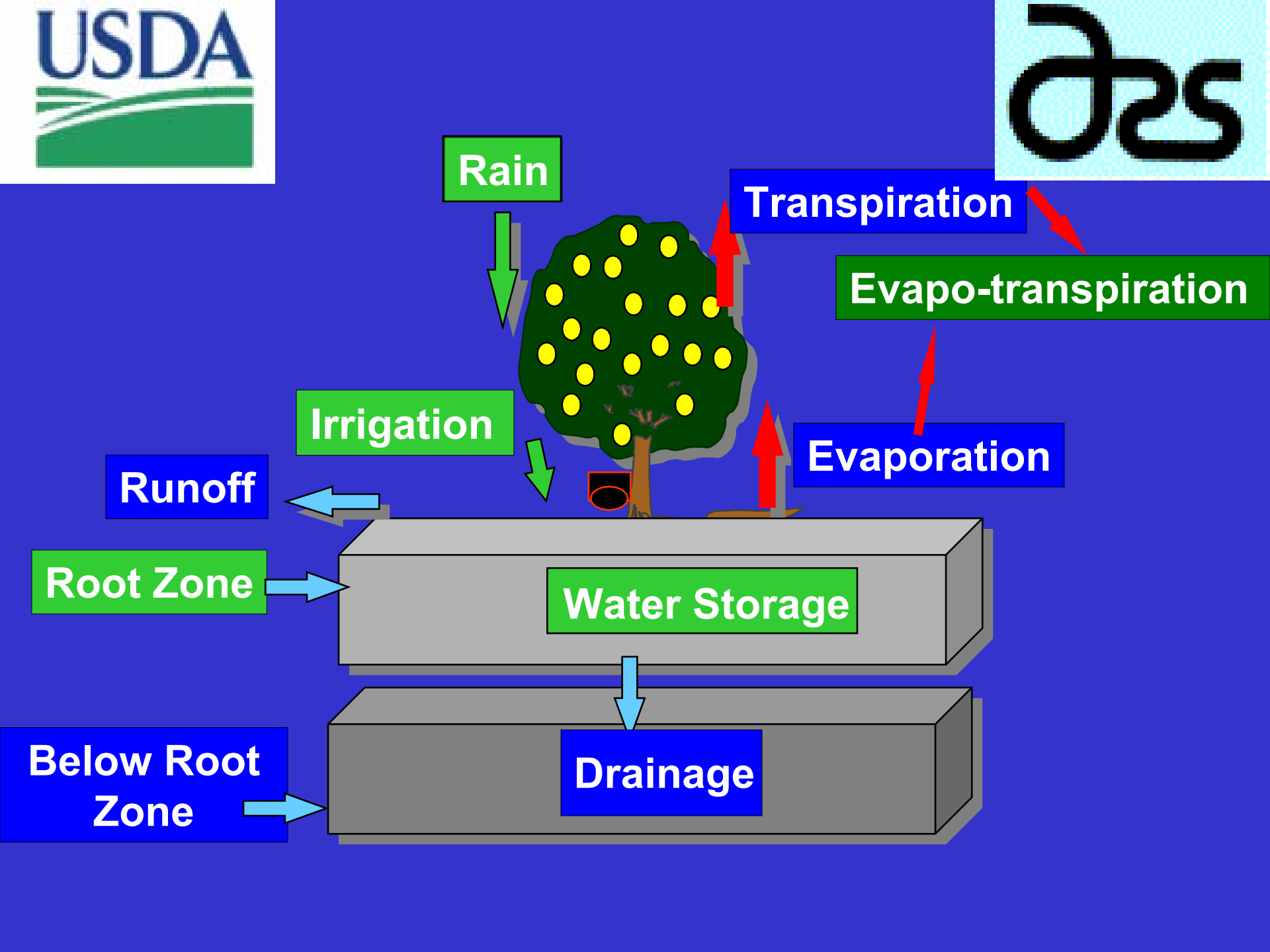

WSG
Water Soluble Granular N Form
CRF
Controlled Release N form
N rates (kg ha-1yr-1)
112
168
224
280
NO3-N in soil solution (mg L-1)
0
2
4
6
8
10
0
60
120
180
240
300
360
Calendar days (1995 Feb - 1996 Feb)

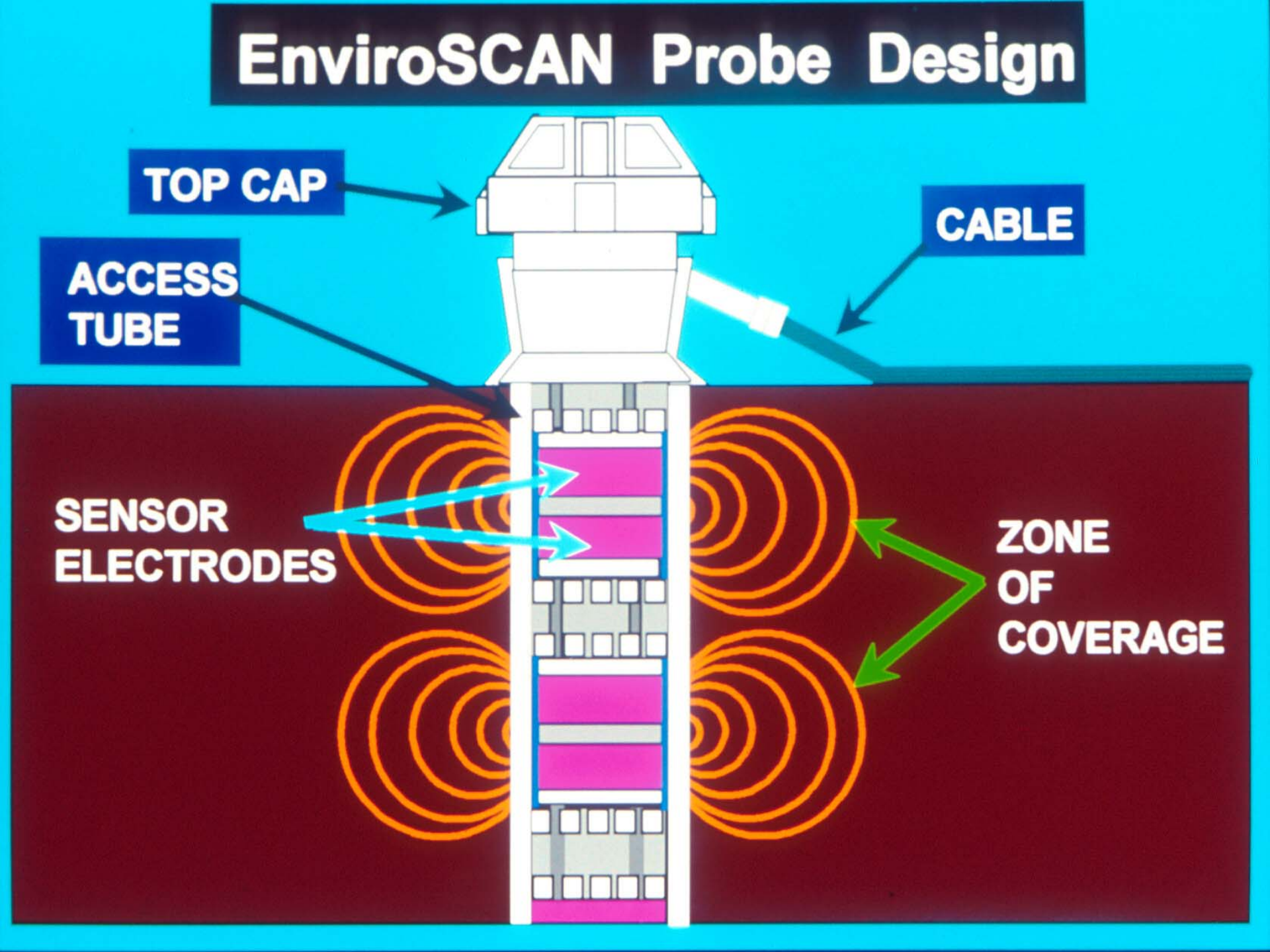

VADOSE ZONE
SURFICIAL AQUIFER
USDA

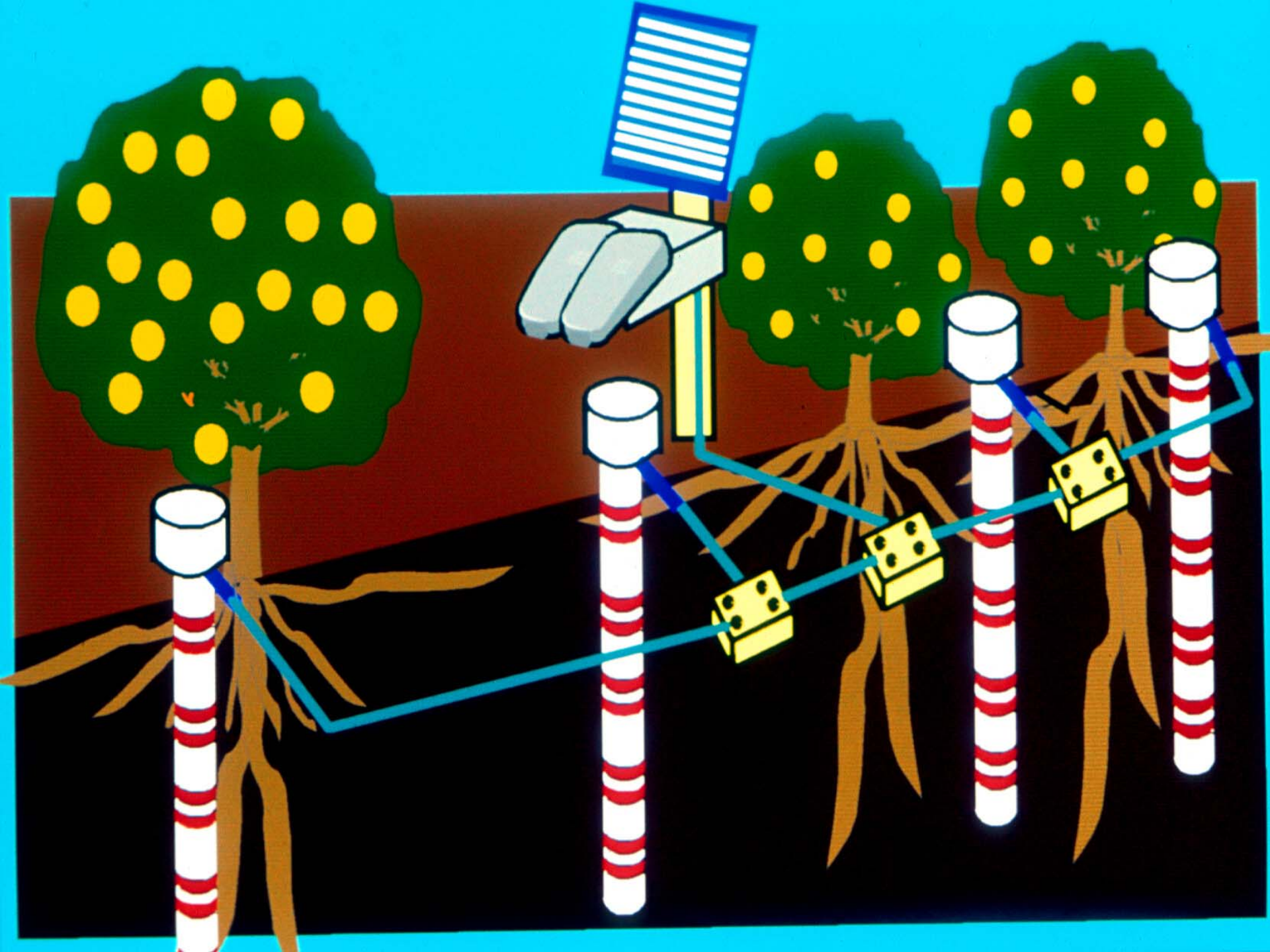

Peristaltic
Pump
VADOSE ZONE
SURFICIAL
AQUIFER
USDA
ars


Irrigation
VADOSE ZONE
SURFICIAL AQUIFER
USDA
ars

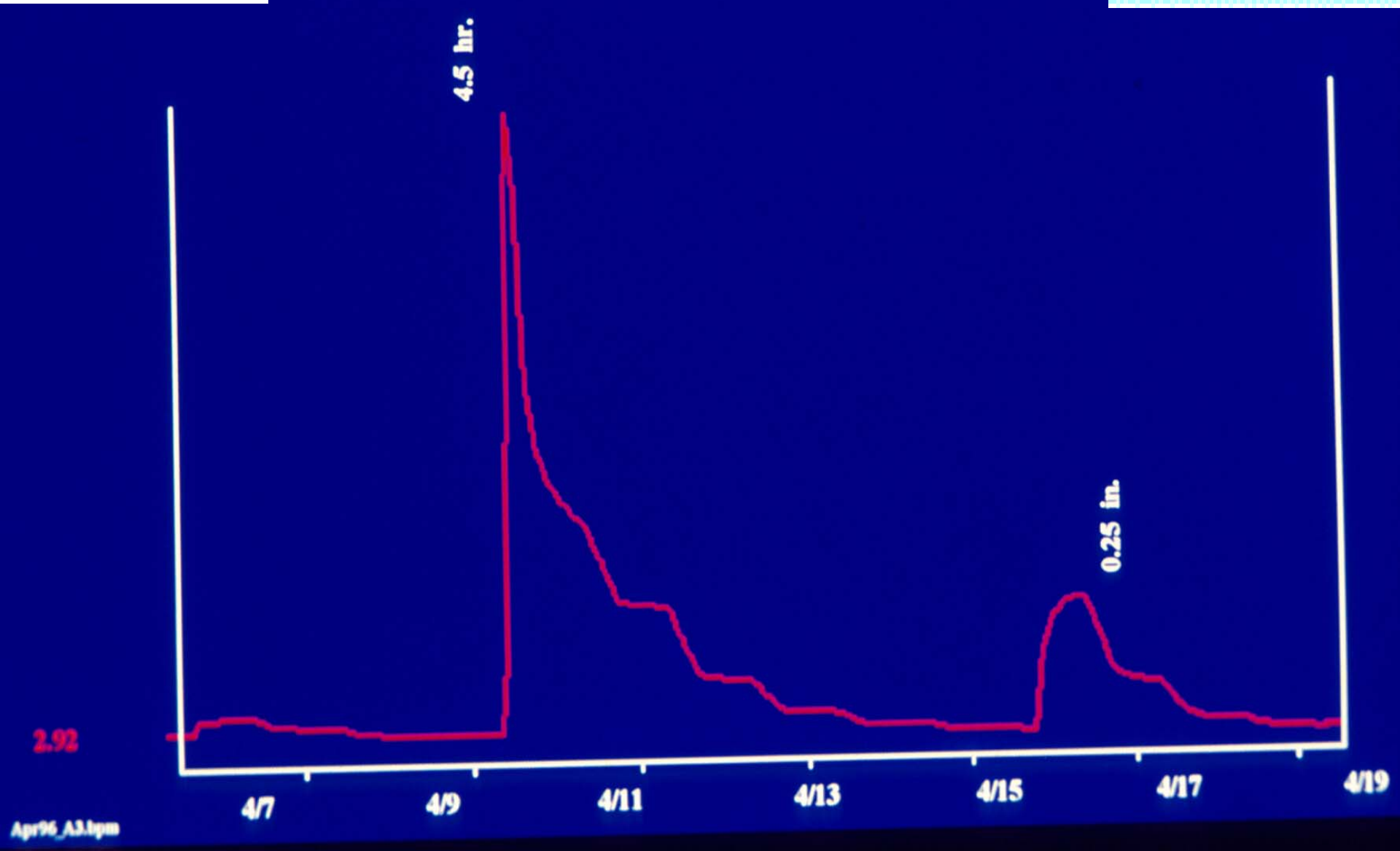

DSF/CRF Broadcast (Block 1- TN)
Fertigation (Block 2 - TS)
LSD = 1.21
Concentration of NO3-N (mg L-1)
24
20
16
12
8
4
0
14 FRT
4 FRT
14 FRT
4 FRT
14 FRT
4 FRT
14 FRT
4 FRT
10 FRT
5 FRT
1995 Jan
1996 Jan
1997 Jan
1998 Jan
1999 Jan
Calendar Days

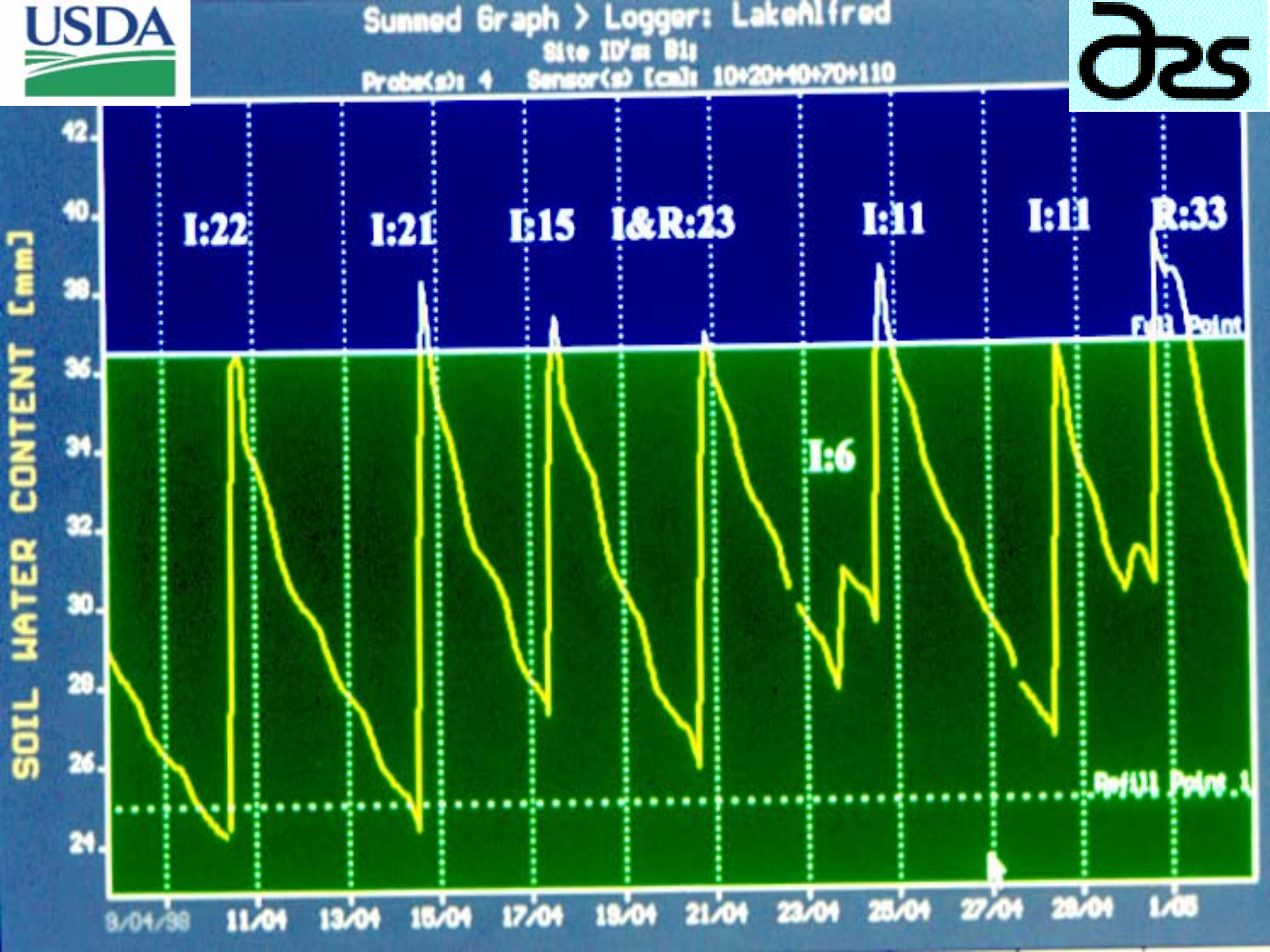

Rain
Transpiration
Evapo-transpiration
Irrigation
Evaporation
Runoff
Root Zone
Water Storage
Drainage
Below Root Zone


EnviroSCAN Probe Design
TOP CAP
CABLE
ACCESS TUBE
SENSOR ELECTRODES
ZONE OF COVERAGE

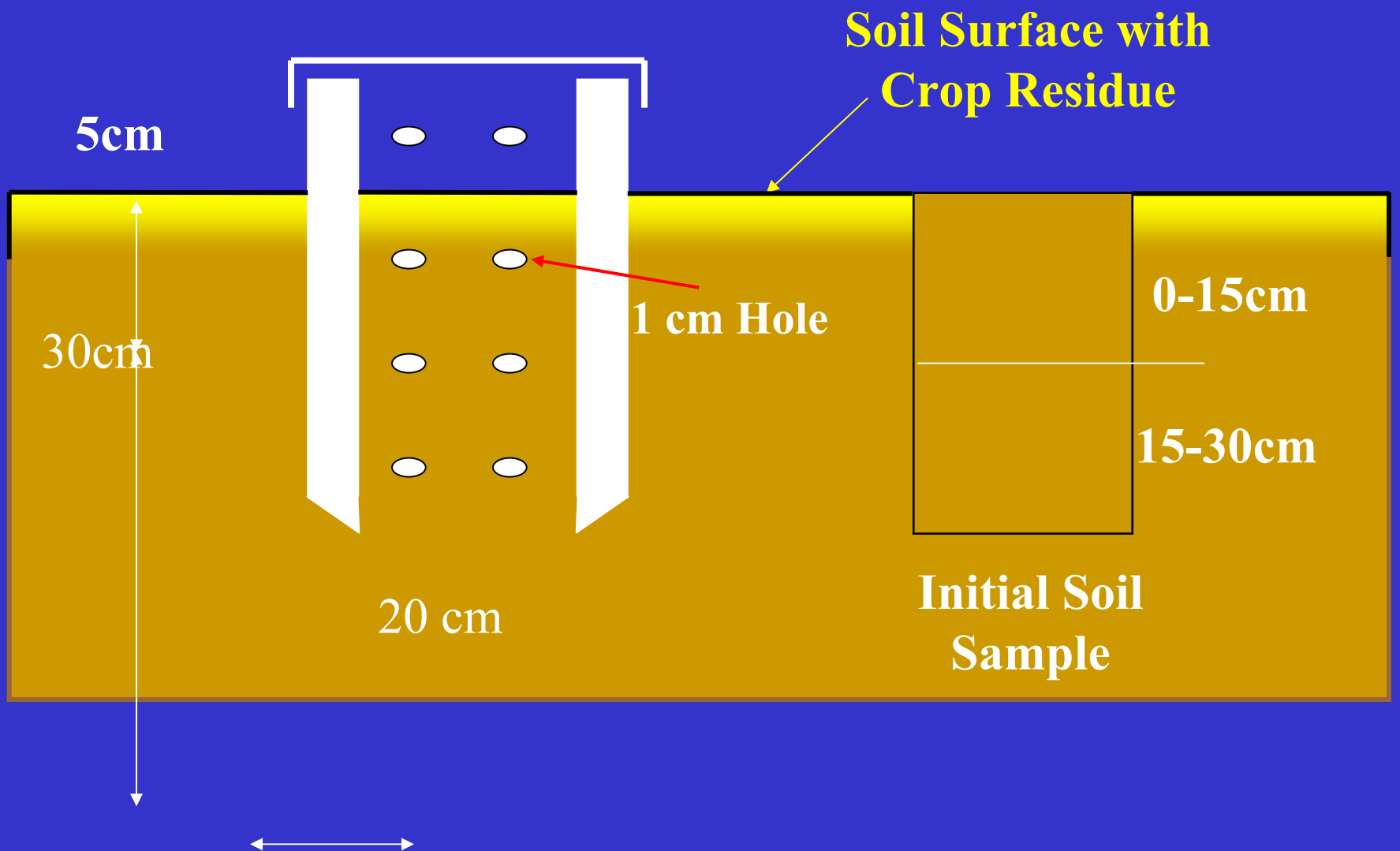


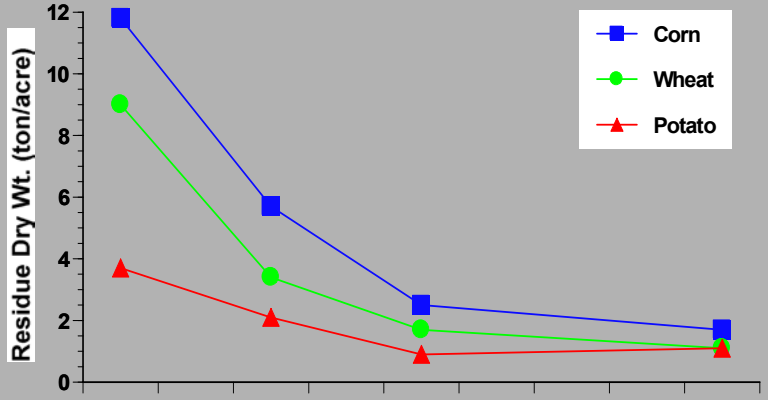
Hamlins / SC, Sept. 93, 10' Wetting area.
Readings from April 1996

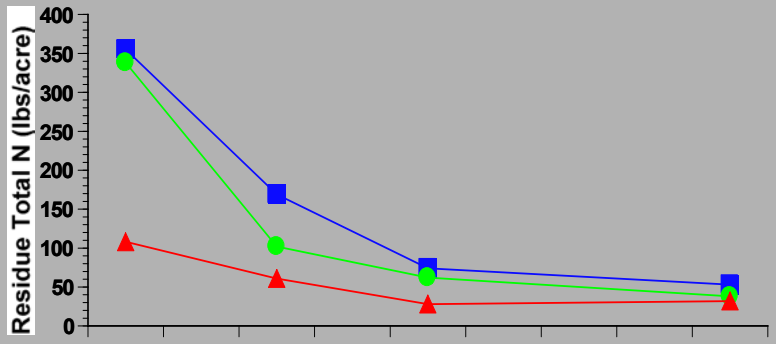


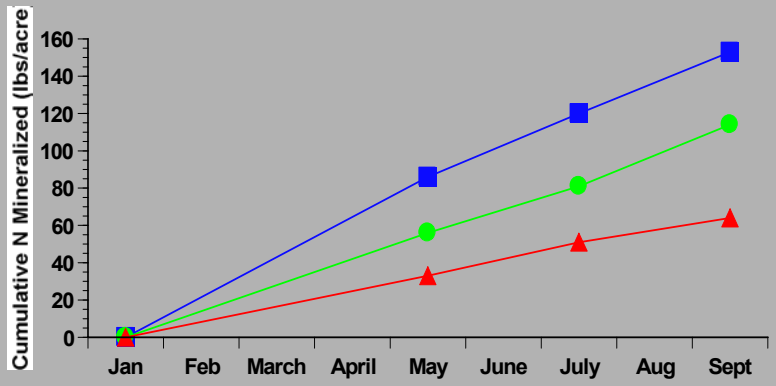

USDA
ars
Summed Graph > Logger: LakeAlfred
Site ID's: B1;
Probe(s): 4 Sensor(s) [cm]: 10+20+40+70+110
SOIL WATER CONTENT [mm]
42
40
38
36
34
32
30
28
26
24
I:22
I:21
I:15
I&R:23
I:11
I:11
R:33
I:6
Full Point
Refill Point
9/04/98
11/04
13/04
15/04
17/04
19/04
21/04
23/04
25/04
27/04
29/04
1/05

In-Situ N Mineralization

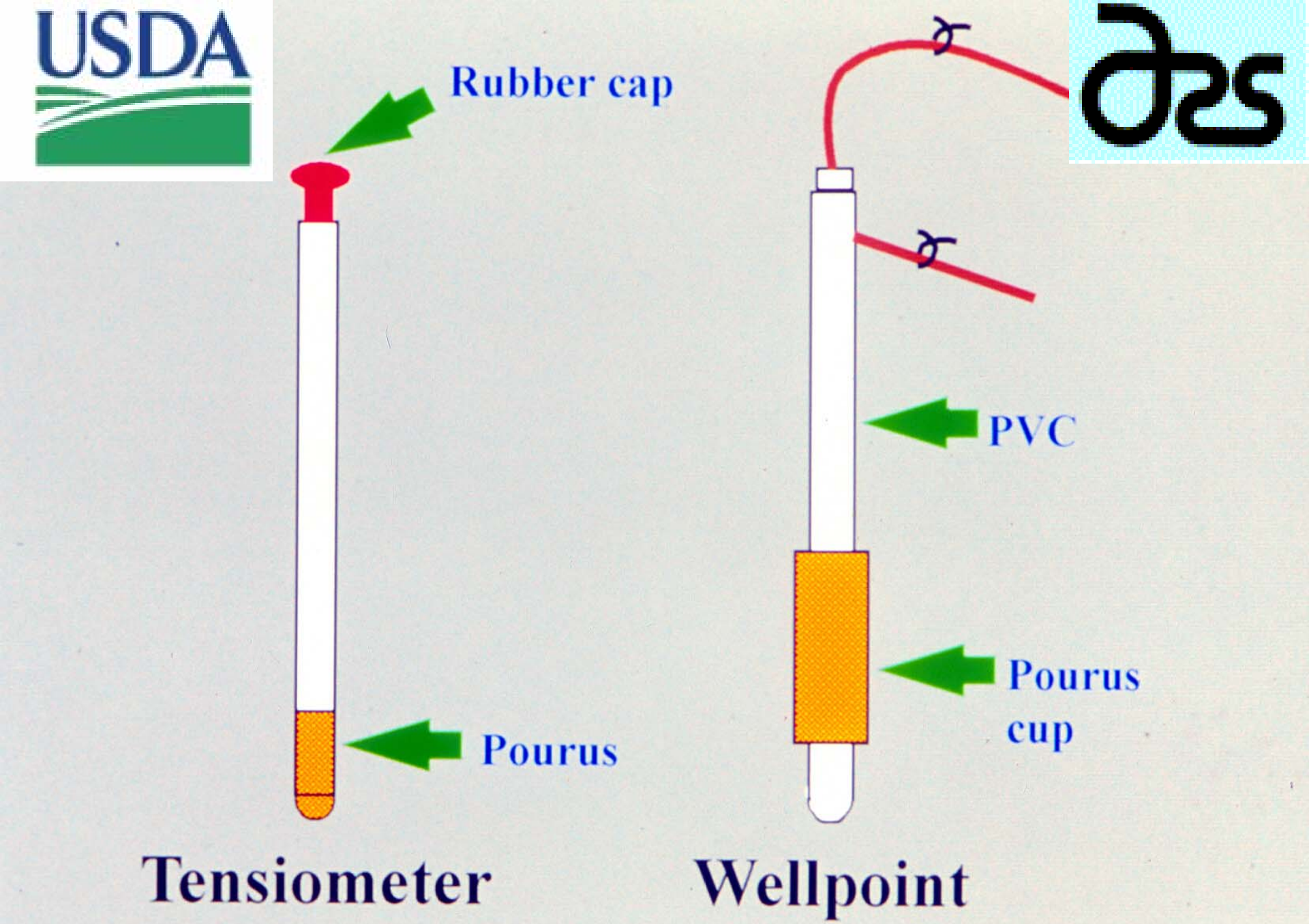



Residue Dry Wt. (ton/acre)
0
2
4
6
8
10
12
Corn
Wheat
Potato


Residue Total N (lbs/acre)
0
50
100
150
200
250
300
350
400


Cumulative N Mineralized (lbs/acre
0
20
40
60
80
100
120
140
160
Jan
Feb
March
April
May
June
July
Aug
Sept

VADOSE ZONE
SURFICIAL AQUIFER
USDA
ars


Rubber cap
Pourus
PVC
Pourus
cup
Tensiometer
Wellpoint

USDA
ARS