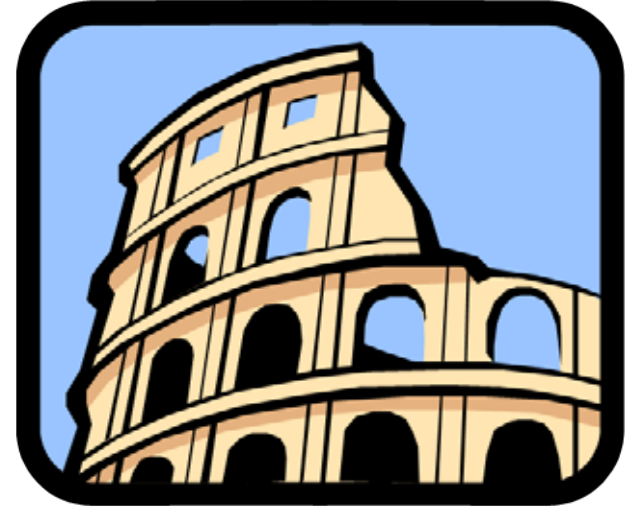
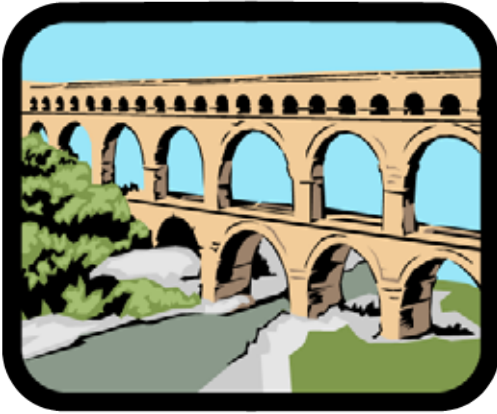


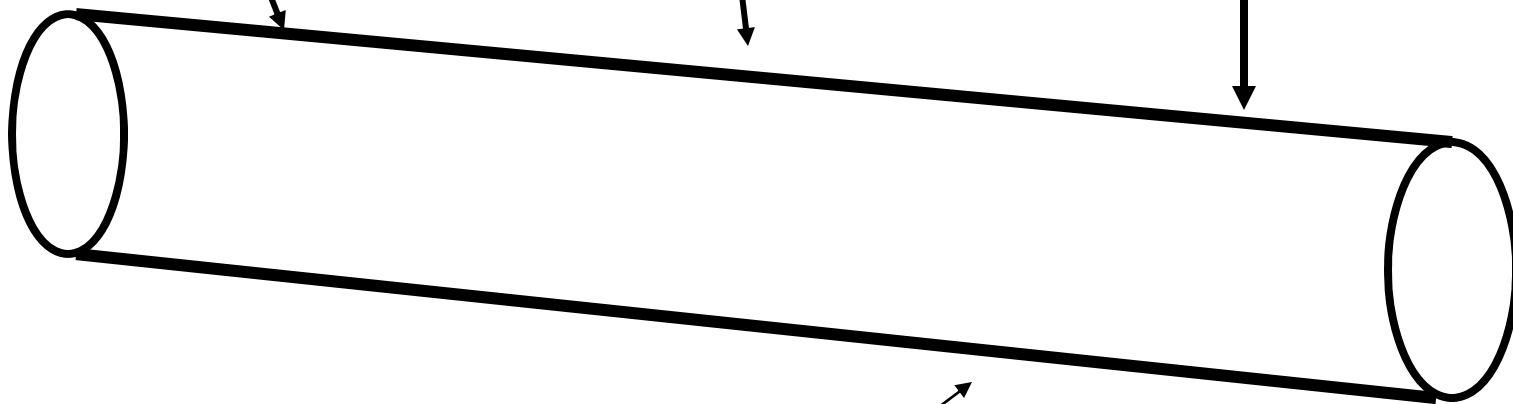
WASTEWATER COLLECTION SYSTEMS

PURPOSE:

**COLLECT and CONVEY
WASTEWATER FROM A
COMMUNITY TO A
TREATMENT PLANT**

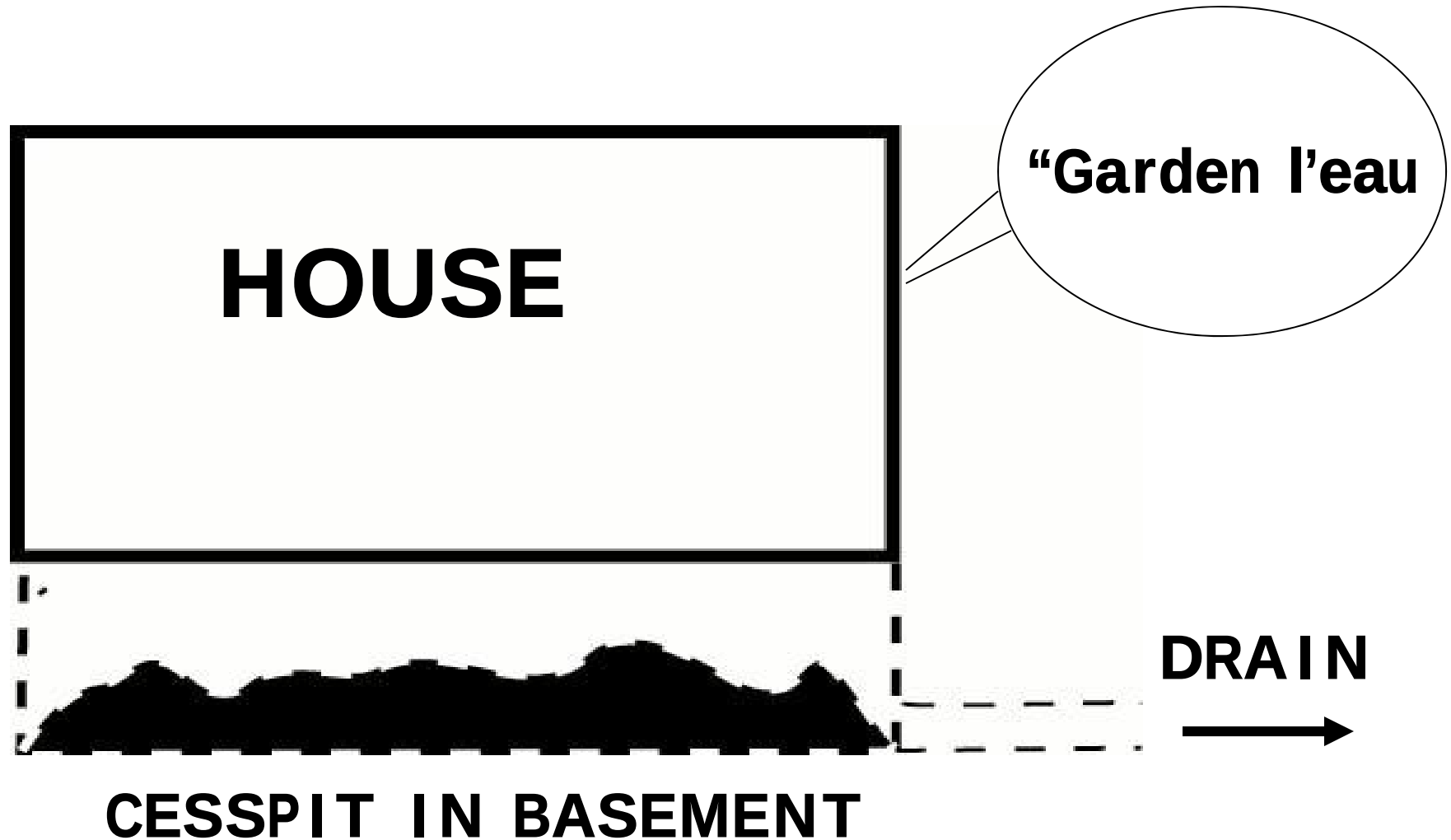


**IN ROME AROUND 600 AD,
ROMANS BUILT THE CLOACA
MAXIMA TO DRAIN A SWAMP**



CLOACA MAXIMA

EARLY LONDON CESSPIT





TYPES OF “LOOS”

EARLY LONDON CESSPIT

HOUSE



DRAIN



CESSPIT IN BASEMENT

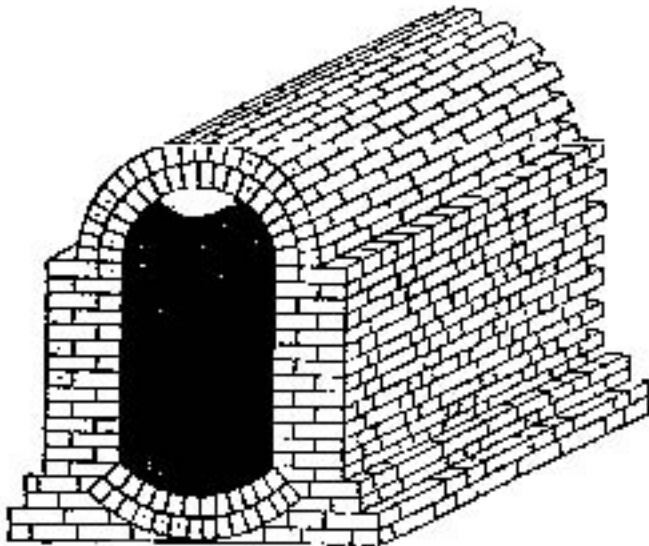
HISTORY OF SEWERS



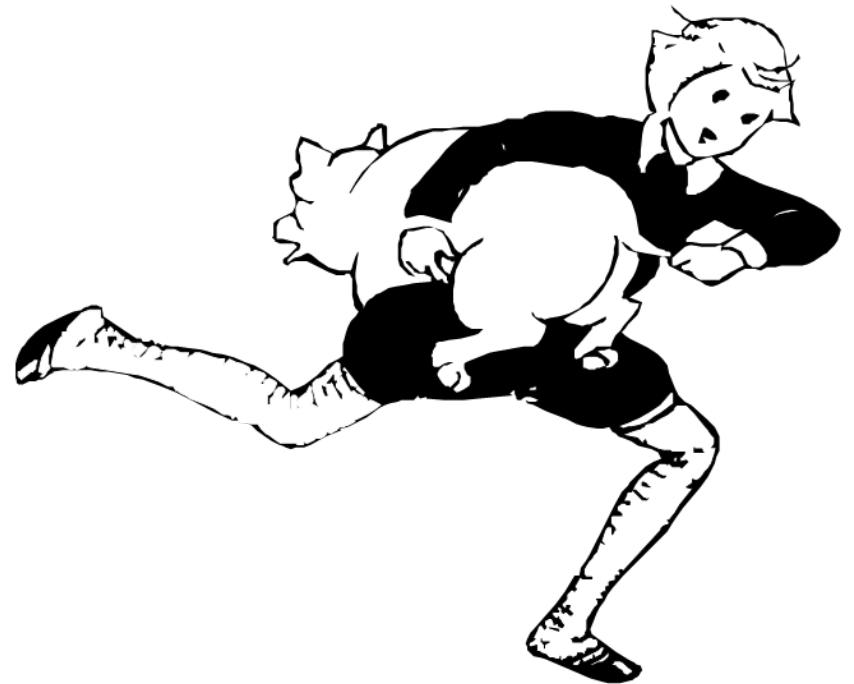
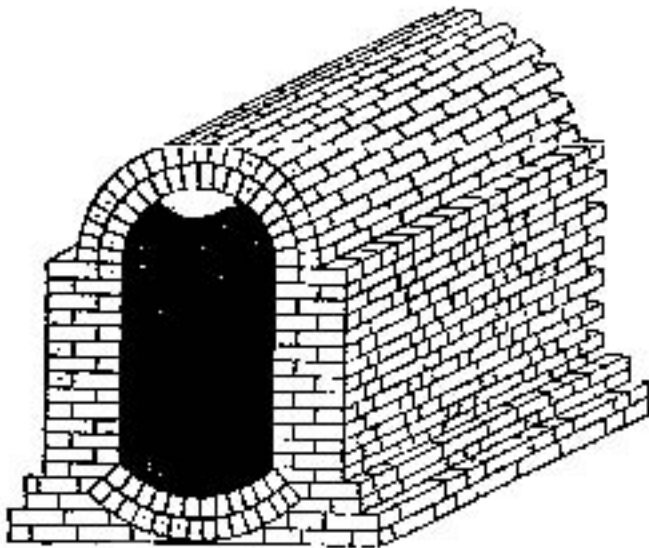
**LONDON'S
SEWERS WERE
CONSTRUCTED
IN 1844**

THE WORD “SEWER”...

**COMES FROM THE OLD
ENGLISH WORD MEANING
“SEA - WARD”**



LOTS OF EARLY “HORROR” STORIES ABOUT SEWER- SWINE AND KILLER RATS





**“VISIT THE SEWERS OF
PARIS”**

**TO COLLECT AND CONVEY
WASTEWATER FOR TREATMENT
WE USE:**

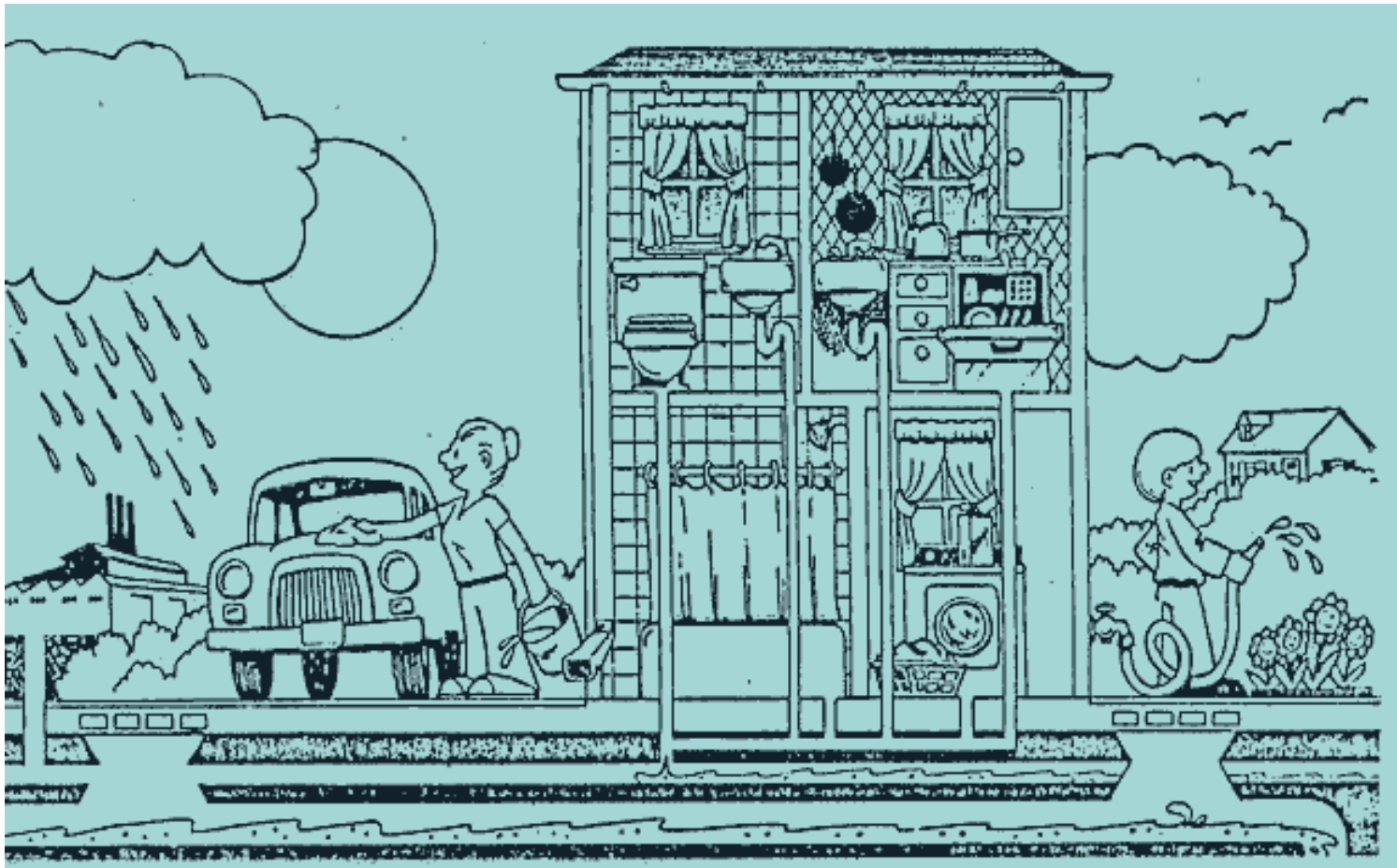
- **SANITARY SEWERS**

- **STORM SEWERS**

- **COMBINED SEWERS**

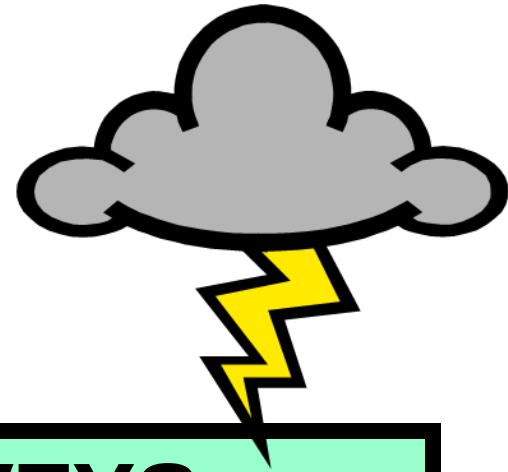
SANITARY SEWERS

**COLLECT WASTEWATER FROM
HOMES, BUSINESSES, and
LIGHT INDUSTRY, and
CONVEYS IT TO THE
TREATMENT PLANT**



**REMEMBER, WE GENERATE FROM
70 to 100 GALLONS of WASTE-
WATER per DAY per PERSON**

STORM SEWERS



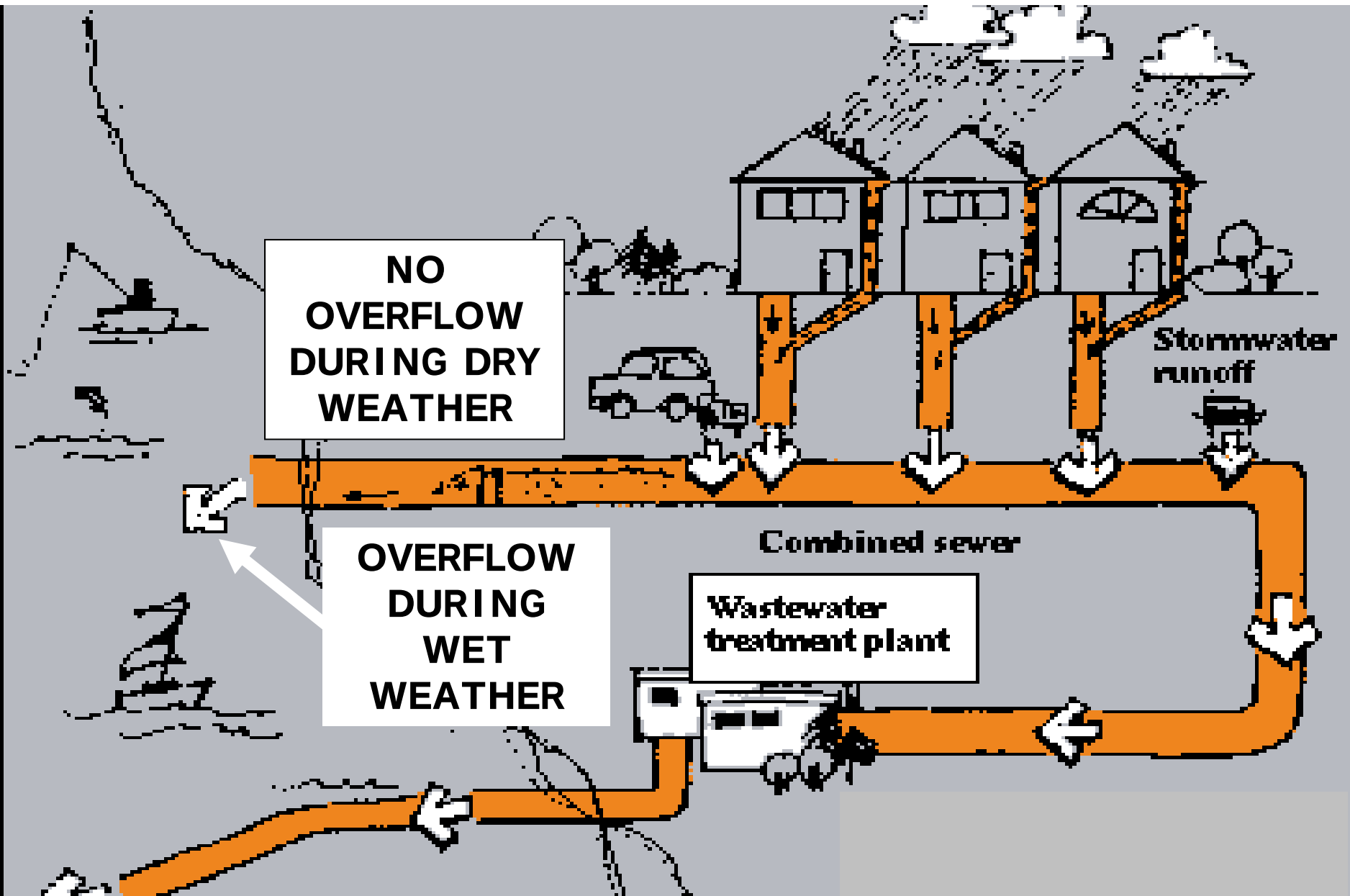
**COLLECTS AND CONVEYS
RUNOFF OF RAINFALL AND
SNOWMELT FROM BUILDINGS,
and PAVEMENT TO A WATER
COURSE (usually no treatment)**

COMBINED SEWERS



COMBINATION OF BOTH
SANITARY AND STORM
WATER FLOWS

COMBINED SYSTEMS—HOW THEY WORK



HOW ARE SEWERS DESIGNED?

- **DESIGN LIFE: 10 to 30 YEARS**

- **DESIGN FLOWS:**

**RESIDENTIAL: 70 to 100
gallons per person/day**

**COMMERCIAL: (flow
estimates vary)**

COMMERCIAL FLOW ESTIMATES:



HOSPITALS:
180 - 250 GPD/BED

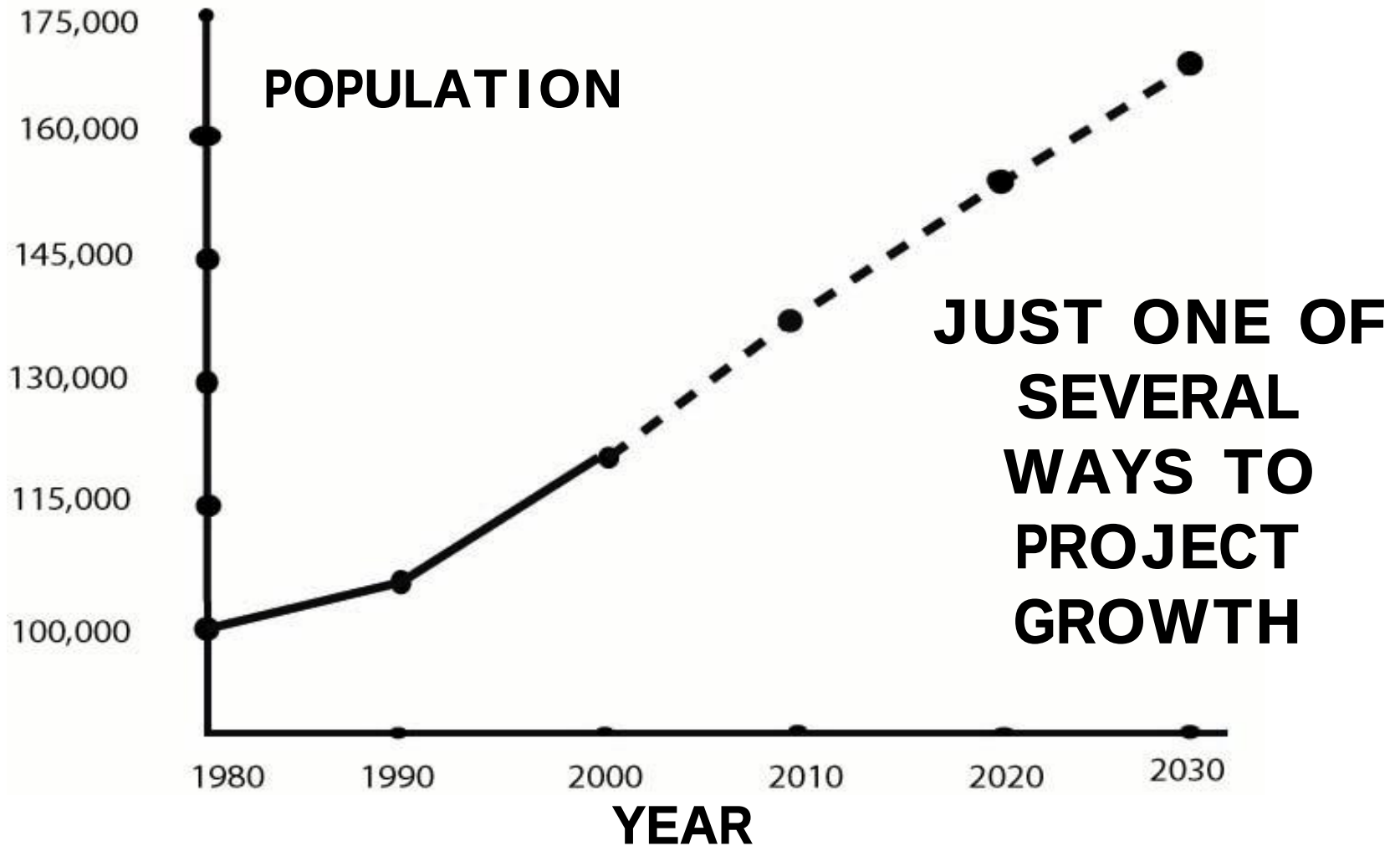


BUILDINGS:
100 GPD/1000 ft²

SCHOOLS: 20
GPD/STUDENT



ESTIMATING POPULATION GROWTH



DESIGN FLOWS

- IN GENERAL, SEWERS ARE DESIGNED TO FLOW BY GRAVITY

- MINIMUM DESIGN FLOW IS 2 feet per second (fps) to prevent settling and septic conditions
- MAXIMUM FLOW = 10 fps to prevent solids separation and pipe erosion

MEASURING VELOCITY

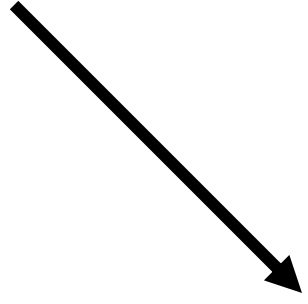
**DYES or FLOATES CAN BE
USED TO ESTIMATE
FLOWS**

**FLOWS MEASURED BY FLOATS ARE
10 - 15% HIGHER THAN THE
AVERAGE VELOCITY**

“GRAVITY” SEWER COMPONENTS

A. BUILDING SEWER

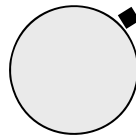
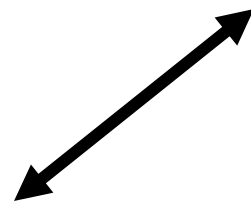
- **4+ INCHES** in
DIAMETER
- **MIN. SLOPE =**
 $\frac{1}{4}$ in per ft



PROPERTY LINE



**UTILITY'S
RESPONSIBILITY**

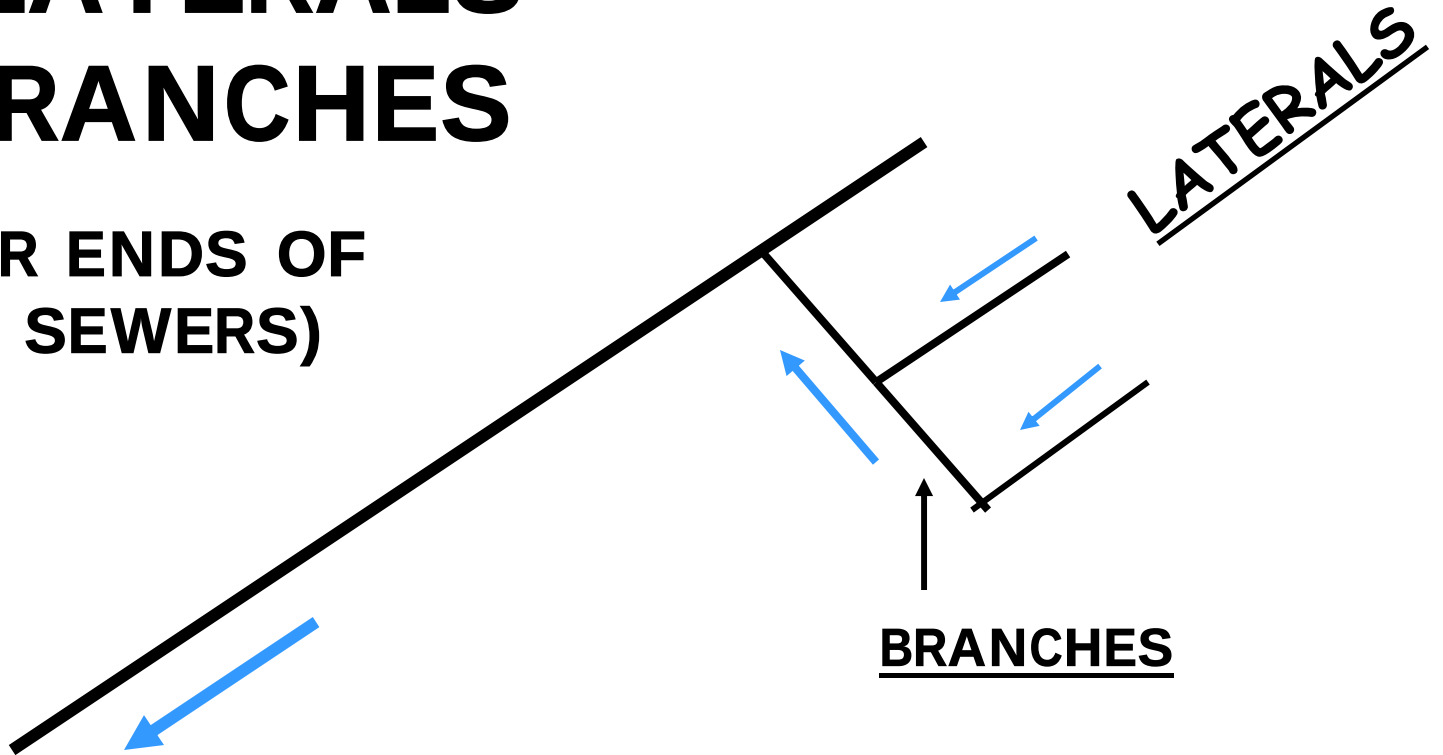


SANITARY SEWER

SEWER COMPONENTS

B. LATERALS & BRANCHES

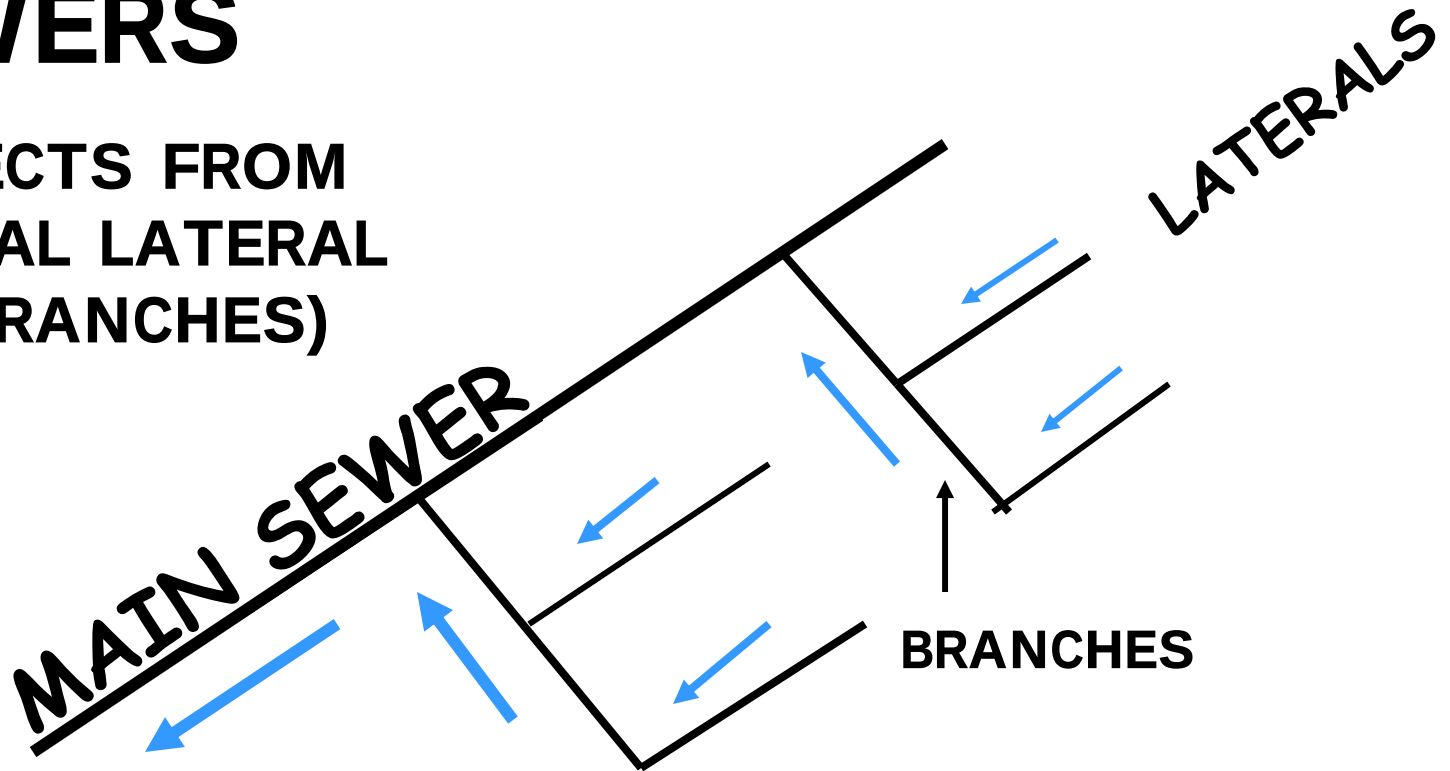
(UPPER ENDS OF
THE SEWERS)



SEWER COMPONENTS

C. MAIN SEWERS

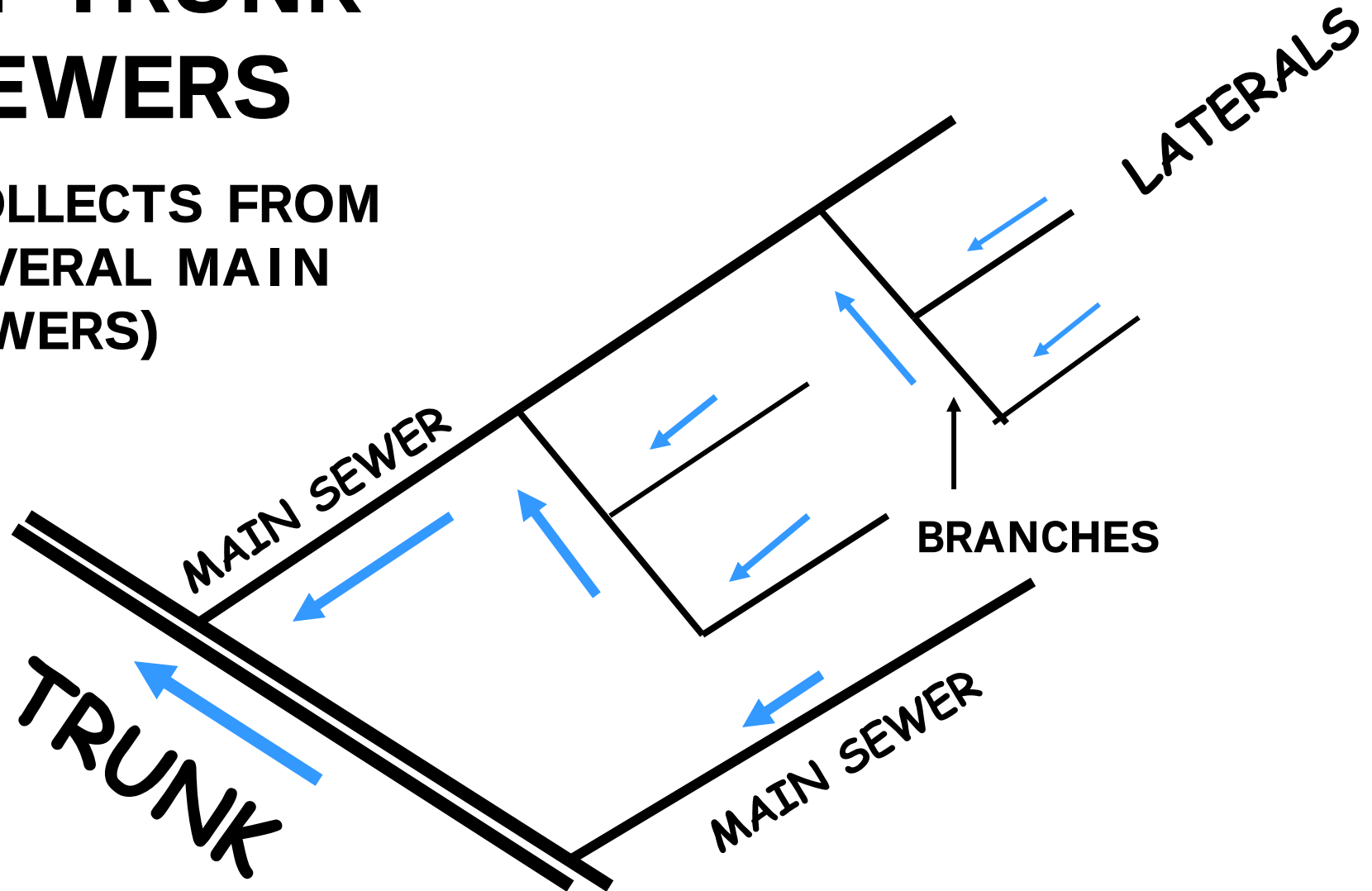
(COLLECTS FROM SEVERAL LATERAL AND BRANCHES)



SEWER COMPONENTS

D. TRUNK SEWERS

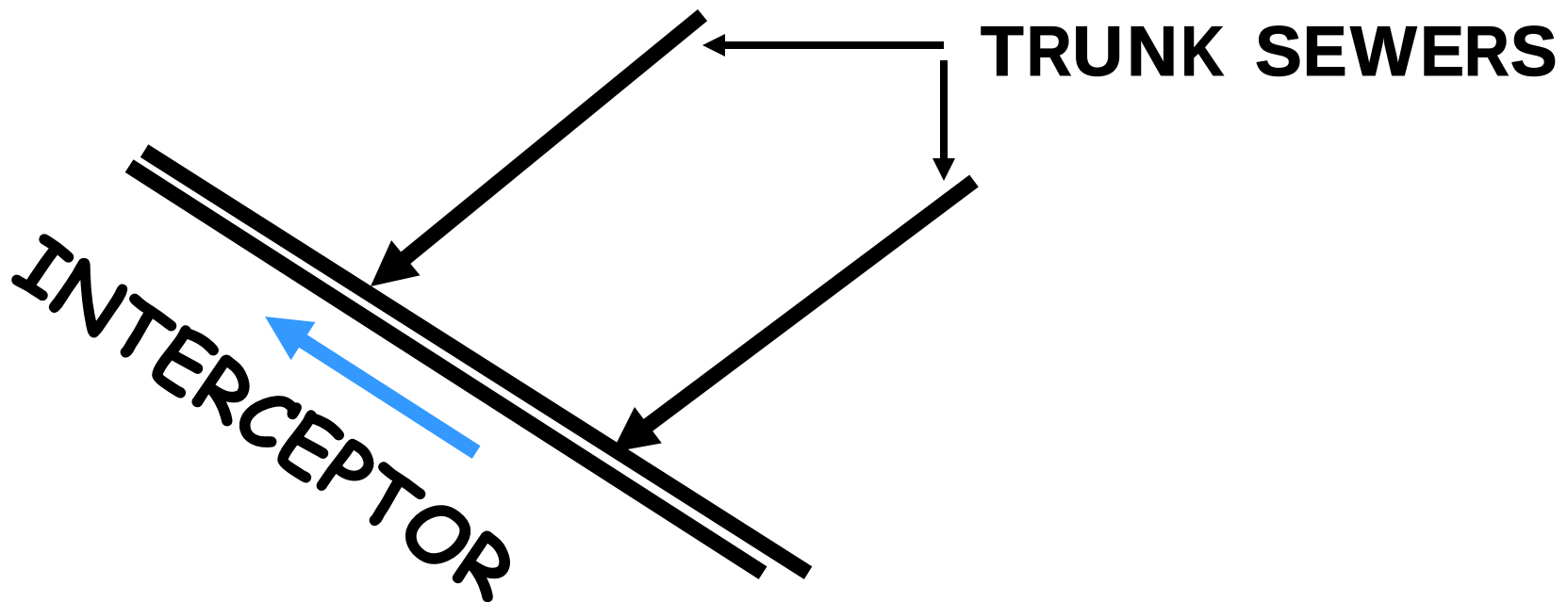
(COLLECTS FROM SEVERAL MAIN SEWERS)



SEWER COMPONENTS

E. INTERCEPT SEWERS

(COLLECTS FROM SEVERAL
TRUNK SEWERS)



WHEN GRAVITY SEWERS WON'T WORK!

(DUE TO SLOPE, INFILTRATION, PIPE SIZE)

• LOW PRESSURE SYSTEMS

**REQUIRES A
GRINDER PUMP,
HOLDING TANK,
CHECK VALVE,
PRESSURE
MAINS**



WHEN GRAVITY SEWERS WON'T WORK!

(DUE TO SLOPE, INFILTRATION, PIPE SIZE)

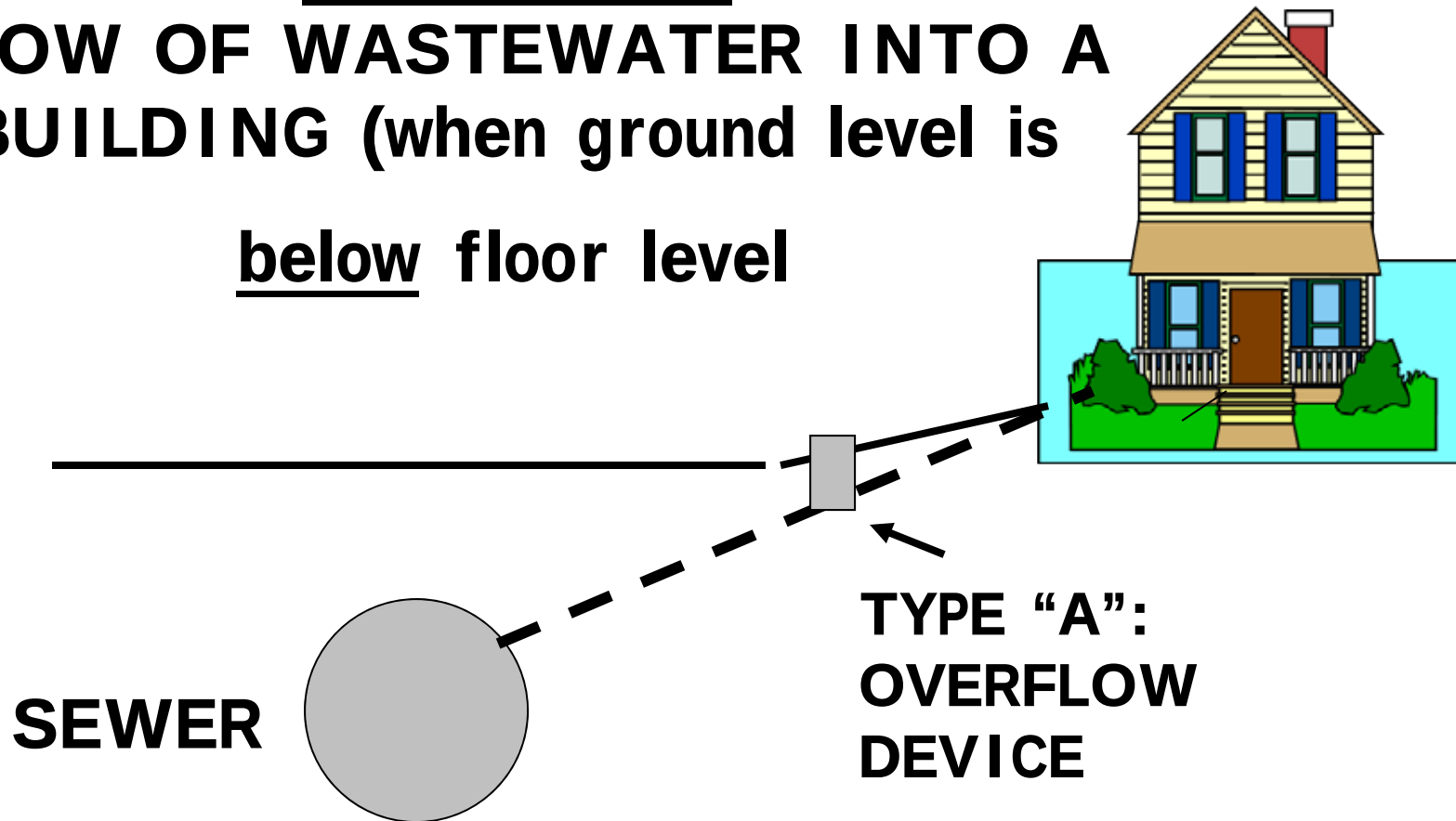
• VACUUM SYSTEMS

**REQUIRES A
HOLDING
TANK,
VACUUM
VALVE AND A
CENTRAL
VACUUM PUMP**



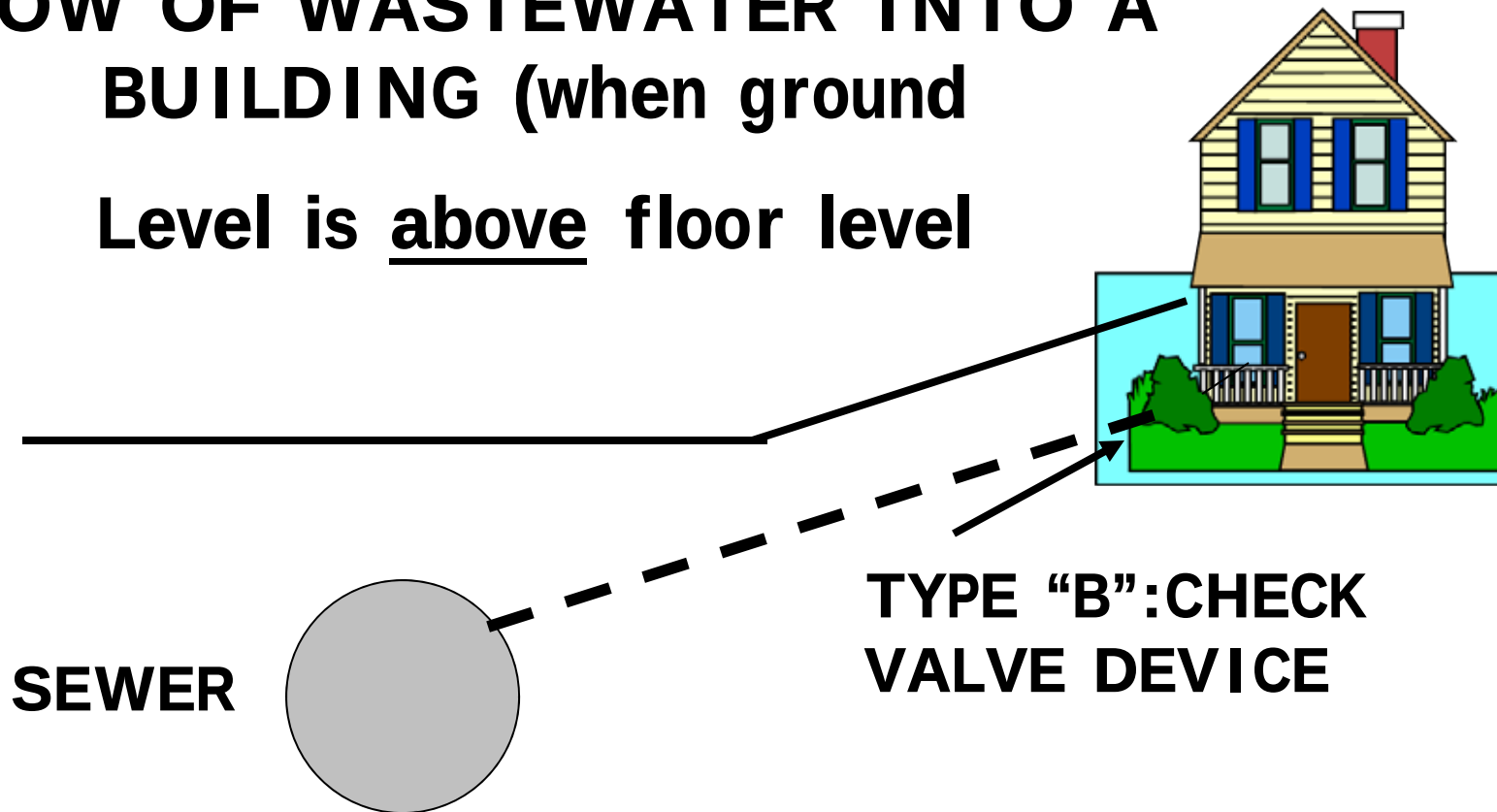
PREVENTING BACKFLOW CONTAMINATION

TO PREVENT BACK-FLOW OR REVERSE
FLOW OF WASTEWATER INTO A
BUILDING (when ground level is
below floor level



PREVENTING BACKFLOW CONTAMINATION

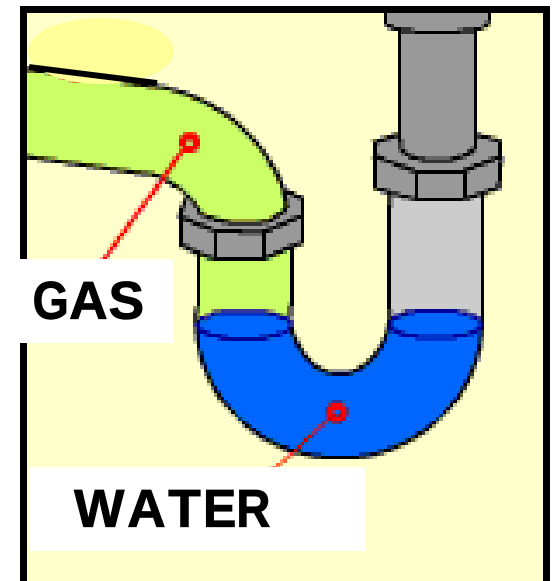
TO PREVENT BACK-FLOW OR REVERSE
FLOW OF WASTEWATER INTO A
BUILDING (when ground
Level is above floor level



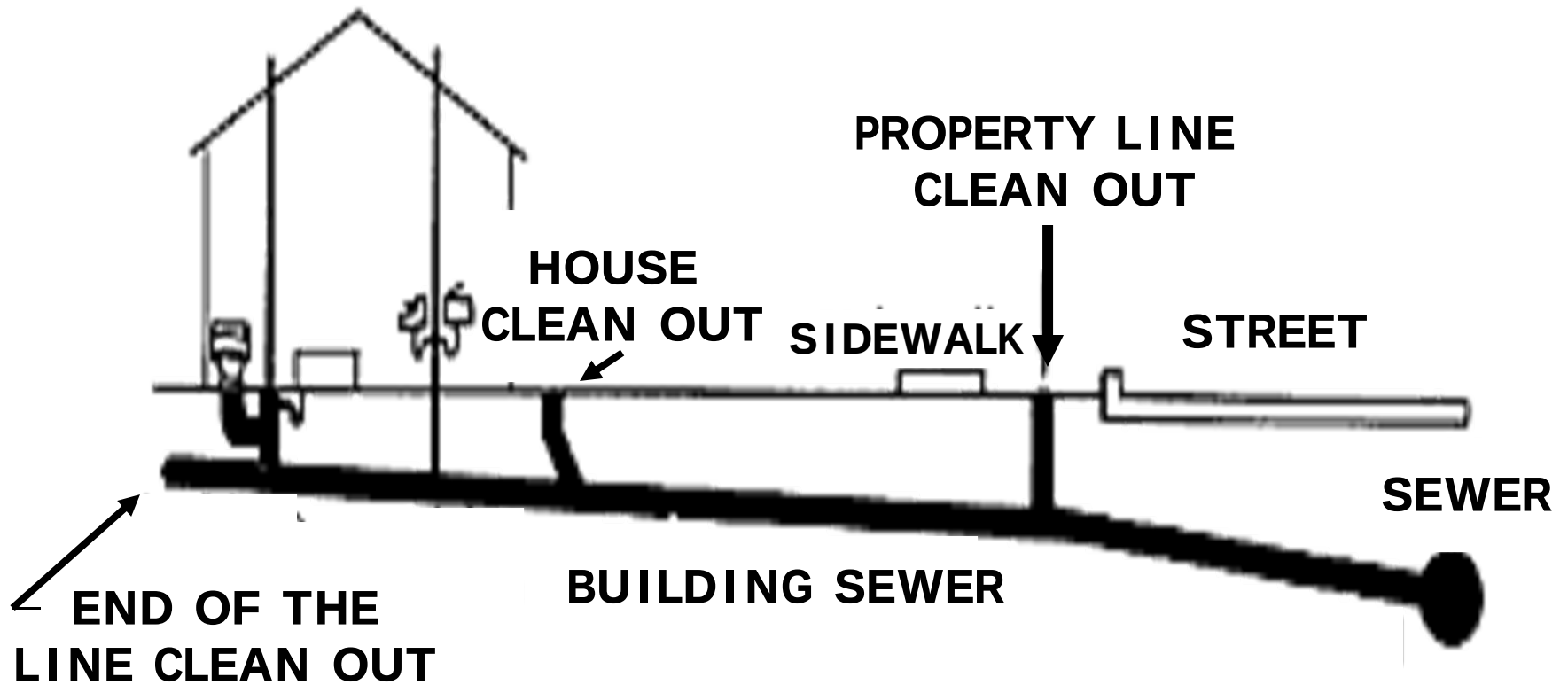
BUILDING SEWER VENT TRAPS

**USED TO PREVENT SEWER
GASSES FROM ENTERING THE
BUILDING.**

**NOT WIDELY USED
TODAY BECAUSE EACH
FIXTURE HAS ITS OWN
P- TRAP**



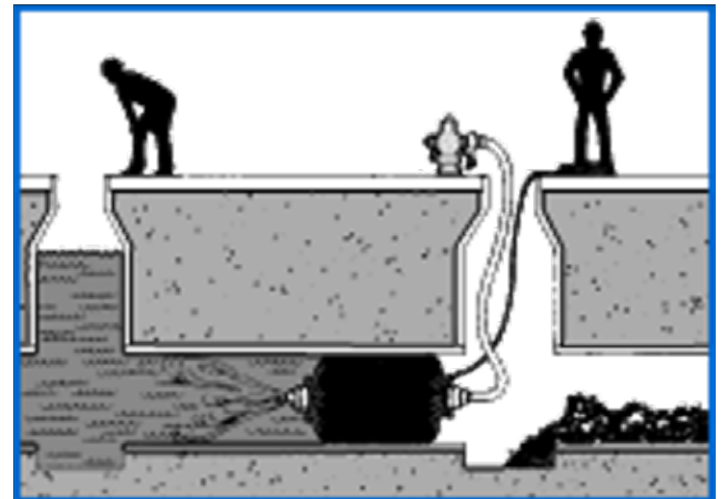
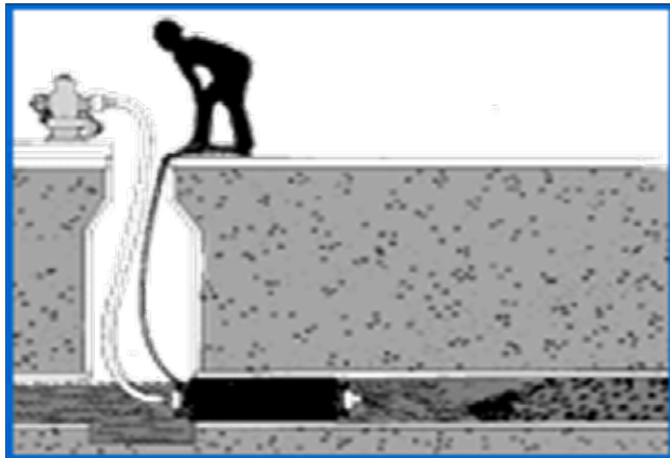
BUILDING SEWER CLEAN OUTS



LOCATED ABOUT 3 ft FROM THE BUILDING

LATERAL and BRANCH CLEANOUTS and FLUSHER BRANCHES

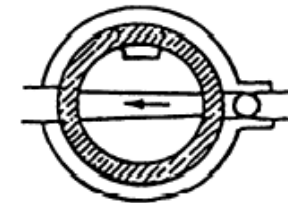
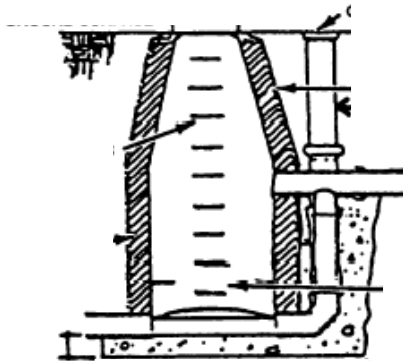
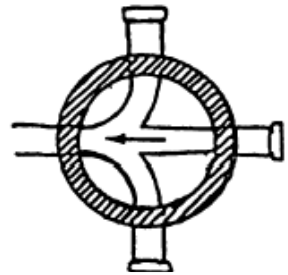
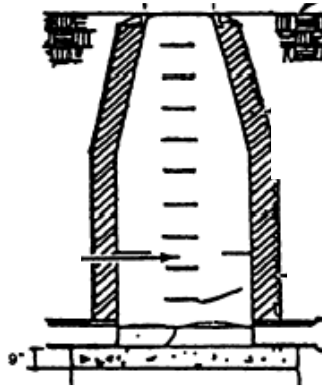
USUALLY LOCATED AT TERMINAL
END OF SEWERS (IN PLACE OF
MANHOLES)

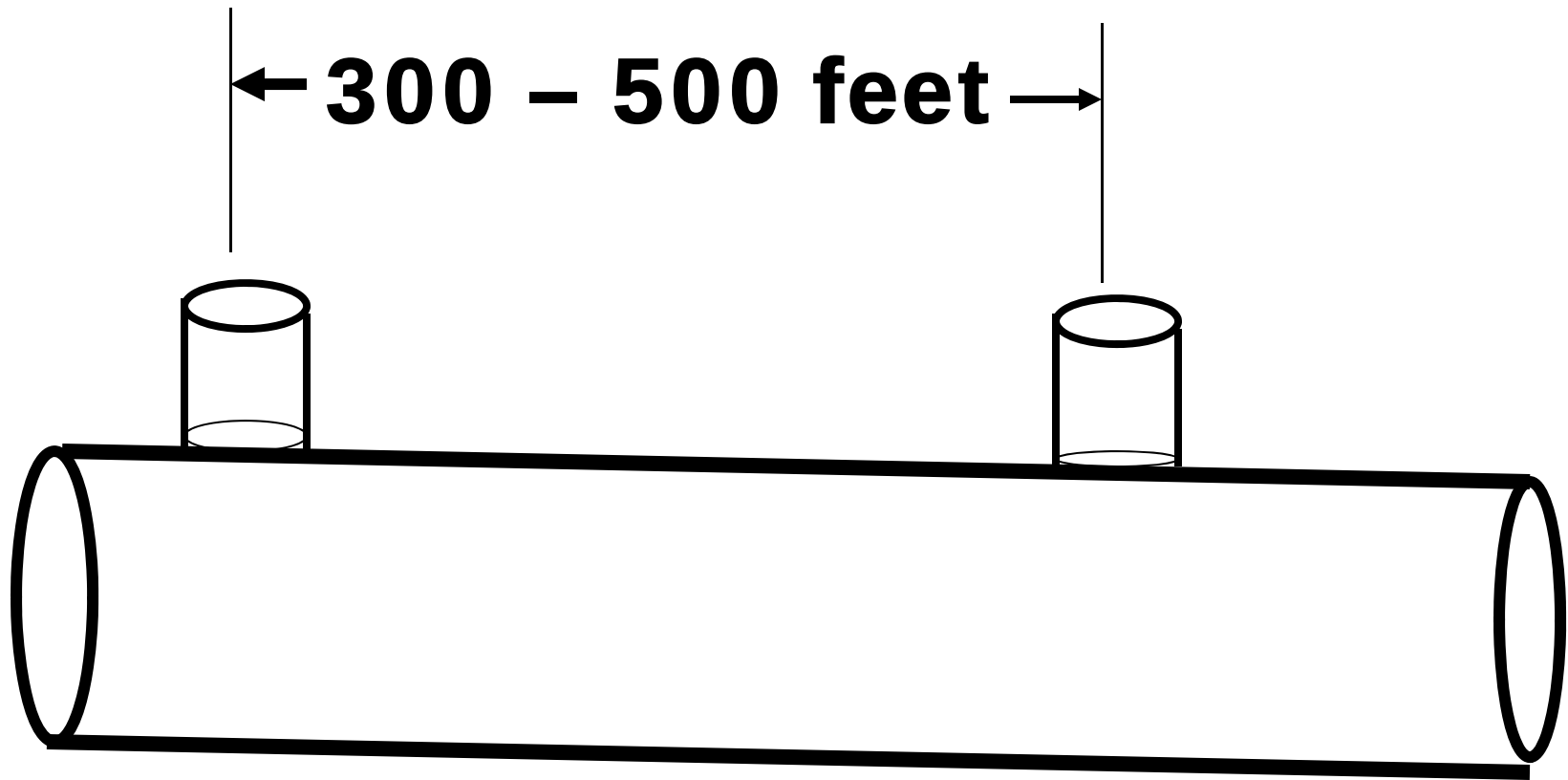


MANHOLES

LOCATIONS:

**ON
LATERALS,
MAIN, TRUNK
&
INTERCEPTOR
SEWERS**





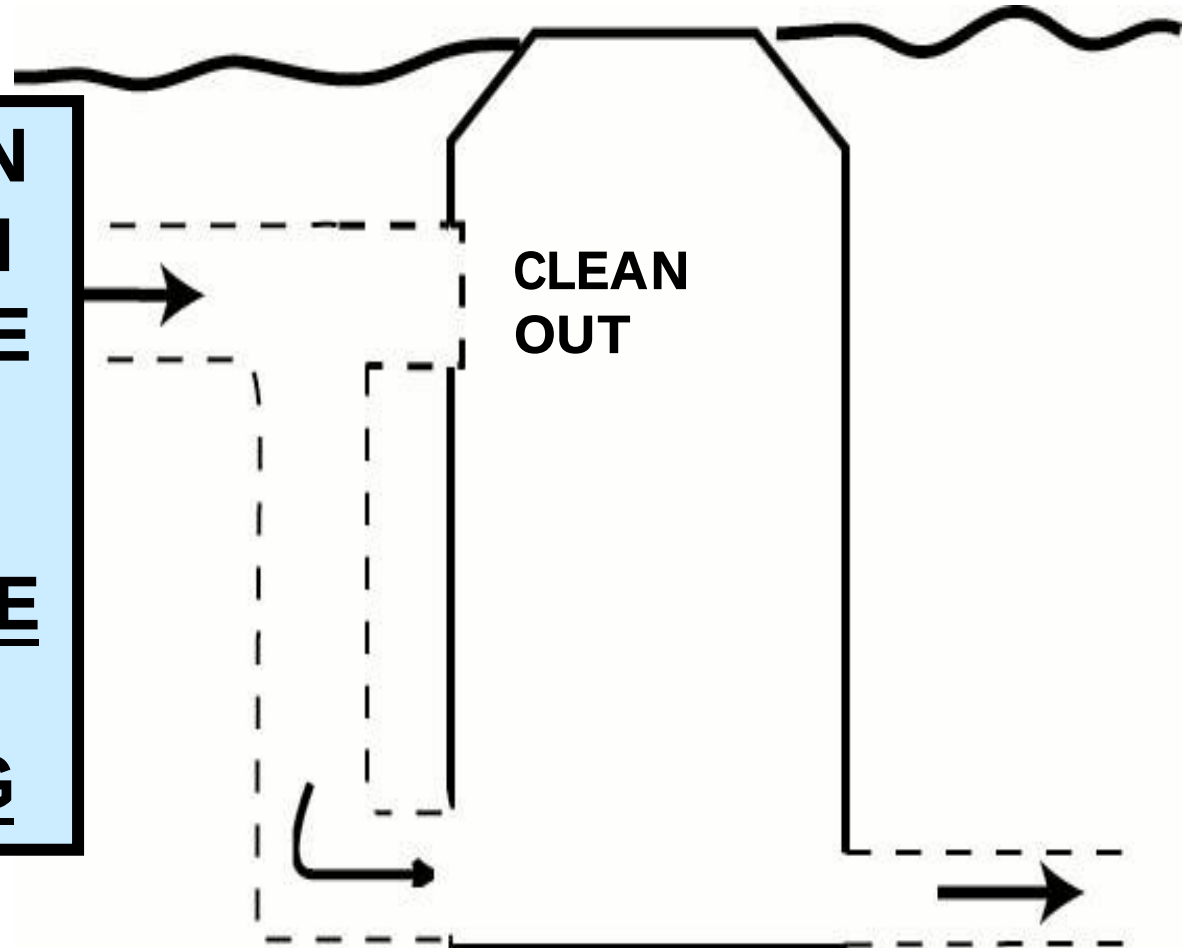
**MANHOLE PLACEMENT ON
SEWERS**

MANHOLES ARE ALSO PLACED AT CHANGES IN:

- **JUNCTIONS**
- **DIRECTION**
- **SLOPE**
- **ELEVATION**
- **PIPE SIZE**

DROP MANHOLES

**USED WHEN
ELEVATION
DIFFERENCE
WOULD
CAUSE
TURBULENCE
AND
SPLASHING**



MANHOLES

PURPOSE:

**TO PLACE PERSONS, EQUIPMENT
MATERIALS INTO SEWERS
FOR MAINTENANCE,
INSPECTING, and CLEANING**

MANHOLE CONSTRUCTION



PRECAST CONCRETE

MANHOLE CONSTRUCTION

- **PRE-CAST SECTIONS
ARE JOINED WITH
MORTAR (TO PREVENT
INFILTRATION)**

- **CAN BE BRICK, POURED IN
PLACE CONCRETE**

**MIN INSIDE DIAMETER = 4 ft;
COVER RARELY EXCEEDS 36 inches**

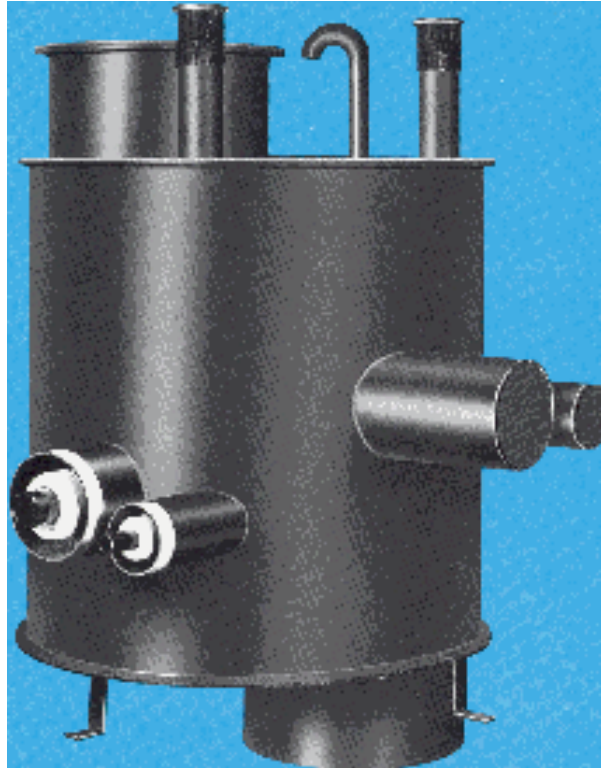


**WHY ARE
MANHOLE
COVERS
ROUND?**



© www.danriller.com

MANHOLE CONSTRUCTION

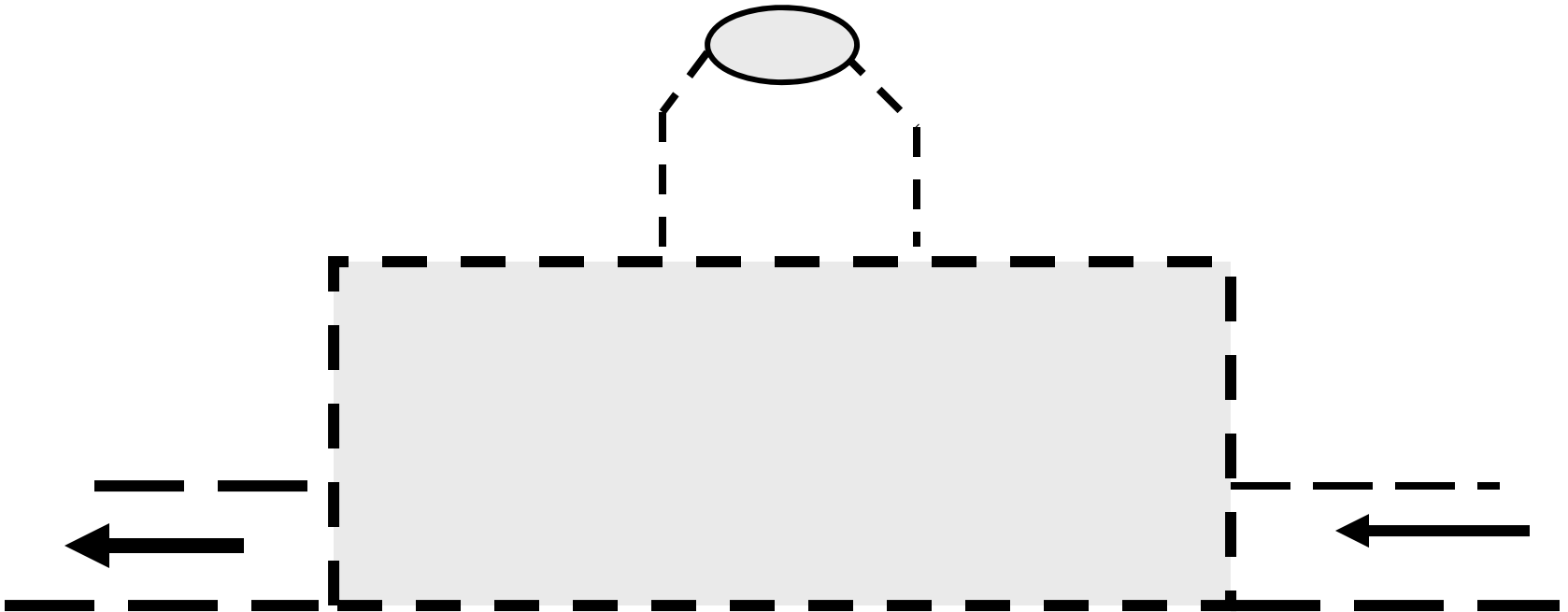


PRE-FAB UNITS



OTHER STRUCTURES

**JUNCTION STRUCTURE: USED
TO JOIN LARGE DIAMETER
TRUNK LINES**



OTHER STRUCTURES

INTERCONNECT SEWERS

(SHORT LINES BETWEEN
MANHOLES—USED TO
REGULATE OR DIVERT
FLOW)

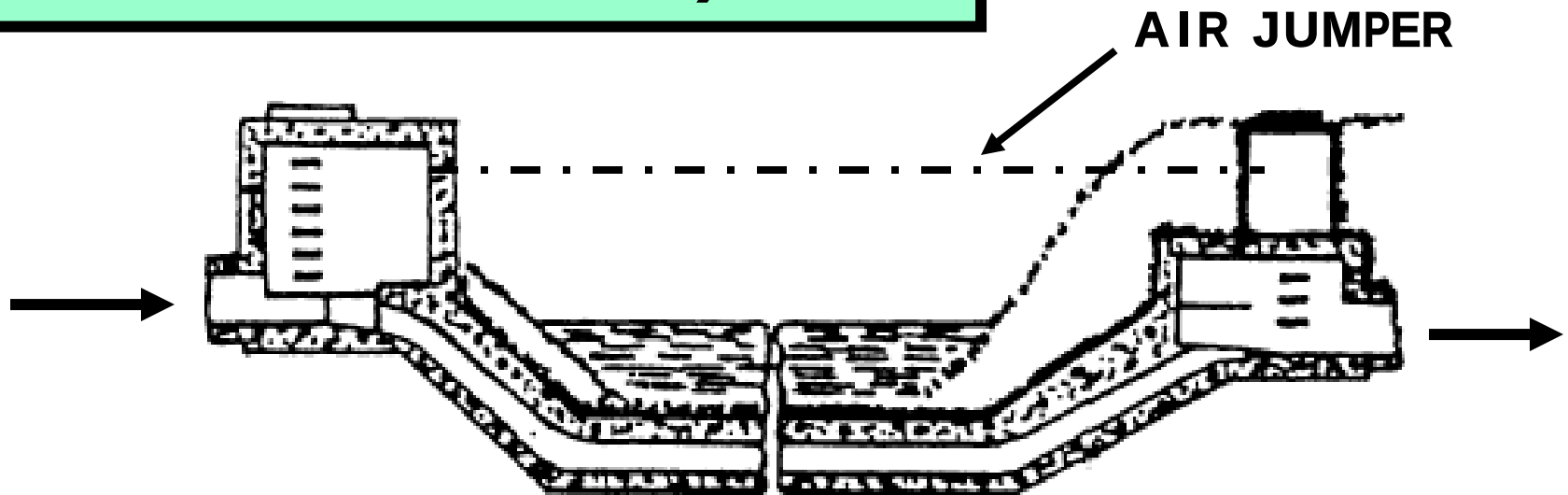


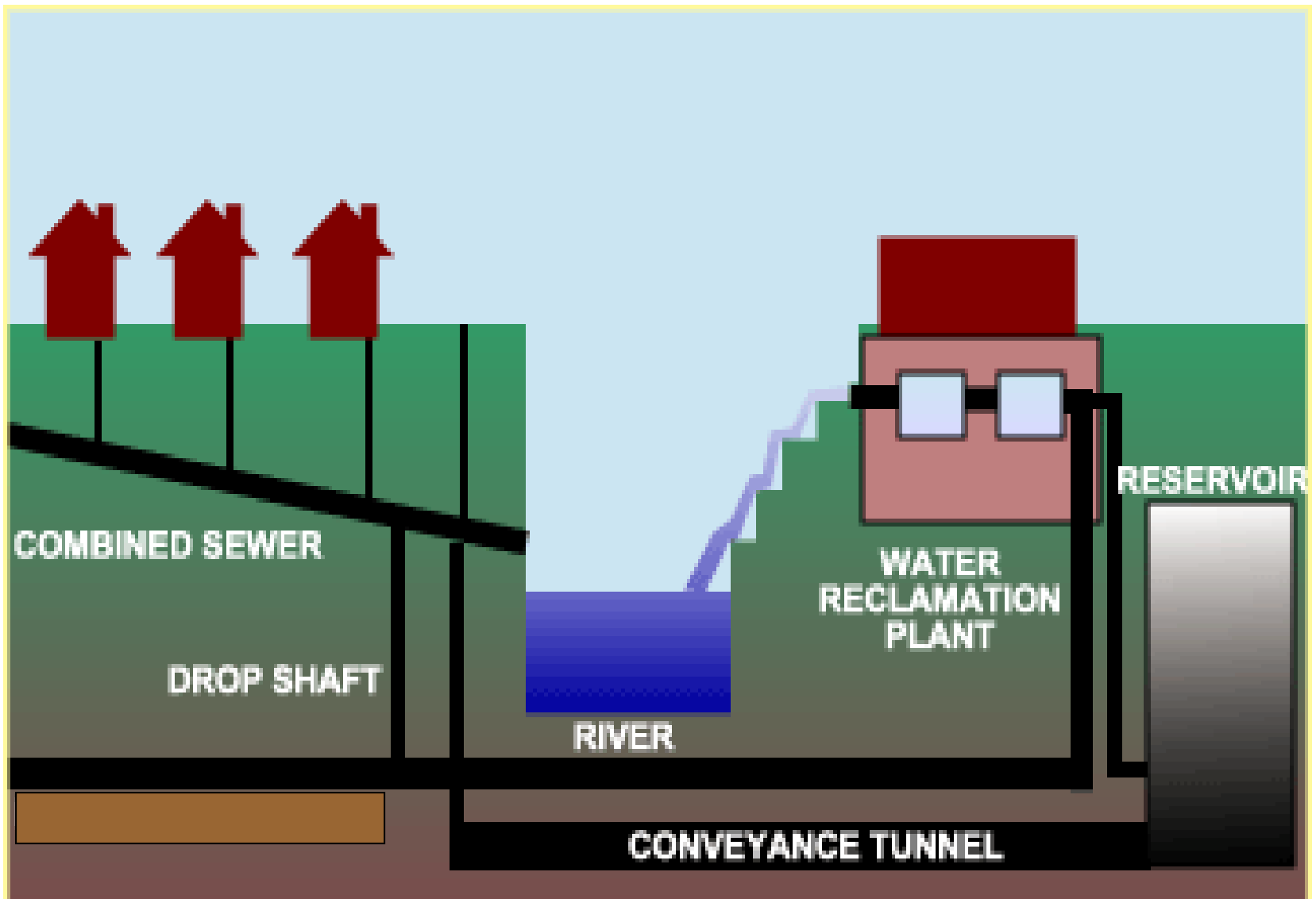
OTHER STRUCTURES

INVERTED SIPHON

(USED TO PASS UNDER
OBSTRUCTIONS; AIR
JUMPER SOMETIMES USED
TO PROVIDE CONTINUOUS
FLOW OF AIR)

NEEDS
REGULAR
CLEANING
DUE TO
SOLIDS
SETTLING





CITY OF CHICAGO

SIZES OF SEWERS

- LARGE ENOUGH TO USE CLEANING EQUIPMENT
- DESIGNED TO FLOW $\frac{1}{2}$ FULL DURING PEAK DAILY “*DRY WEATHER DESIGN FLOW*”

WHAT MAKES A GOOD SEWER PIPE?

- **RESISTANT TO THE
WASTEWATER AND SOIL**
- **HIGH STRENGTH TO
WITHSTAND STREET
LOADS/TRAFFIC**
- **RESISTANT TO TREE
ROOTS, INFILTRATION &
EXFILTRATION**
- **LOW COST & INSTALLATION**

TYPES OF PIPE MATERIAL

1. ACRYLONITRILE BUTADIENE STYRENE (ABS)

**+ : FLEXIBLE; ABRASION RESISTANT;
RESISTANT TO ACIDS & BASES**

**- : SOFTENS IN CONTACT WITH
PETROLEUM PRODUCTS;
BACKFILL CAREFULLY TO PREVENT
DEFORMATION; not rodent resistant**

TYPES OF PIPE MATERIAL

2. ASBESTOS CEMENT (A/C)

**+: RIGID; WATER
TIGHT; ABRASION
RESISTANT;
RODENT RESISTANT**

**-: WILL
CORRODE FROM
ACIDS**



**USE A MASK
WHEN CUTTING
A/C PIPE**

TYPES OF PIPE MATERIAL

3. CAST IRON (CI)

+: RIGID; RESISTANT TO CRUSHING (CAN BE USED IN SHALLOW TRENCHES); GOOD FOR STREAM/BRIDGE CROSSINGS; RESISTANT TO CORROSION AND ROOTS

-: RELATIVELY EXPENSIVE

TYPES OF PIPE MATERIAL

4. CORRUGATED METAL PIPE (CMP)

**+ : INEXPENSIVE;
EASY TO WORK
WITH;**

**- : JOINTS MAY
LEAK; BITUMAS-
TIC COATING MAY
BREAK OFF**



TYPES OF PIPE MATERIAL

5. POLYVINYL CHLORIDE (PVC)

**+: RIGID/FLEX;
RESISTANT TO
MOST CHEMICALS
FOUND IN
WASTEWATER; LOW
COST**

**- : PROBLEMS WITH
EXTERNAL LOADS**



TYPES OF PIPE MATERIAL

6. REINFORCED CONCRETE (RCP)

**RIGID;
CORRODED BY
ACIDS; LEAKS
IF INSTALLED
IMPROPERLY**



TYPES OF PIPE MATERIAL

7. FIBERGLASS REINFORCED (FRP)

**FLEXIBLE;
RESISTANT TO
MOST
CHEMICALS/ACIDS;
DAMAGED BY $\underline{\text{H}}_2\underline{\text{S}}$;
LOW CRUSHING
STRENGTH**



TYPES OF PIPE MATERIAL

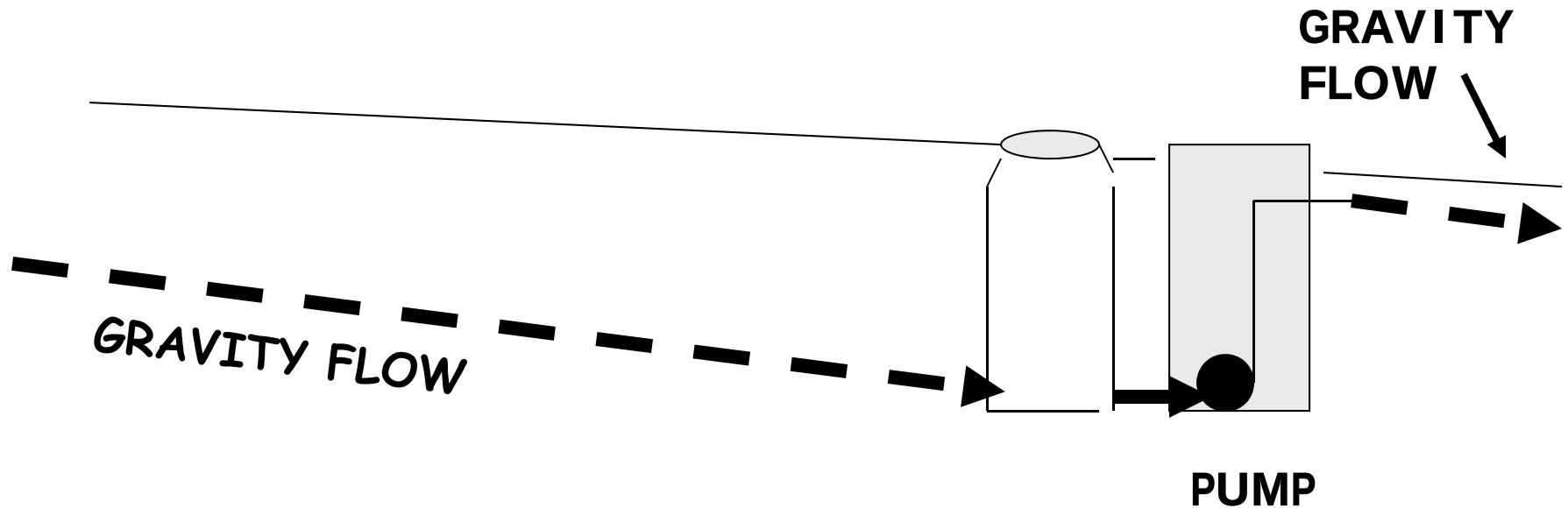
8. VITRIFIED CLAY PIPE (VCP)

**RIGID;
RESISTANT TO
DETERIORATION;
COMPRESSION
JOINTS HAVE
REPLACED OLD
MORTAR JOINTS;
EASILY BROKEN
(BE CAREFUL)**



LIFT STATIONS

**PURPOSE: TO LIFT WASTE-
WATER TO HIGHER
ELEVATION TO ALLOW IT
TO FLOW BY GRAVITY AGAIN**



LIFT STATIONS

TYPES:

- WET WELL

PUMPS ARE SELF
PRIMING; 3-5 min
BETWEEN STARTS

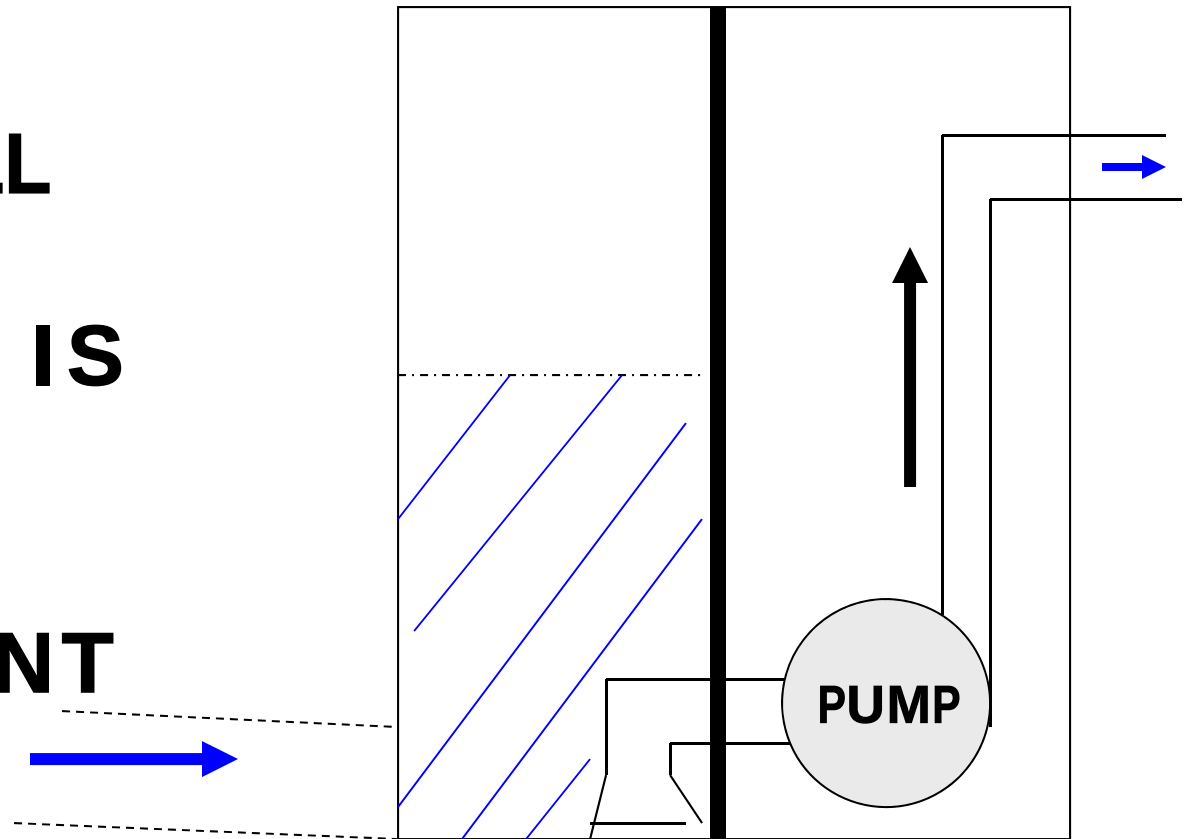


LIFT STATIONS

TYPES:

- DRY WELL

EQUIPMENT IS
LOCATED IN
THE “DRY”
COMPARTMENT



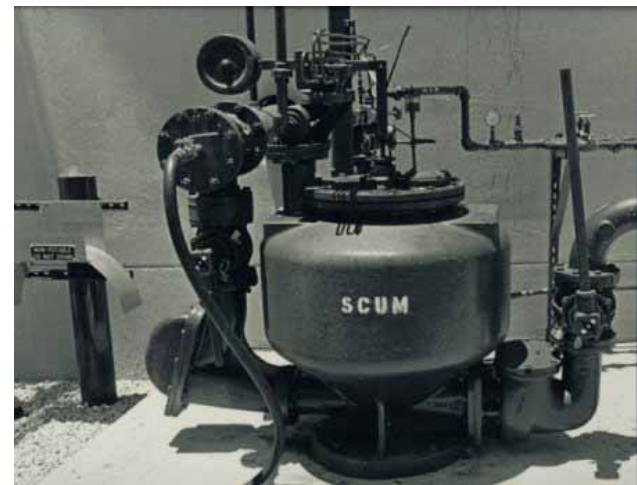
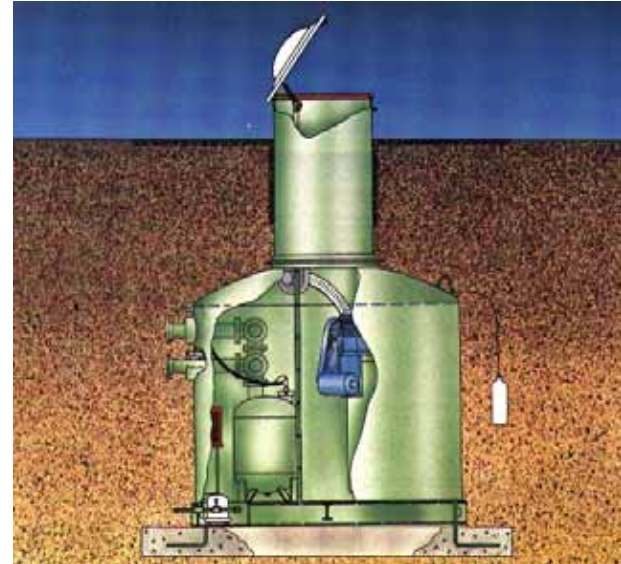
LIFT STATIONS

TYPES:

- **PNEUMATIC
EJECTOR**

**COMPRESSED AIR IS
USED TO “PUMP” THE
WASTEWATER.**

CYCLES EVERY 30 sec



LIFT STATION DESIGN

- **USUALLY DESIGNED TO HANDLE PEAK FLOWS**

**THIS MAY CREATE PROBLEMS
DURING LOW FLOW WITH
SOLIDS SETTLING OUT.**

**(AERATION IN THE WET WELL MIGHT HELP
BUT MIGHT HAVE TO PUT AIR RELIEF
VALVES DOWN THE LINE)**

LIFT STATION DESIGN

WET WELL DIMENSIONS

- IF TOO SMALL... PUMPS START AND STOP EXCESSIVELY
- IF TOO LARGE... SOLIDS SETTLE OUT

WET WELL ACCESS

MOST IMPORTANT: SAFETY

THESE ARE “CONFINED SPACES”:

- OXYGEN DEFICIENCY
- SLIPPERY SURFACES
- POISONOUS GASSES??



TAKE A BUDDY WITH YOU!

PERSONAL PROTECTIVE EQUIPMENT (PPE)



AIR TEST METER

**ATMOSPHERE
IS OXYGEN
DEFICIENT
WHEN
OXYGEN IS
LESS THAN
19.5%**



DON'T FORGET TO PROTECT YOUR EYES AND EARS

WETWELL ACCESS



**BE CAREFUL WITH
“BUILT-IN” LADDERS**

**RUNGS MAY BE
CORRODED**

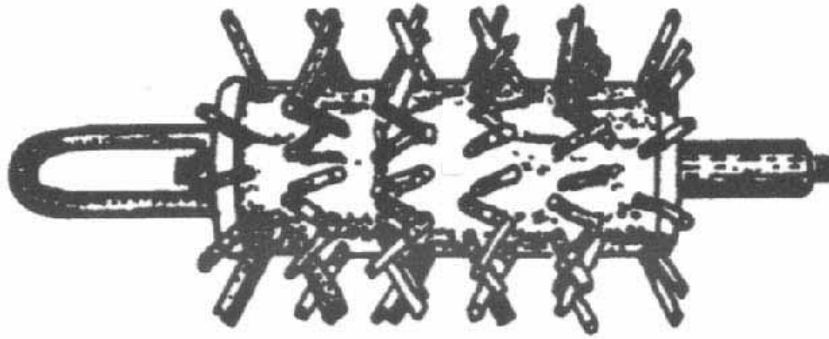
**WHAT IS THE LD50 FOR
LADDERS?**

ANS: 11 feet

SEWER CLEANING

SEWER RODS





PORCUPINE

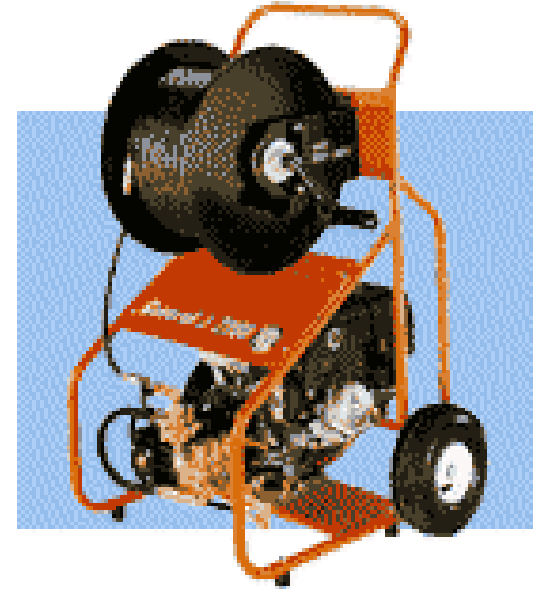
**(USED FOR
SCOURING
SEWERS)**



HARRY CRANE and HOW SEWER RODS CHANGED THE WORLD

SEWER CLEANING

HYDRAULIC (JET) CLEANERS



SEWER CLEANING



BUCKET CLEANERS

(USE AT LOW FLOWS or
UPSTREAM DIVERSION)

WORKING SAFELY IN TRAFFIC



**PUBLIC UTILITY
WORKERS DO NOT
ADEQUATELY
PROTECT
THEMSELVES FROM
TRAFFIC
HAZZARDS**



WORKING SAFELY IN TRAFFIC



SEWER INSPECTIONS

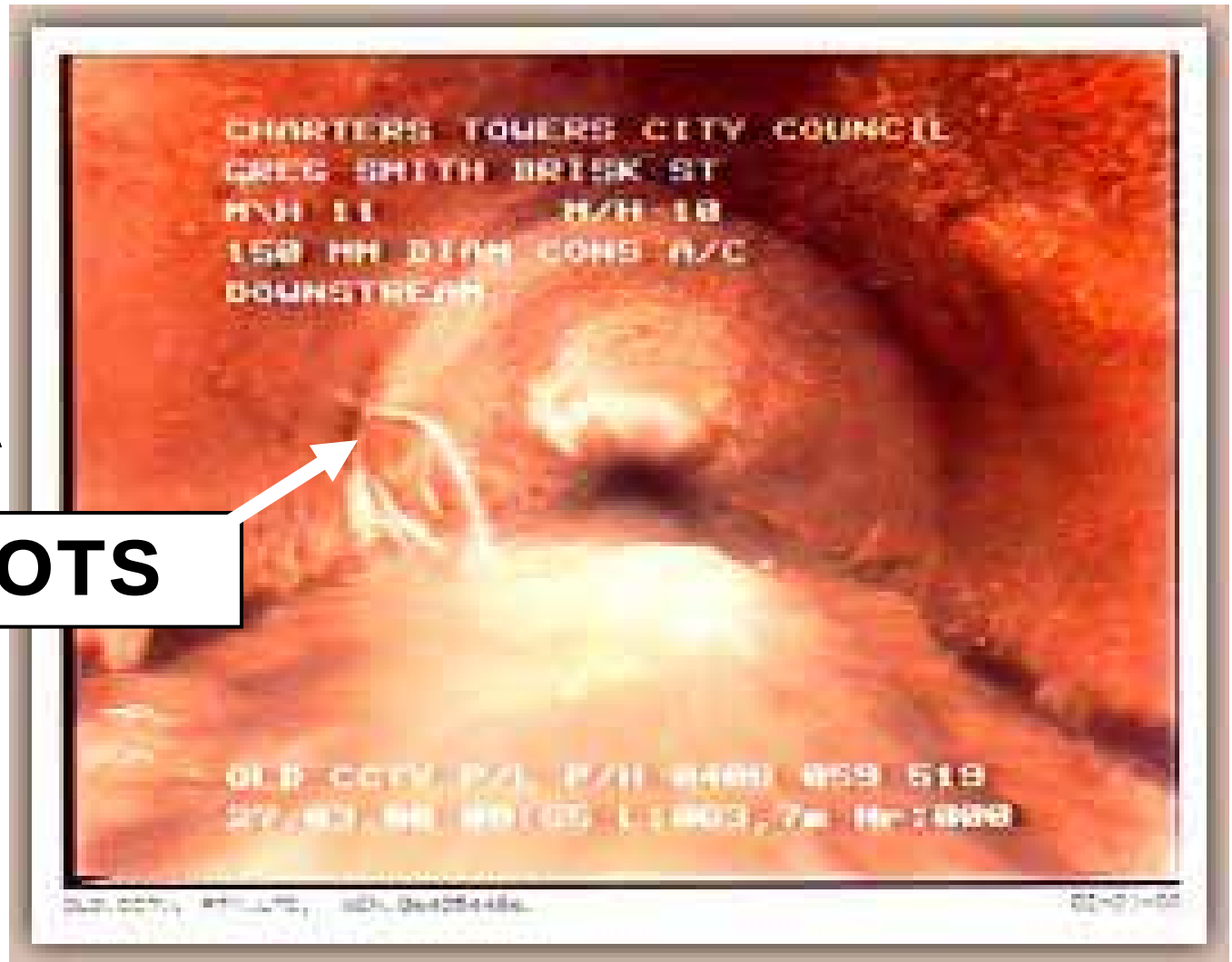


CLOSED CIRCUIT TV EQUIPMENT

SEWER INSPECTION

**TV
CAMERA**

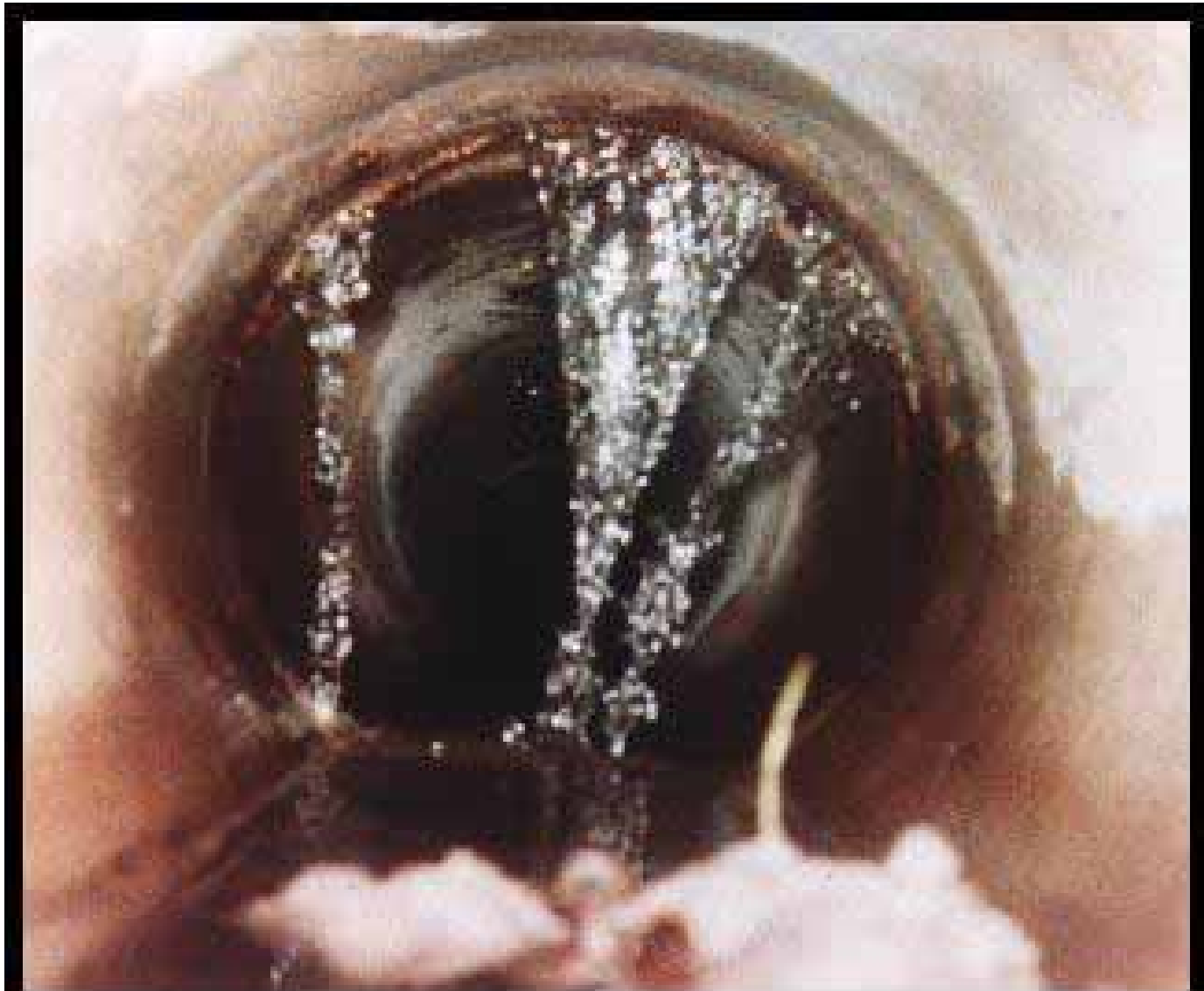
NOTE ROOTS



TV CAMERA SHOWING COLLAPSED PIPE



TV CAMERA SHOWING INFILTRATION



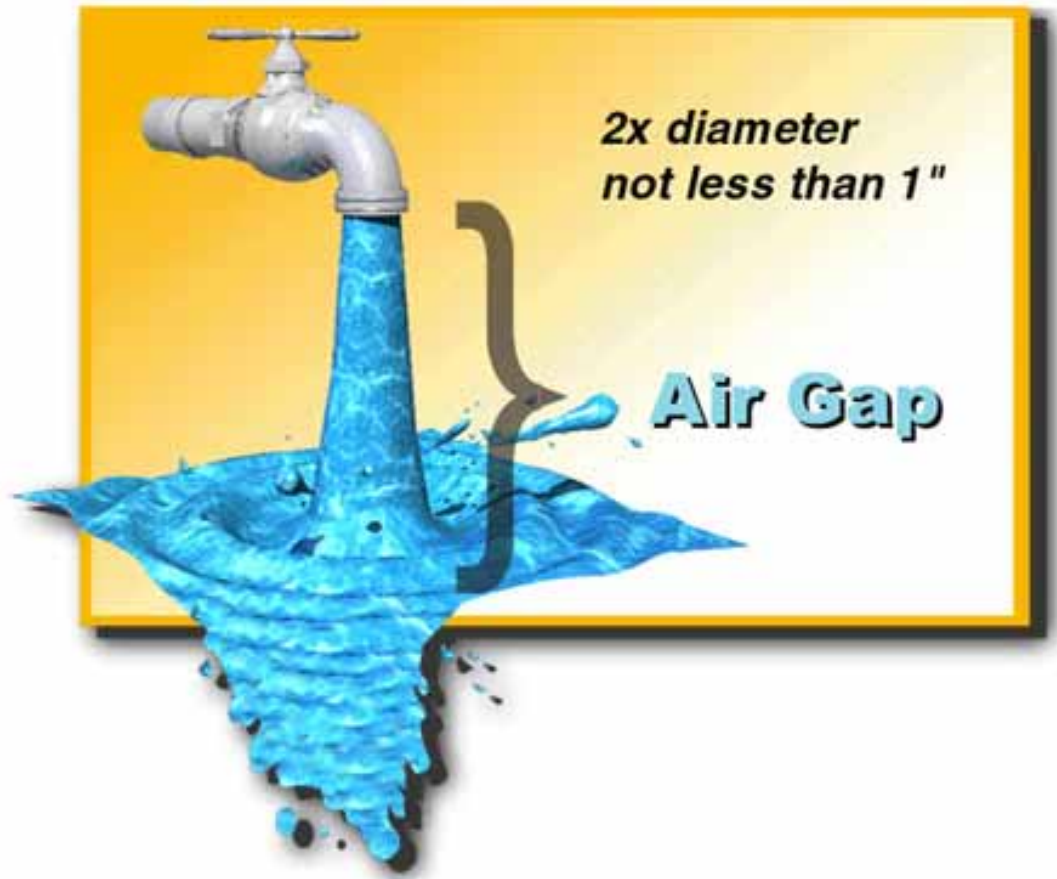
CROSS CONNECTION AWARENESS

**A CROSS CONNECTION EXISTS WHEN
WATER OF UNKNOWN QUALITY IS
CONNECTED WITH POTABLE WATER**



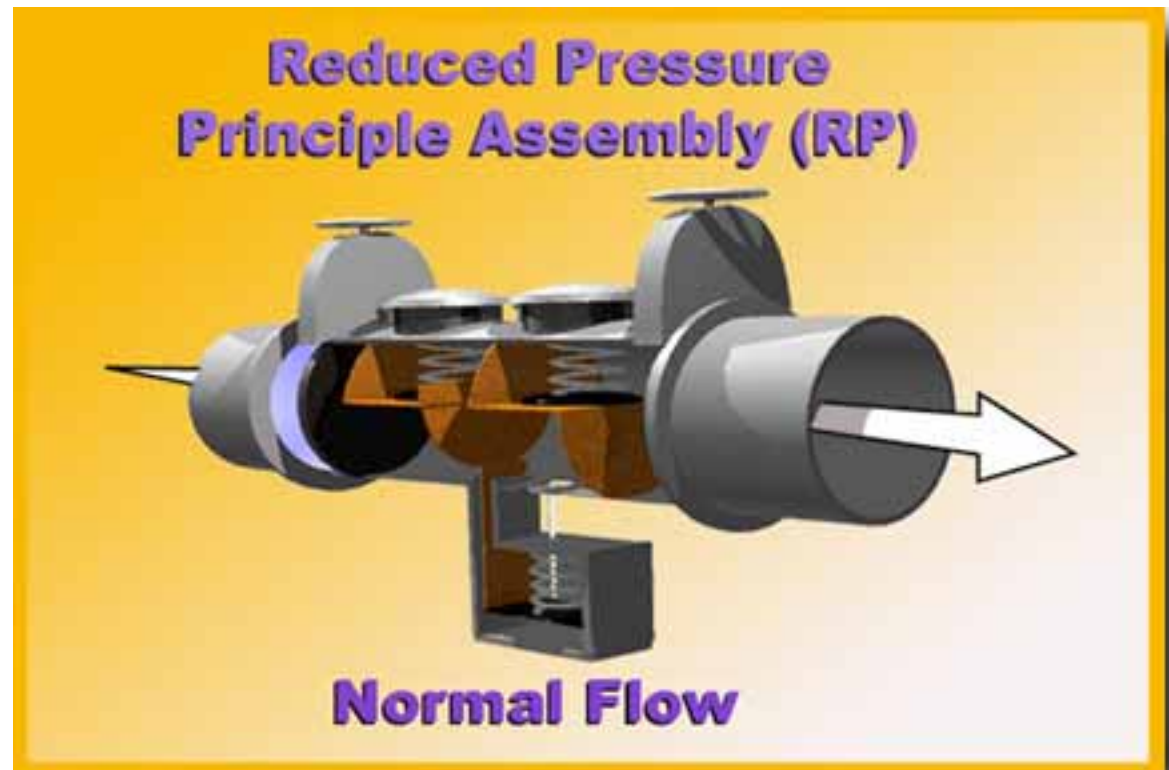
CROSS CONNECTION PROTECTION

**SHOULD
USE AN
"AIR GAP"**



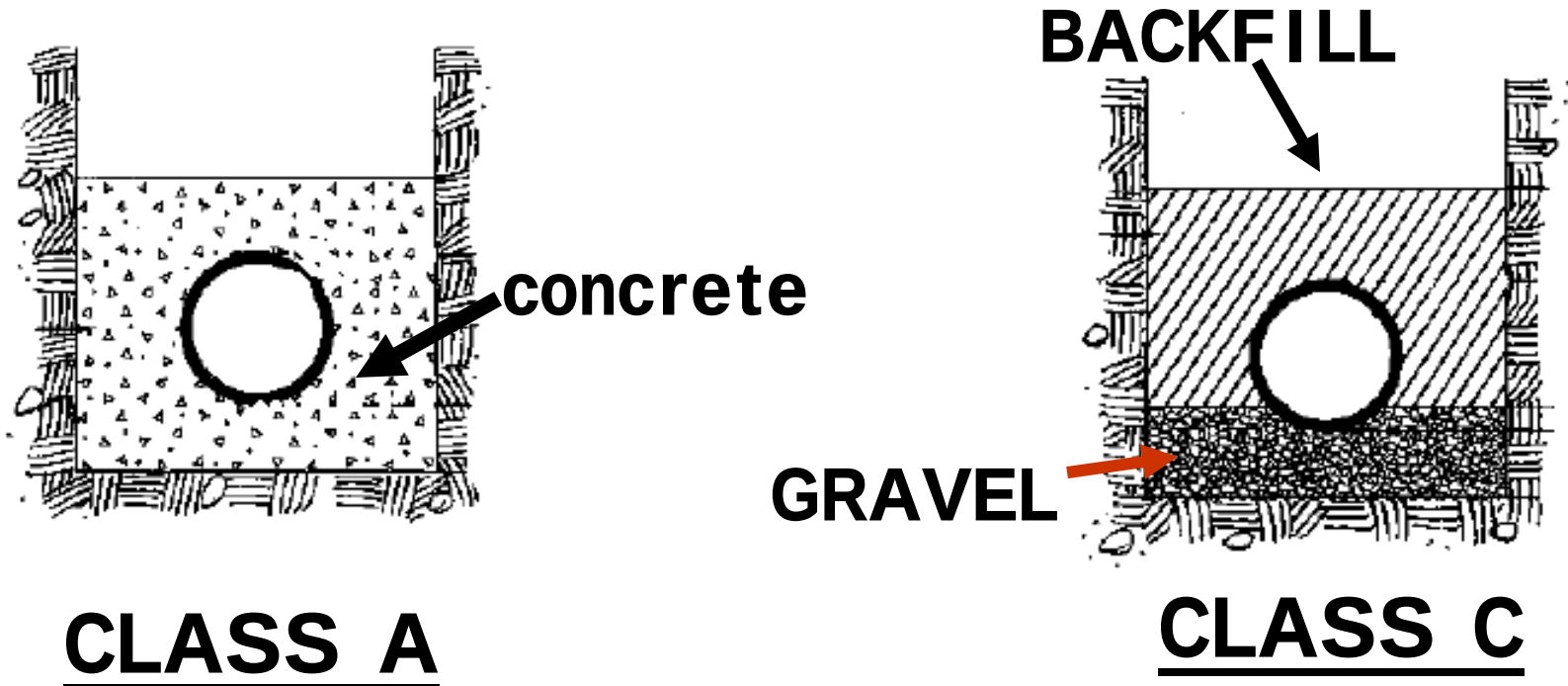
CROSS CONNECTION PROTECTION

**AN “RP”
DEVICE IS
USED FOR
BACKUP
PROTECTION**

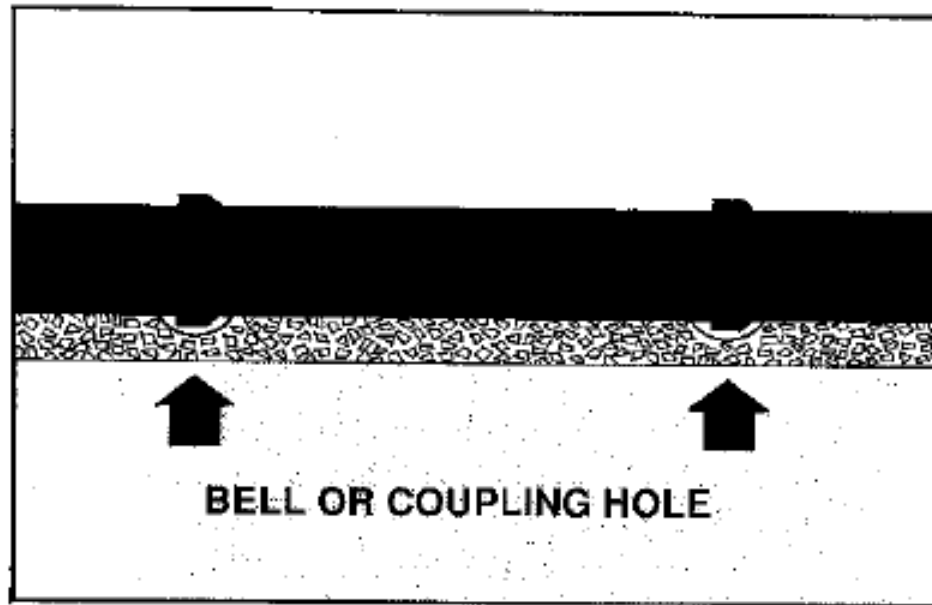


TRENCHING, BEDDING & BACKFILLING

“BEDDING”: THE PIPE'S FOUNDATION



TRENCHING, BEDDING & BACKFILLING



PROPER BEDDING AND BACK-FILLING ARE CRUCIAL FOR LONG-LASTING SEWERS

TRENCHING, BEDDING & BACKFILLING



- <5 ft depth, spoils should be at least 1 ft from edge

- >5 ft depth, spoils should be at least 2 ft from the edge

TRENCHING, BEDDING & BACKFILLING

DEWATERING:



**NEED TO
CONTROL
SURFACE WATER
RUNOFF;
GROUNDWATER
INTRUSION**

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

- 1. ATMOSPHERE**
- 2. PHYSICAL INJURY**
- 3. INFECTIONS & DISEASES**
- 4. SPIDERS, INSECTS, & RODENTS**
- 5. TOXICANTS**
- 6. DROWING**

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

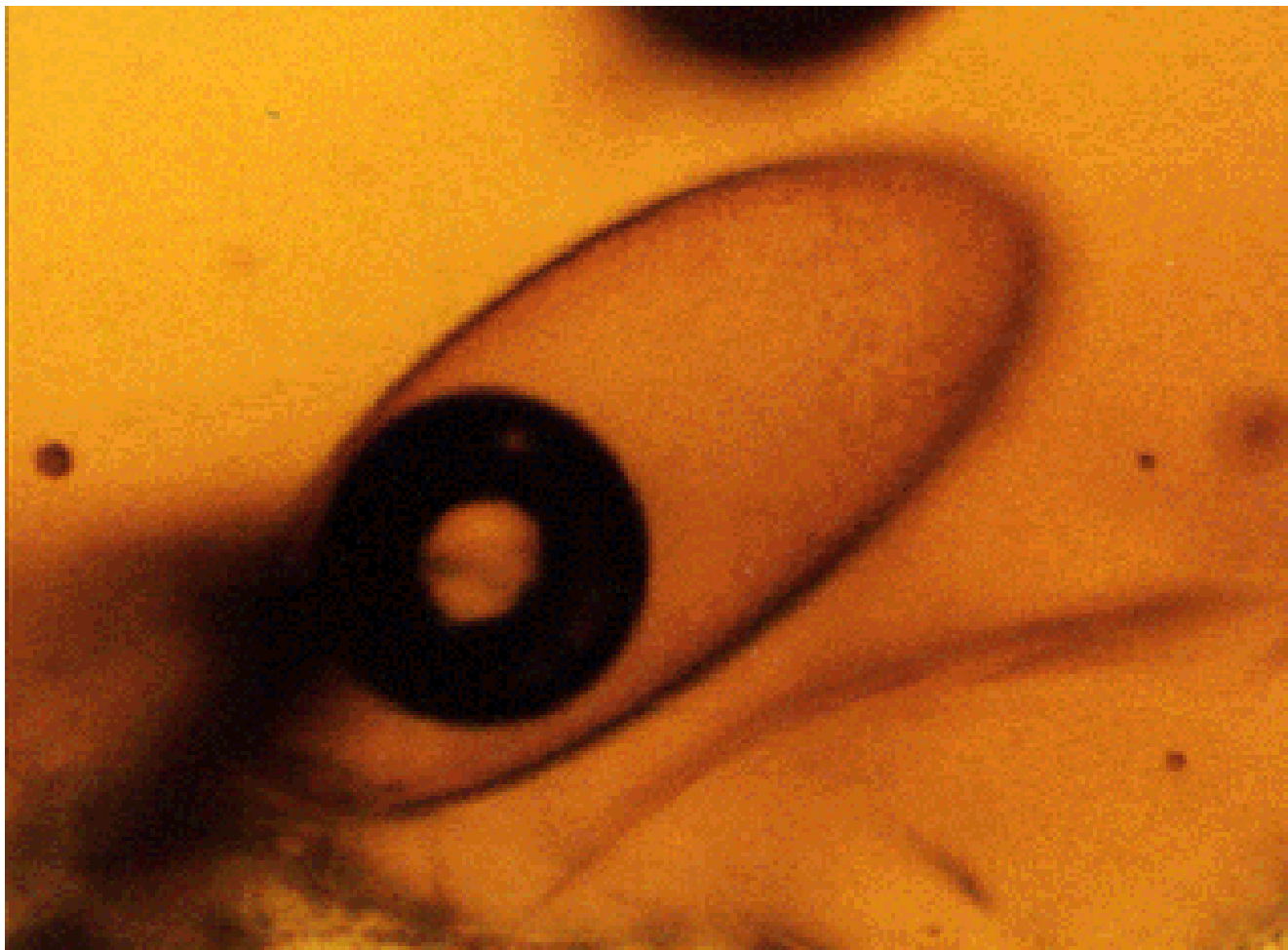
1. ATMOSPHERIC

- **OXYGEN DEFICINECY**
- **TOXIC GASSES**
- **EXPLOSIVE**

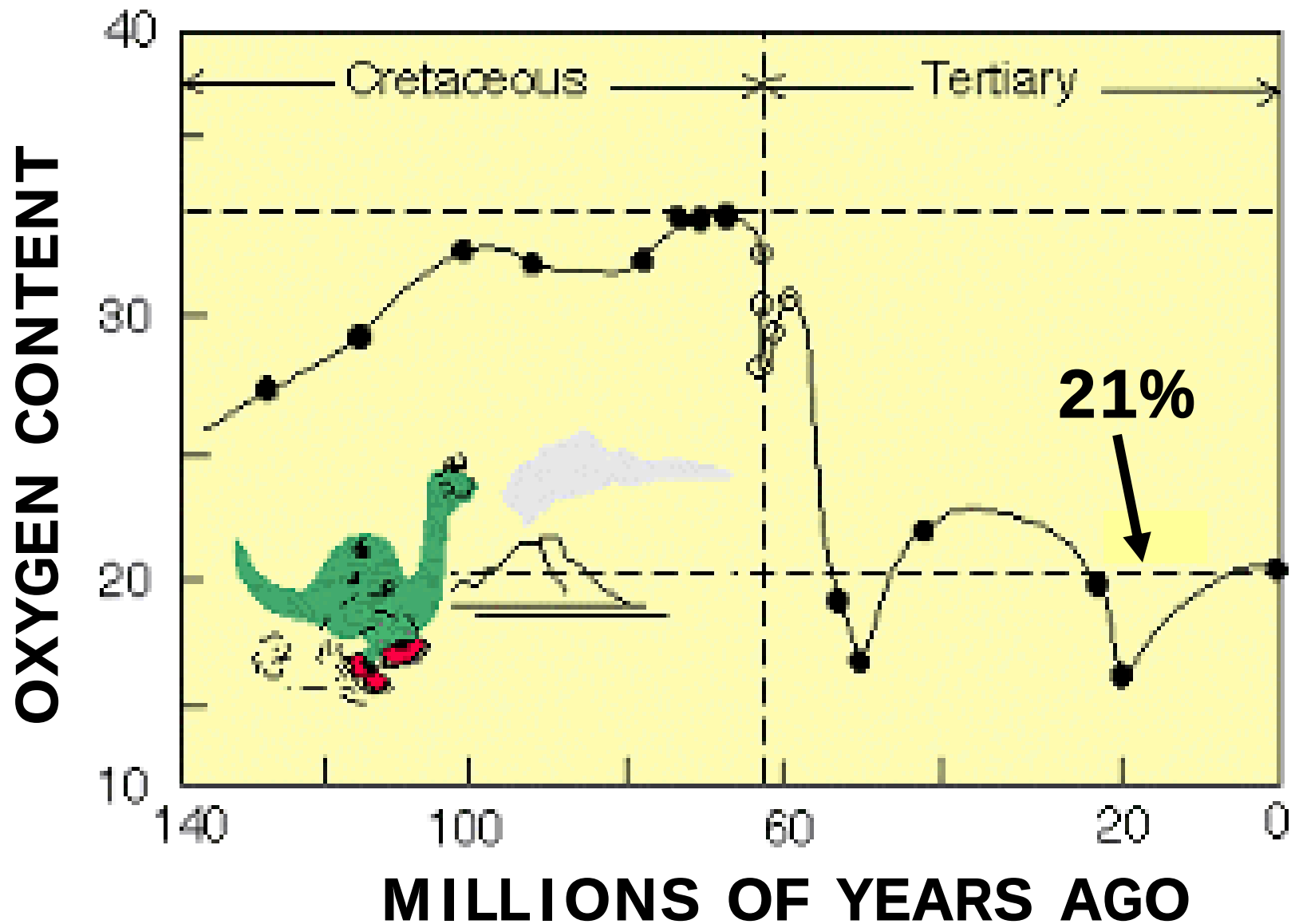
OXYGEN DEFICIENCY

**NORMAL AIR CONTAINS
21.5% OXYGEN: DANGER
WHEN O₂ LEVEL DROPS TO
19.5%**

**OXYGEN LEVEL IN
ATMOSPHERE HAS VARIED
OVER THE YEARS**



**OXYGEN CONTENT IN THIS
AMBER BUBBLE = 35%**



MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

1. ATMOSPHERIC

- **OXYGEN DEFICINECY**
- **TOXIC GASSES**

TOXIC GASSES

**MAIN PROBLEM IS
HYDROGEN SULFIDE (H₂S)**

FOR 8 hour EXPOSURE:

10 PPM – HEADACHE, EYE IRRITATION

50 PPM – SYMPTOMS OF POISONING

300 PPM – CAN CAUSE DEATH

3000 PPM – QUICKLY FATAL

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

1. ATMOSPHERIC

- OXYGEN DEFICINECY
- TOXIC GASSES
- EXPLOSIVE

EXPLOSIVE ATMOSPHERE

**METHANE (CH₄) GASS IS LIGHTER
THAN AIR SO WILL ESCAPE IF
SEWER/MANHOLE IS VENTILATED**

**GASOLINE, PROPANE & SOLVENTS
ARE HEAVIER THAN AIR—WILL
ACCUMULATE IN LOW SPOTS
WHERE WILL BE:**

- **EXPLOSIVE or WILL DISPLACE O₂**

GASOLINE CAN COME FROM:

- STORAGE TANKS**
- GAS STATIONS**
- SPIILLS**
- PIPELINES**

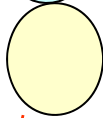
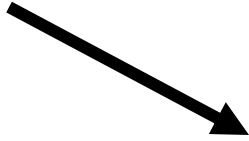


APRIL, 1992

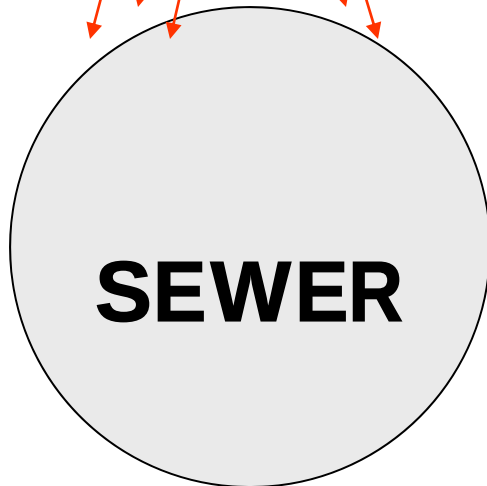
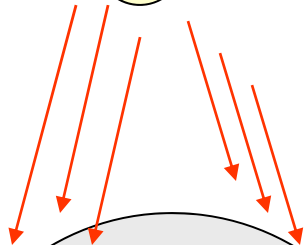
20 BLOCKS OF SEWER EXPLODED IN GUADALAJARA, MEXICO

- 215 PEOPLE KILLED**
- 1500 INJURED**
- 15,000 HOMELESS**

WATER LINE



GASOLINE LINE



SEWER

**OVER \$32
MILLION IN
DAMAGES**

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

2. PHYSICAL INJURY

- **SLIPS, FALLS, FALLING
OBJECTS, STRUCTURAL
FAILURES**





**MANY PLACES HAVE
BANNED THE USE OF
HEAVY LADDERS
(BECAUSE THEY WOULD DROP
THEM ON WORKERS)**

**ASSUME MANHOLE
RUNGS ARE UNSAFE
AND DO NOT USE
UNLESS YOU HAVE
FALL PROTECTION**

**HAND ALL TOOLS DOWN IN
A BUCKET. DO NOT DROP
THEM INTO THE MANHOLE!**



MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

3. INFECTIONS & DISEASES

**RECALL: EVERY DISEASE,
PARASITE, INFECTION, VIRUS
AND ILLNESS CAN END UP IN
WASTEWATER. YOU CAN BE
EXPOSED**



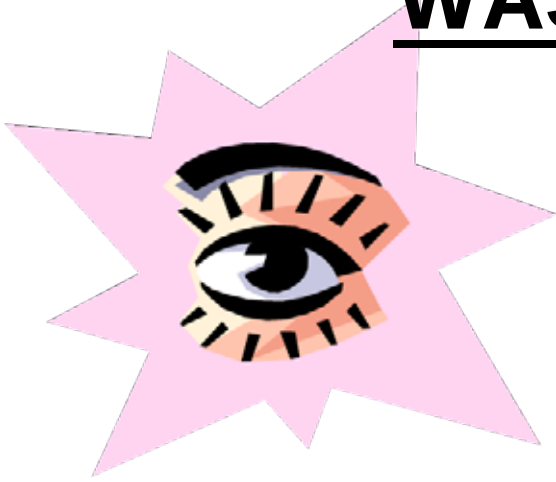
**LEPTOSPIROSIS CAN BE
TRANSMITTED BY RAT FECES
AND URINE**

**...CAUSES FEVER, HEADACHES,
NAUSEA, VOMITING, AND
THIRST. GIT ANTIBIOTICS**

**DO NOT RUB YOUR EYES
WITH YOUR GLOVES.**

**EYES AND NOSE ARE MOST
VULNERABLE ROUTE OF
DISEASE ENTRY**

WASH YOUR HANDS!!



**MAY WANT TO DISINFECT
THE MANHOLE BEFORE
ENTRY IF LOCATED NEXT
TO:**

**•HOSPITAL, DISEASE
TREATMENT CENTER**

**•CLINICAL LABORATORY,
VETERINARY OFFICE**

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

4. SPIDERS, BUGS, & RODENTS





$\frac{1}{4}$

INCH

BROWN RECLUSE (AKA FIDDLE SPIDER)

MANHOLE HAZARDS

**(SHOULD BE TREATED AS A
CONFINED SPACE)**

5. TOXICANTS

**ANY SUBSTANCE THAT CAN BE
POISONOUS.**

**PROPER BOOTS AND GLOVES AND
AWARENESS ARE EFFECTIVE
PROTECTION**

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

6. DROWNING



**WEAR A LIFE JACKET WHEN
WORKING IN OR NEAR LARGE
DIAMETER SEWERS**

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

- 1. ATMOSPHERE**
- 2. PHYSICAL INJURY**
- 3. INFECTIONS & DISEASES**
- 4. SPIDERS, INSECTS, & RODENTS**
- 5. TOXICANTS**
- 6. DROWING**

DO NOT ENTER A MANHOLE WITHOUT:

- **AN EXPERIENCED TEAM**
- **PROPER VENTILATION**
- **GAS TESTING EQUIPMENT**
- **PERSONAL PROTECTIVE
EQUIPMENT**



VENTILATION BLOWER

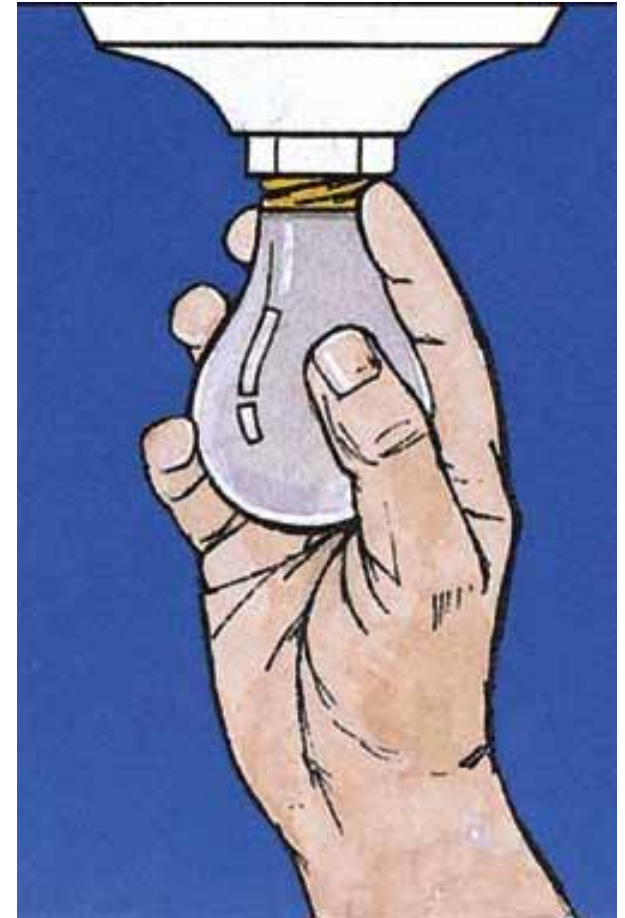
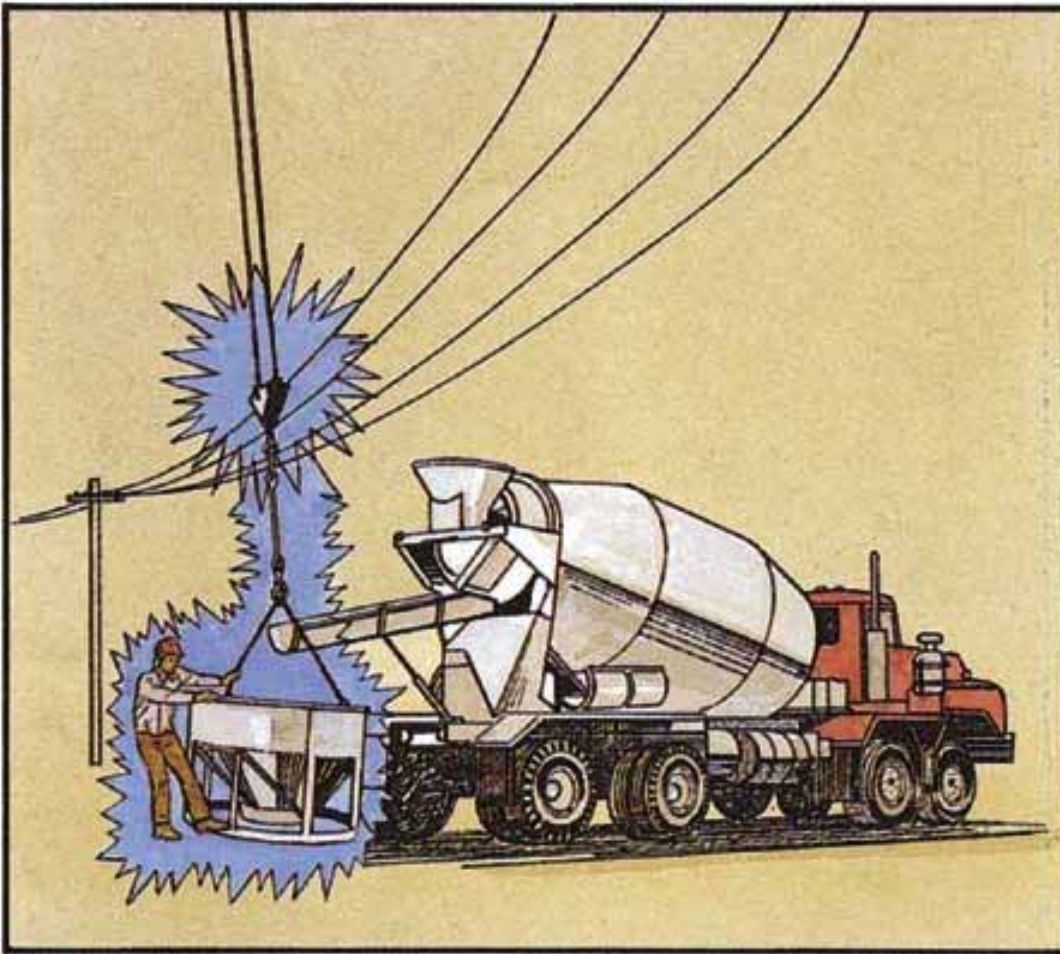


**SELF
CONTAINED
BREATHING
APPARATUS
(SCBA)**



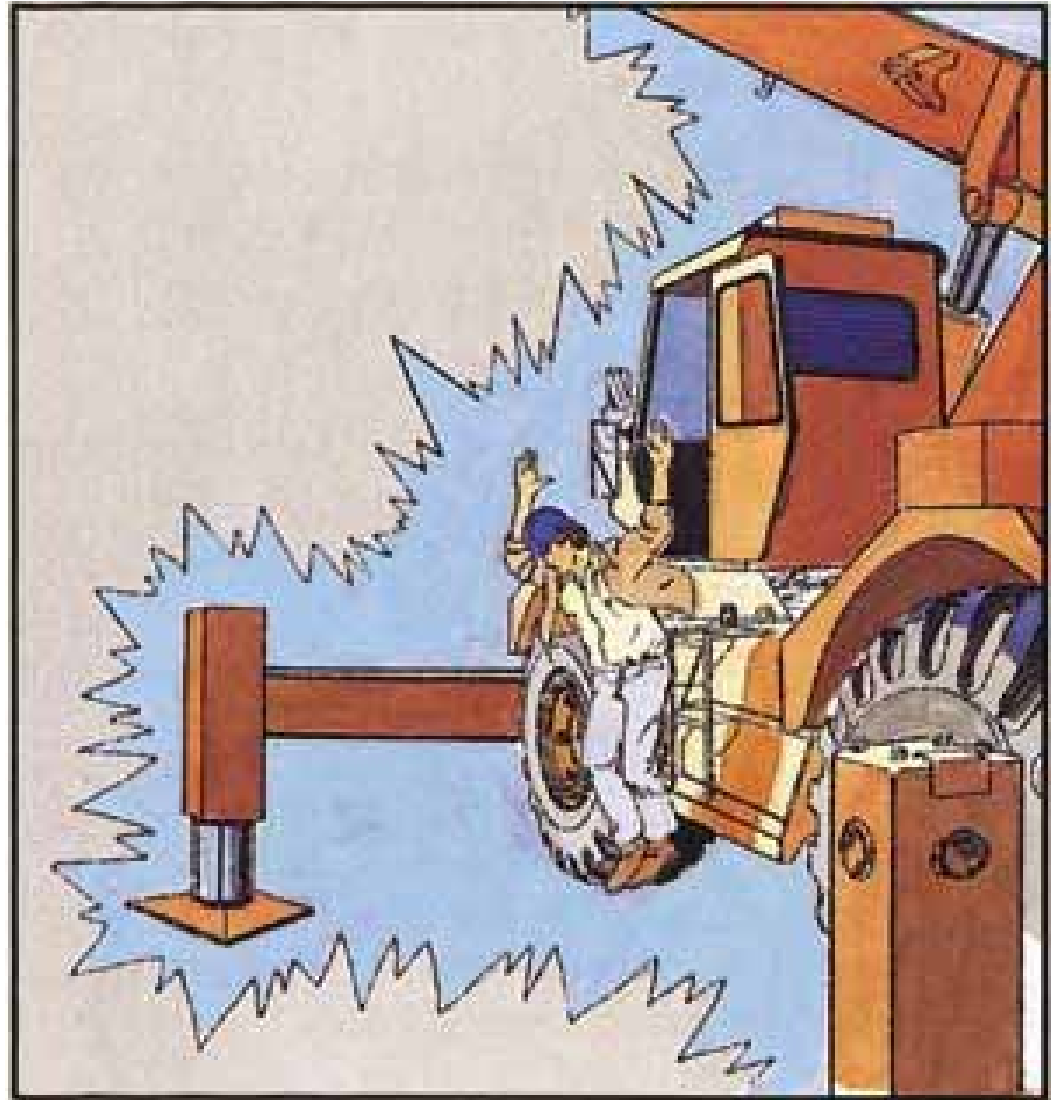
**UNLESS MANHOLE
WORKERS HAVE A
MEDICAL OR
RELIGIOUS
REASON FOR NOT
SHAVING, HAVE
THEM SHAVE OR
FIND ANOTHER
JOB!**

(SCBA WON'T FIT)



**HEADS UP AROUND ELECTRICAL
POWER: USE A “GFI”**

REMEMBER TO “JUMP CLEAR”

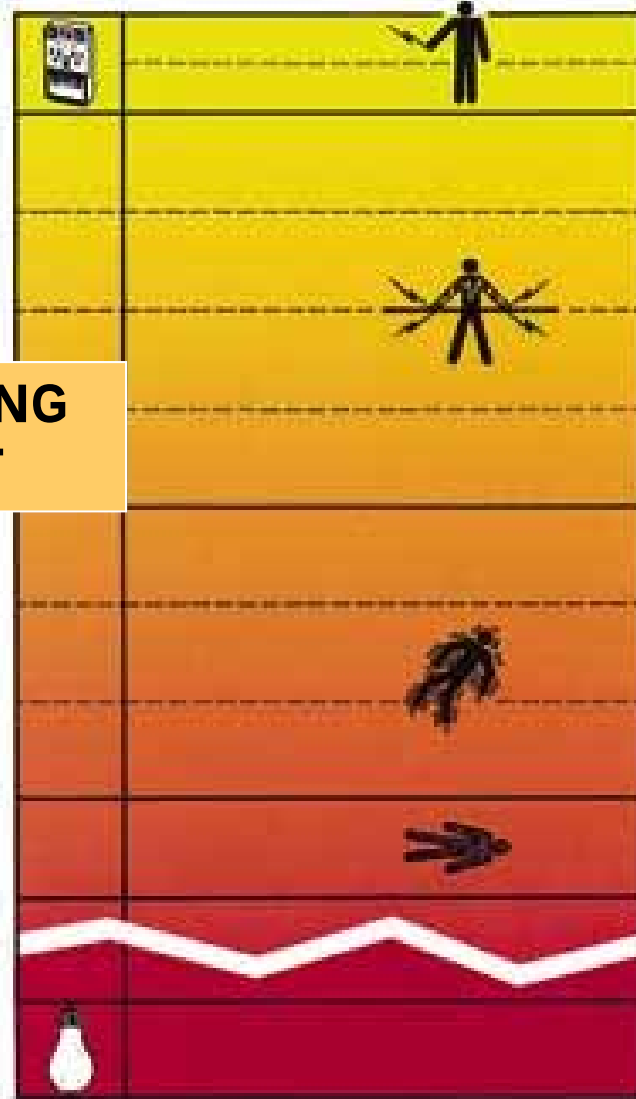


1 MILLIAMP

**INCREASING
CURRENT**

30 MILLIAMPS

1000 MILLIAMPS



ELECTRICITY CAN “KILL”

**CLOTHES WORN IN
THE MANHOLE SHOULD
NOT BE WORN HOME
OR WASHED WITH THE
FAMILY LAUNDRY**

**DO NOT EXPOSE YOUR
FAMILY TO ???**

OEWU - 130

- GENERATION**
- COLLECTION**
- TREATMENT**
- DISPOSAL**

OF WASTEWATER

**THANK YOU FOR YOUR
ATTENTION**

