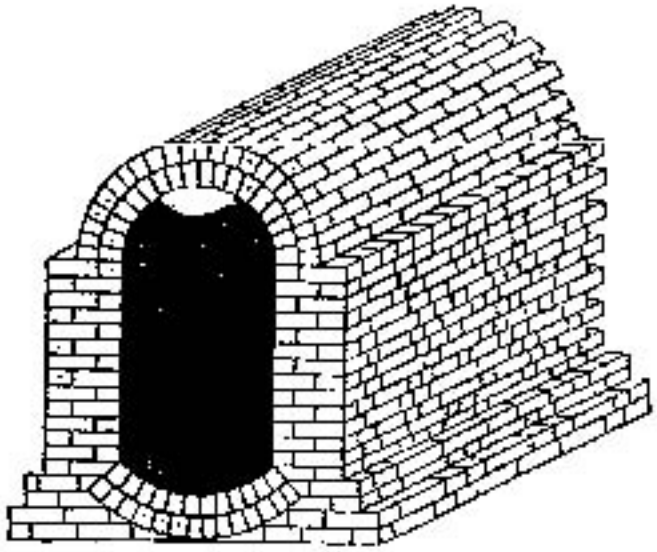
HISTORY OF SEWERS

LONDON'S SEWERS WERE CONSTRUCTED IN 1844

THE WORD *"SEWER"*...

COMES FROM THE OLD ENGLISH WORD MEANING "SEA-WARD"



WASTEWATER COLLECTION SYSTEMS

PURPOSE:

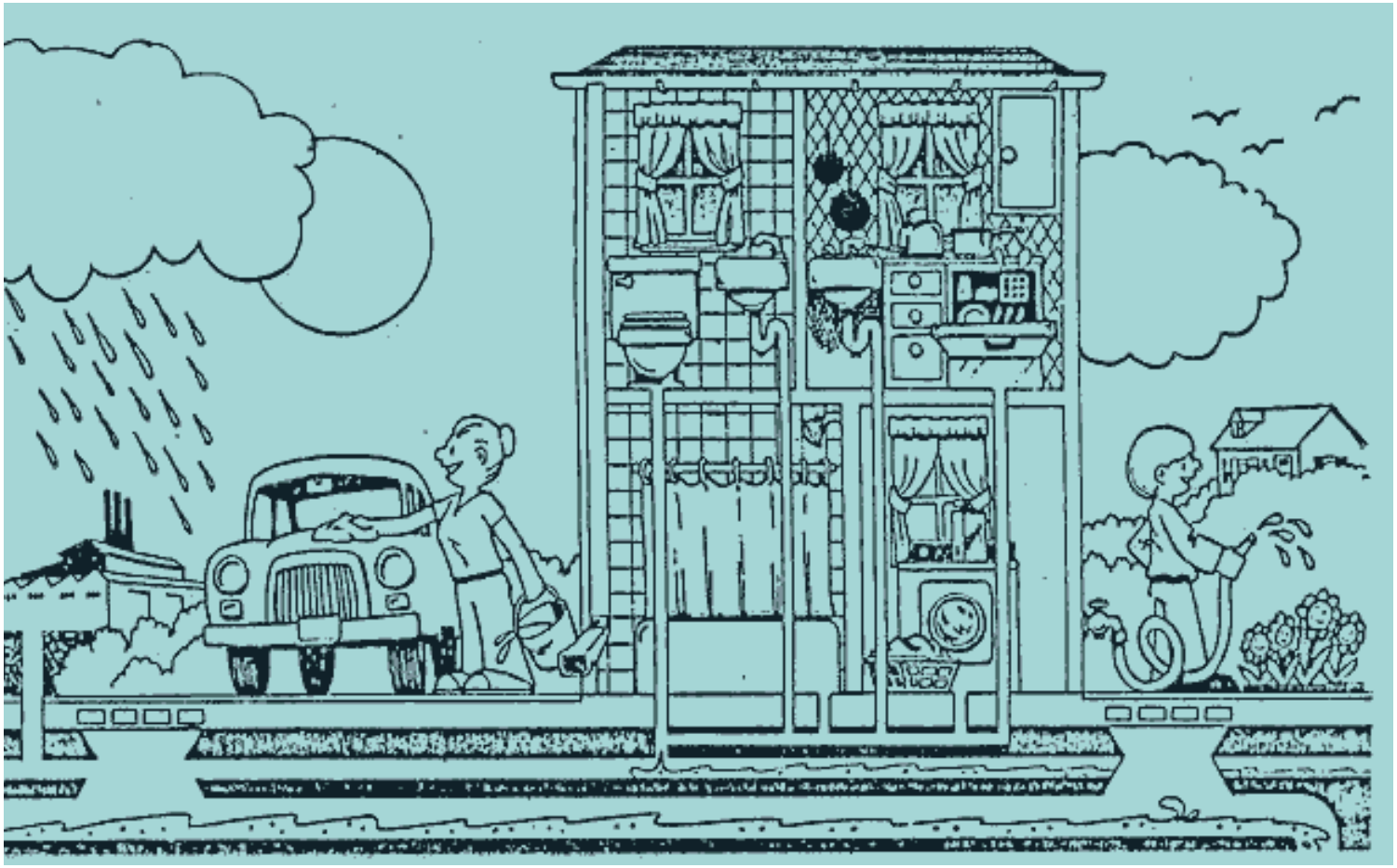
COLLECT and CONVEY WASTEWATER FROM A COMMUNITY TO A TREATMENT PLANT

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 <u>BOTH</u> <u>SANITARY</u> AND <u>STORM</u> <u>WATER</u> FLOWS

HOW ARE SEWERS DESIGNED?

- DESIGN LIFE: 10 to 30 YEARS

- DESIGN FLOWS:

  RESIDENTIAL: 70 to 100 gallons per person/day

  COMMERCIAL: (flow estimates vary)

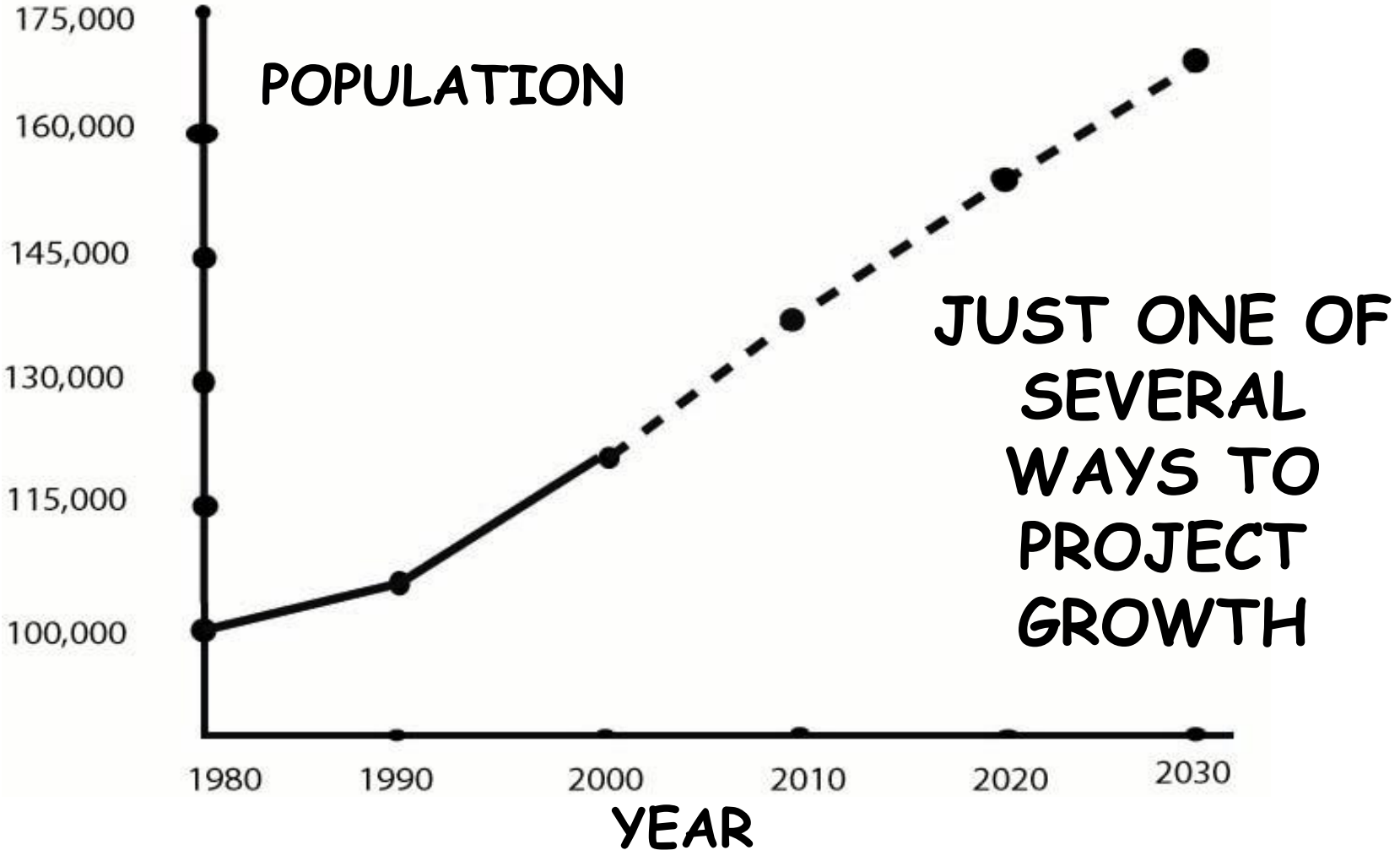
COMMERCIAL FLOW ESTIMATES:

HOSPITALS:
180-250 GPD/BED

BUILDINGS:
100 GPD/1000 ft^2

SCHOOLS: 20 GPD/STUDENT

ESTIMATING POPULATION GROWTH



DESIGN FLOWS

- **IN GENERAL, SEWERS ARE DESIGNED TO FLOW BY GRAVITY**

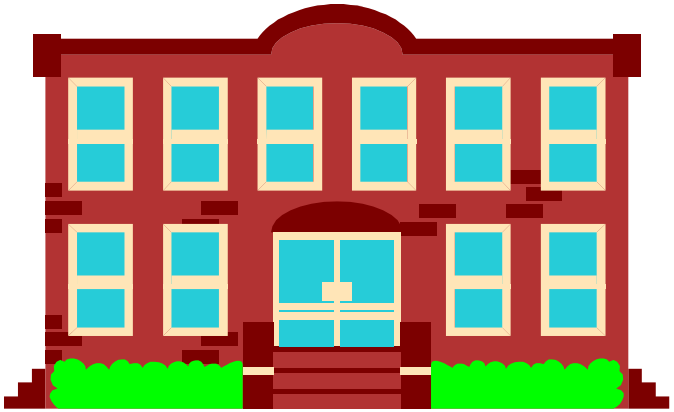
- **MINIMUM DESIGN FLOW IS 2 feet per second (fps) to prevent settling and septic conditions**

- **MAXIMUM FLOW = 10 fps to prevent solids separation and pipe erosion**

"GRAVITY" SEWER COMPONENTS

A. BUILDING SEWER

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



PROPERTY LINE

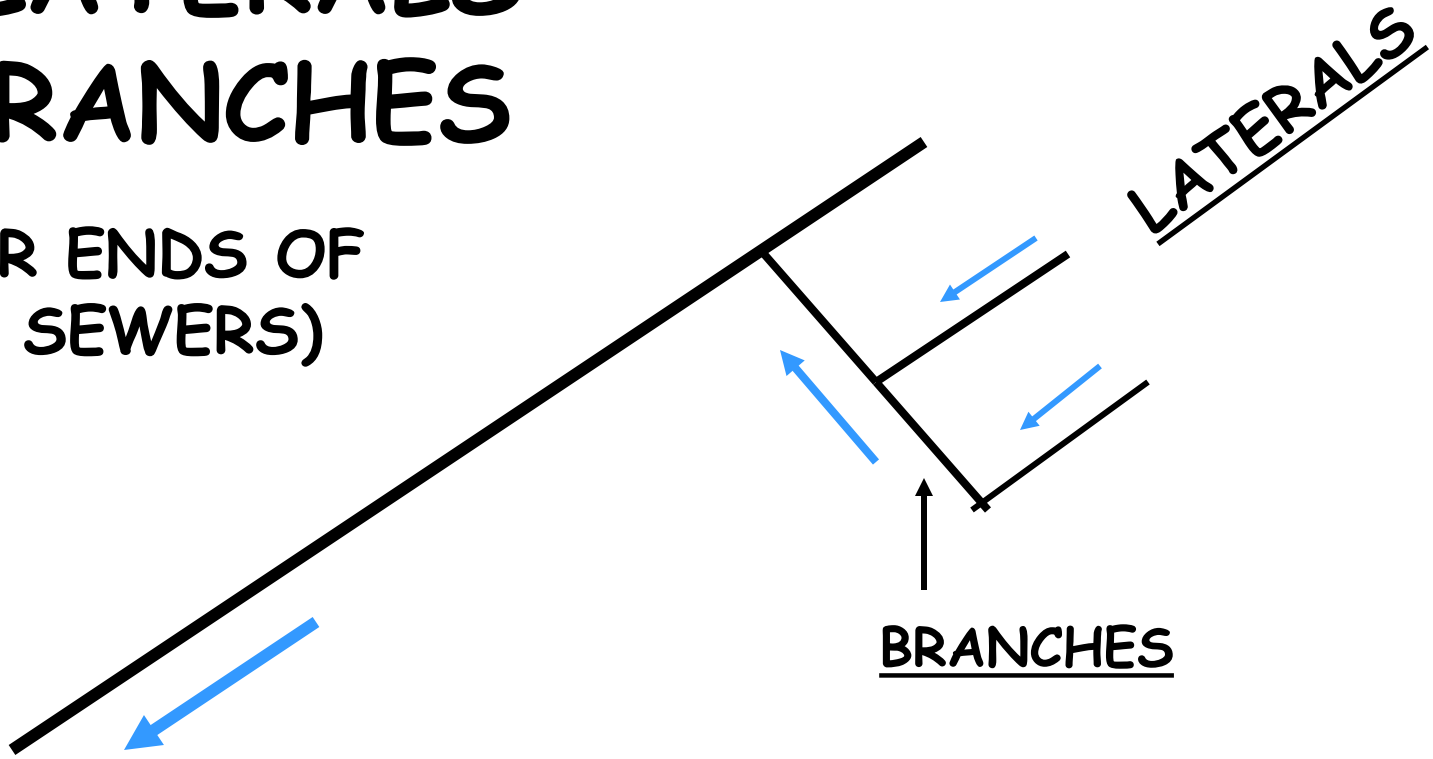
UTILITY'S RESPONSIBILITY

SANITARY SEWER

SEWER COMPONENTS

B. LATERALS & BRANCHES

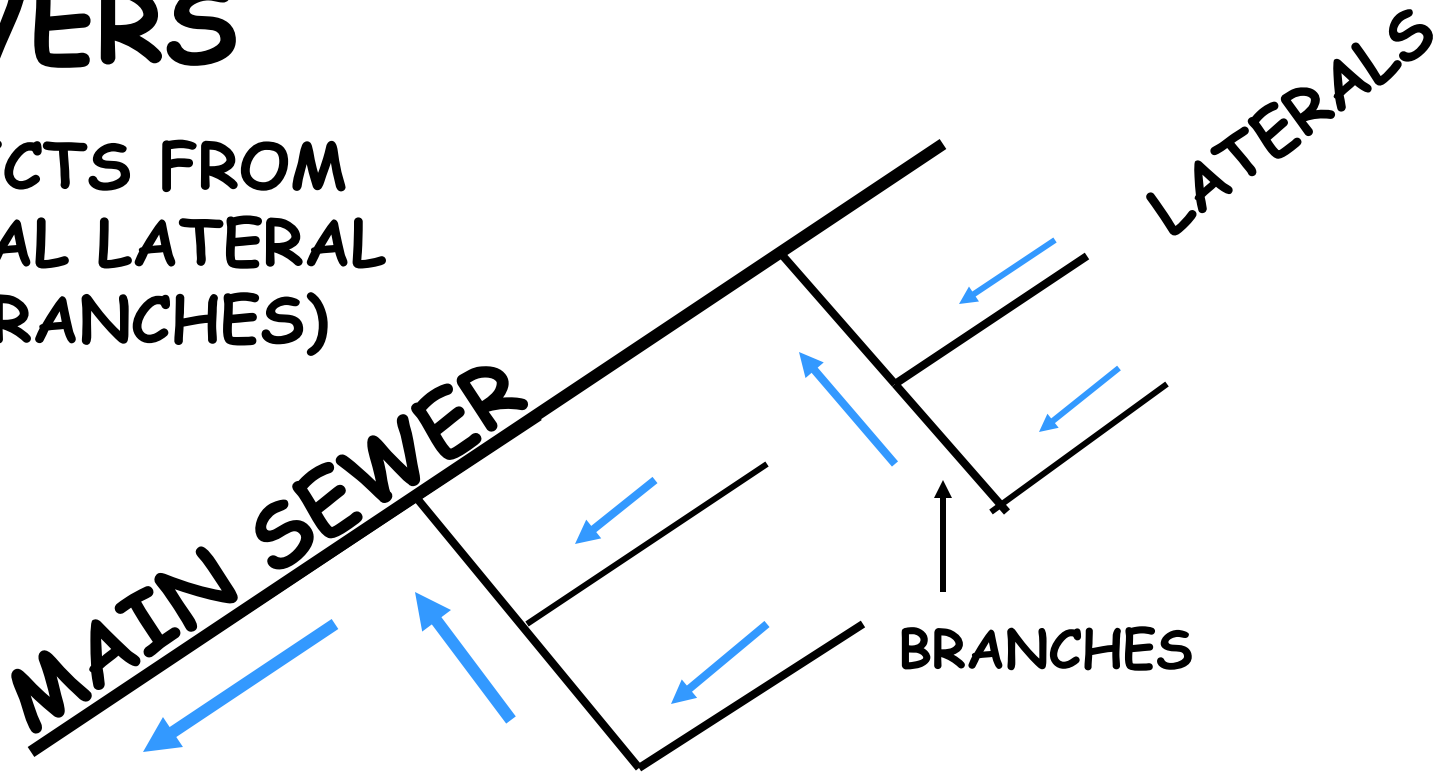
(UPPER ENDS OF THE SEWERS)



SEWER COMPONENTS

C. MAIN SEWERS

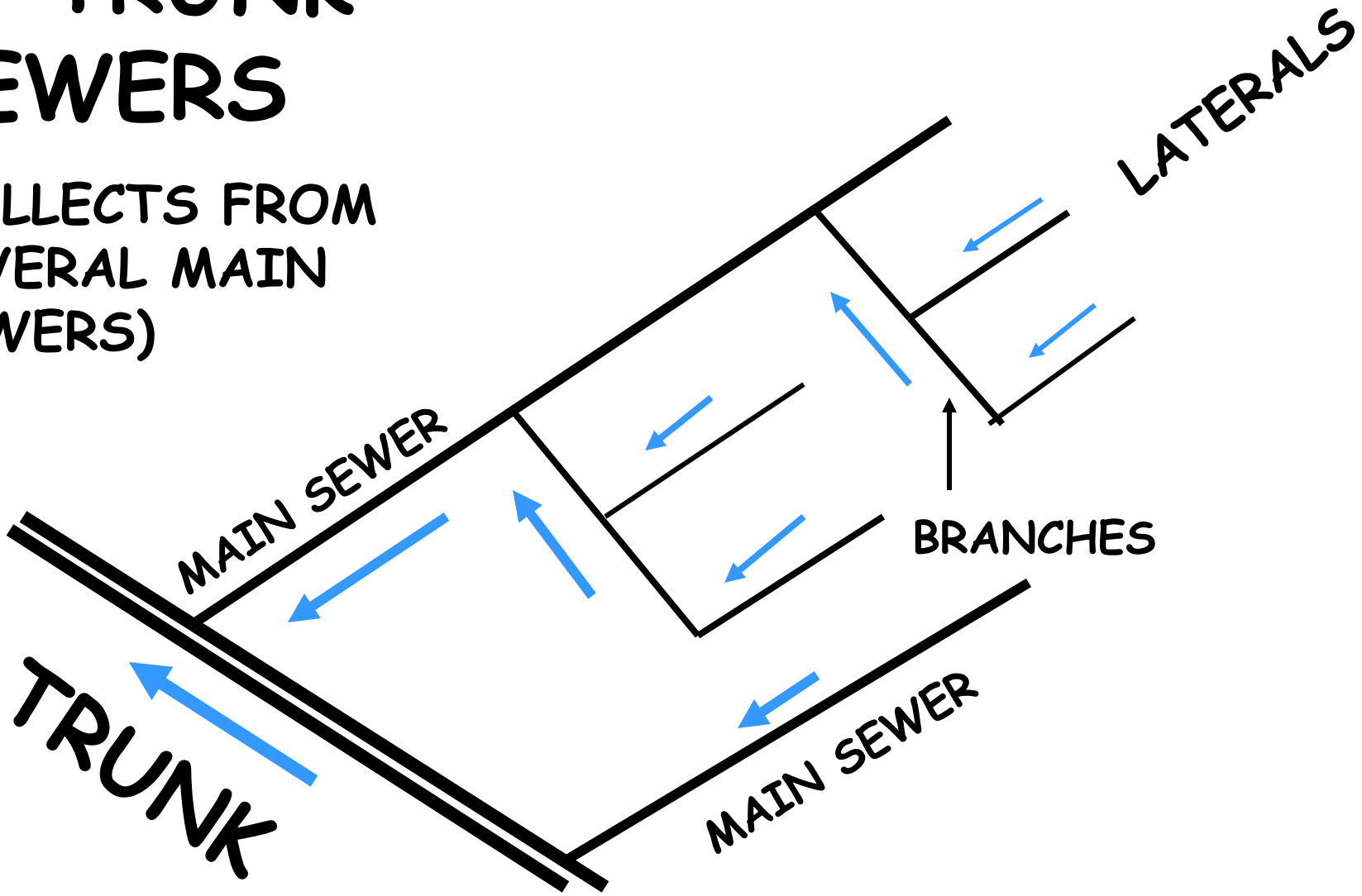
(COLLECTS FROM SEVERAL LATERAL AND BRANCHES)



SEWER COMPONENTS

D. TRUNK SEWERS

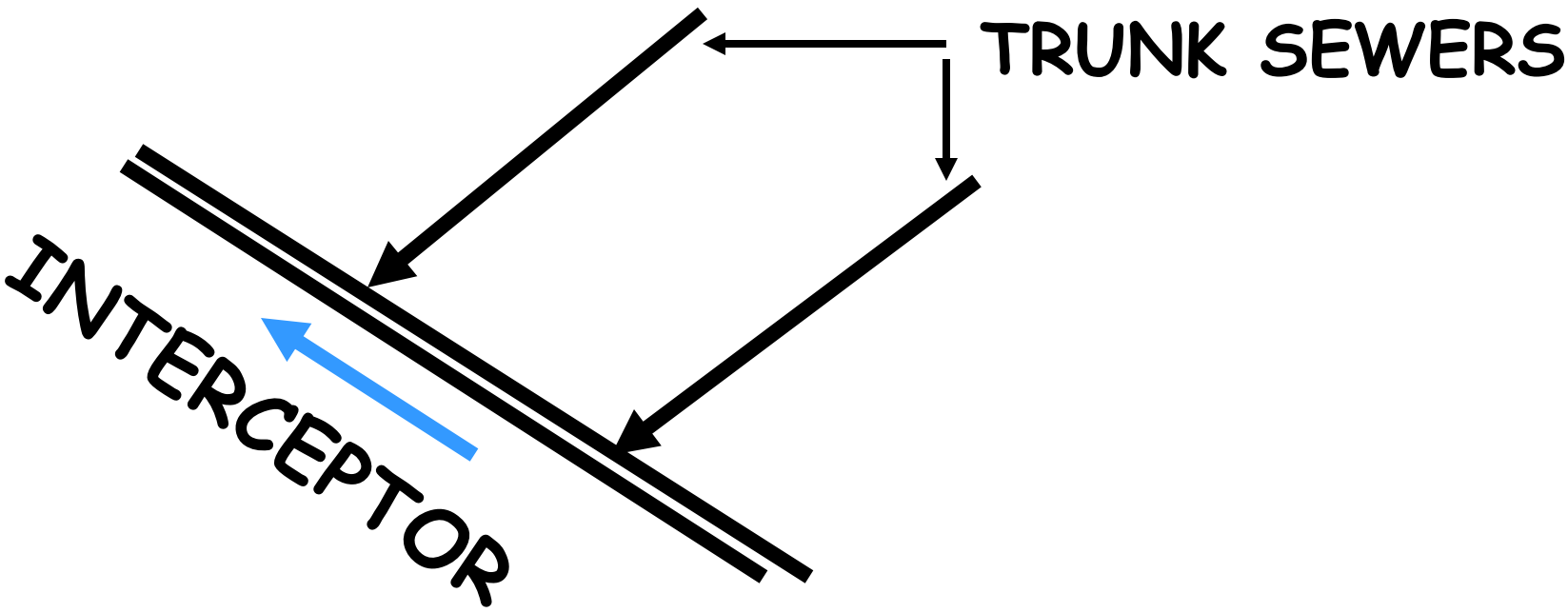
(COLLECTS FROM SEVERAL MAIN SEWERS)



SEWER COMPONENTS

E. INTERCEPTOR SEWERS

(COLLECTS FROM SEVERAL TRUNK SEWERS)



WHEN GRAVITY SEWERS WON'T WORK!

(DUE TO SLOPE, INFILTRATION, PIPE SIZE)

- LOW PRESSURE SYSTEMS

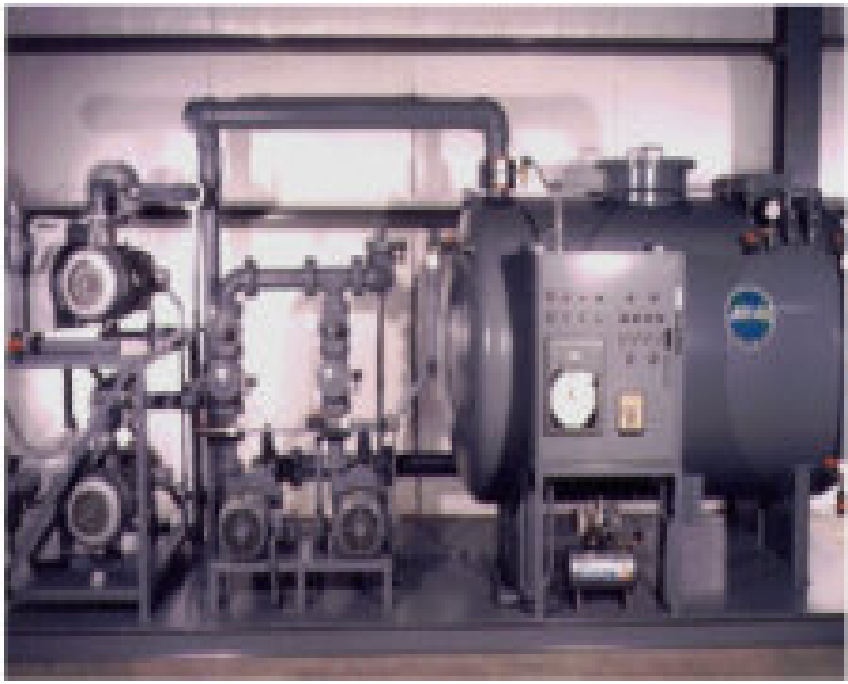
REQUIRES A GRINDER PUMP, HOLDING TANK, CHECK VALVE, PRESSURE MAINS

WHEN GRAVITY SEWERS WON'T WORK!

(DUE TO SLOPE, INFILTRATION, PIPE SIZE)

- VACUUM SYSTEMS

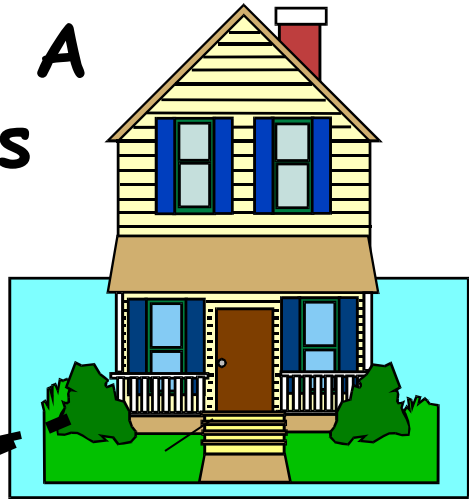
REQUIRES A HOLDING TANK, VACUUM VALVE AND A CENTRAL VACUUM PUMP

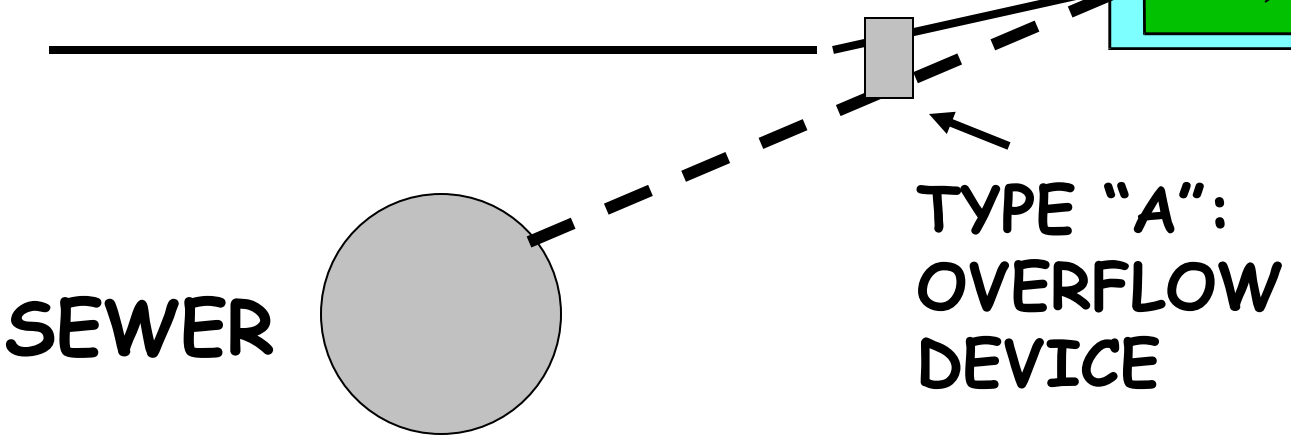


PREVENTING BACKFLOW CONTAMINATION

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

below floor level

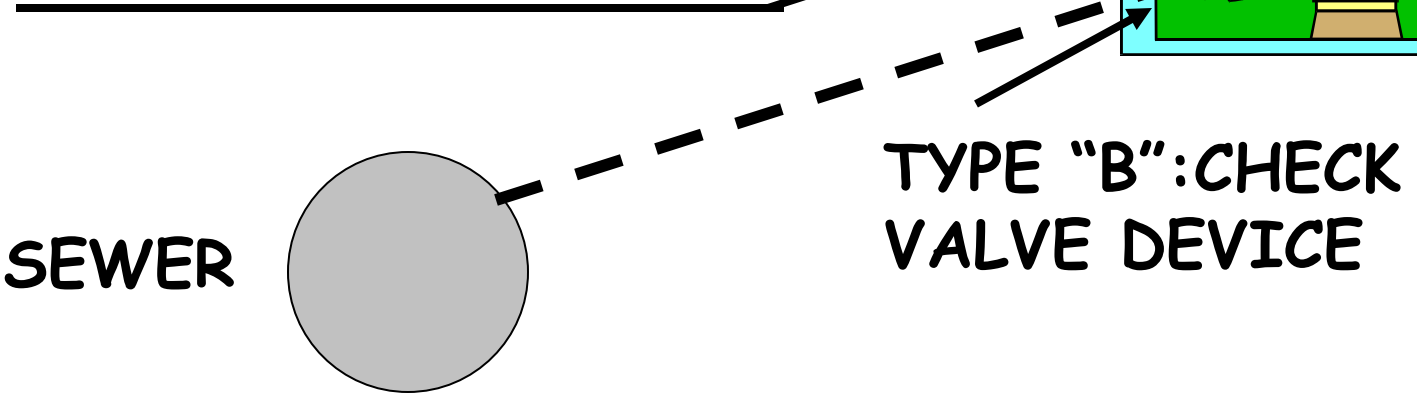




PREVENTING BACKFLOW CONTAMINATION

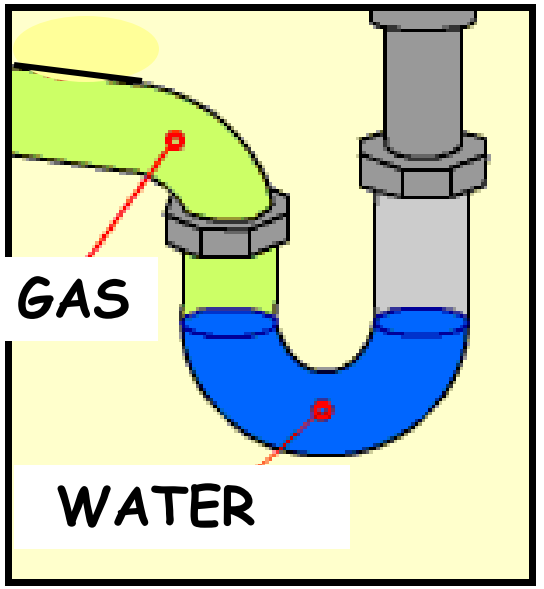
TO PREVENT BACK-FLOW OR REVERSE FLOW OF WASTEWATER INTO A BUILDING (when ground

Level is <u>above</u> floor level



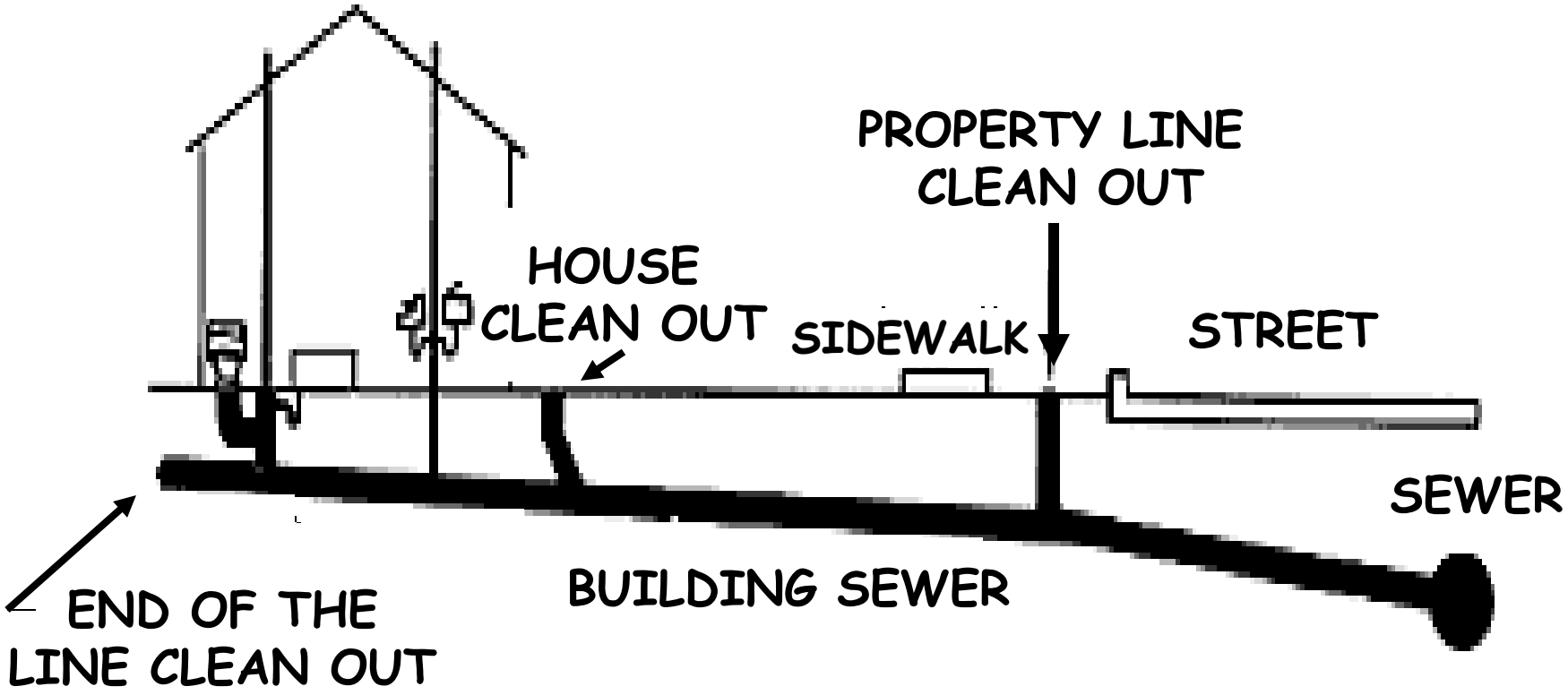
BUILDING SEWER VENT TRAPS

USED TO PREVENT SEWER GASSES FROM ENTERING THE BUILDING.



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

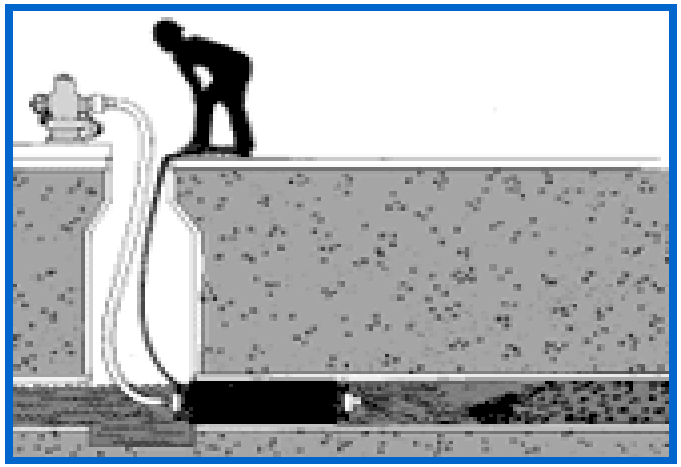
BUILDING SEWER CLEAN OUTS

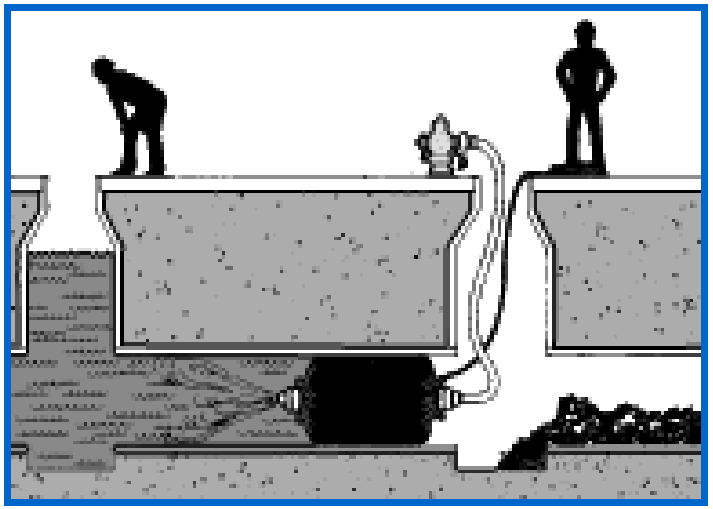


LOCATED ABOUT <u>3 ft</u> FROM THE BUILDING

LATERAL and BRANCH CLEANOUTS and FLUSHER BRANCHES

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

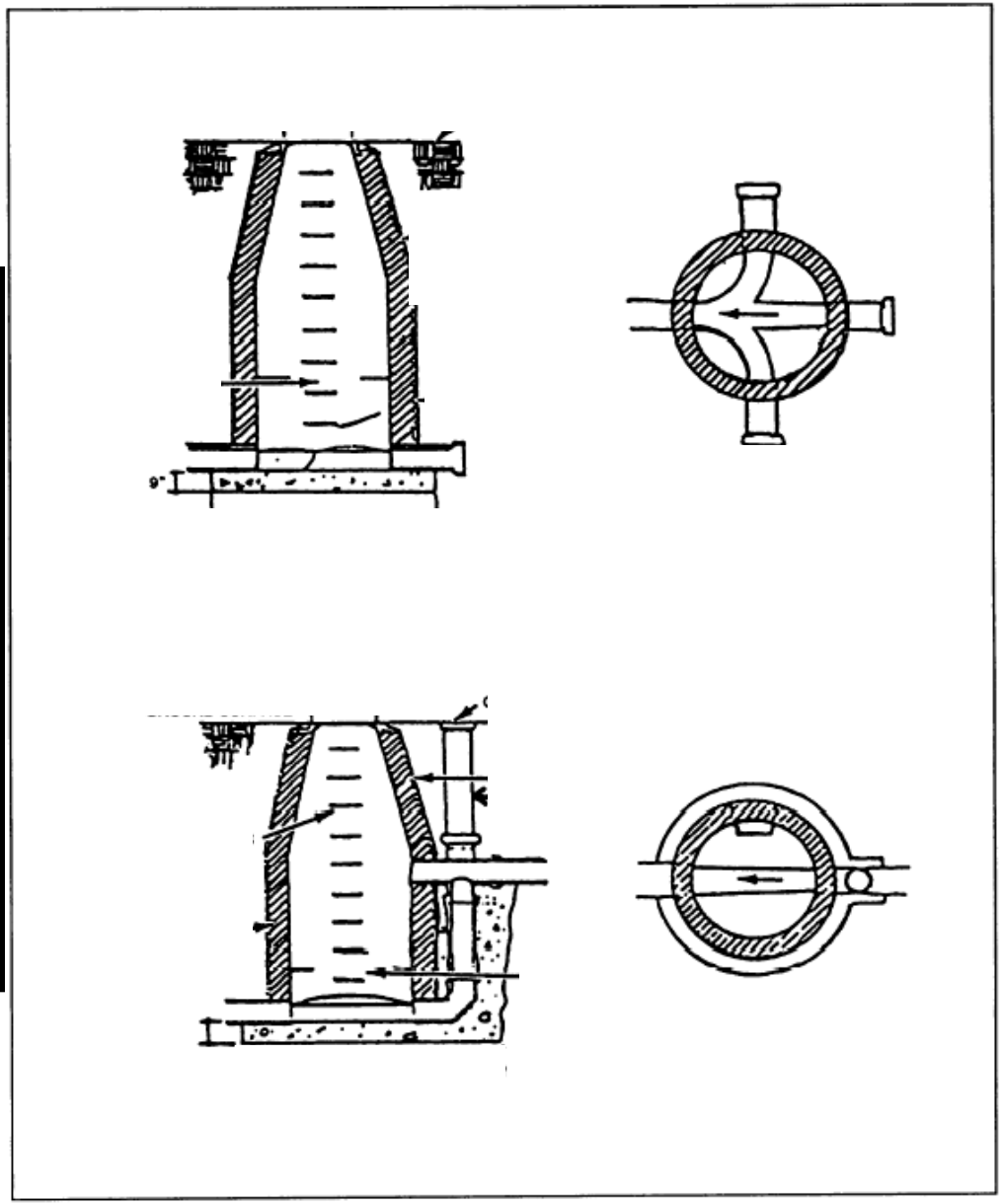


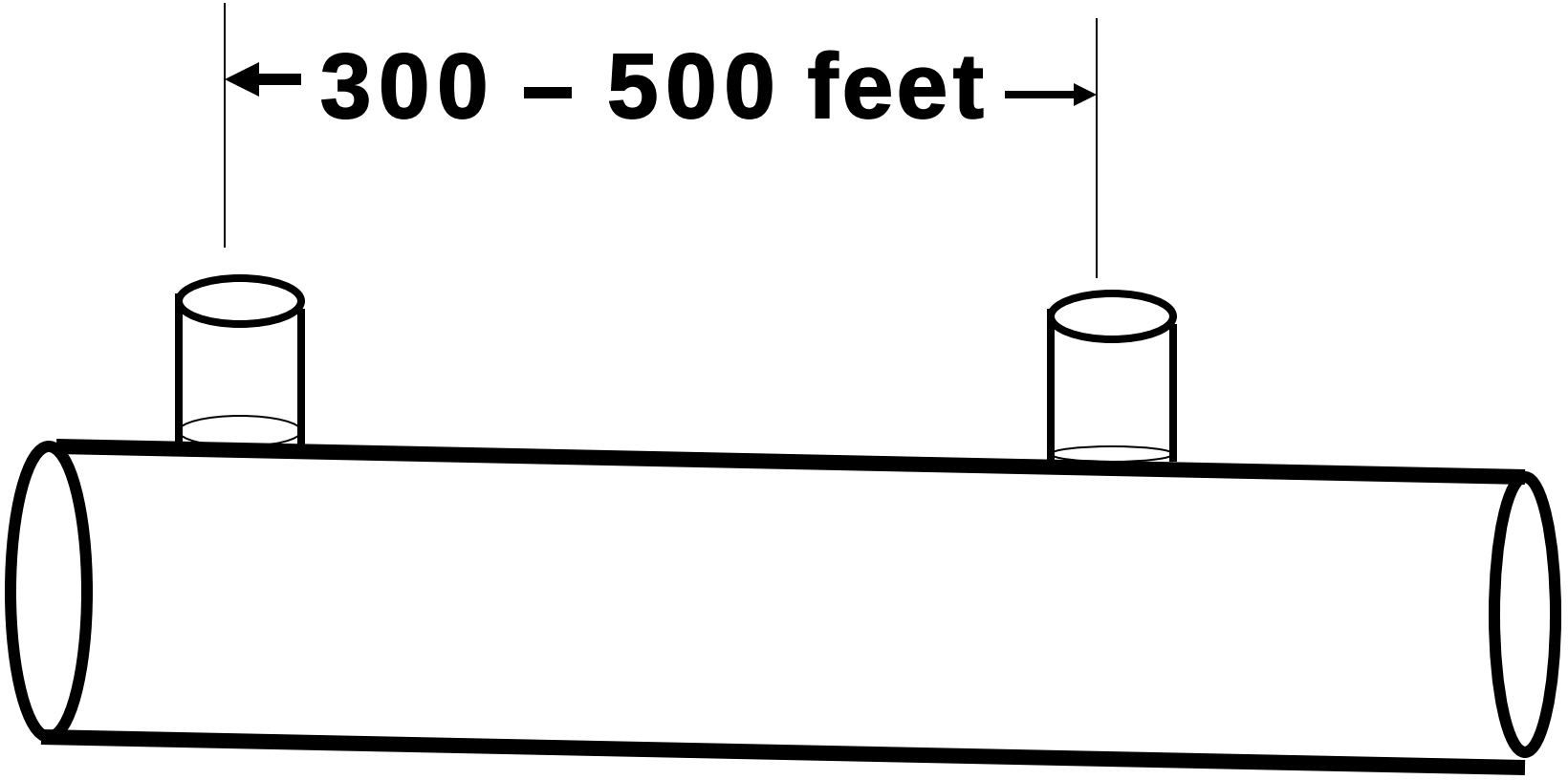


MANHOLES

LOCATIONS:

ON LATERALS, MAIN, TRUNK & INTERCEPTOR SEWERS





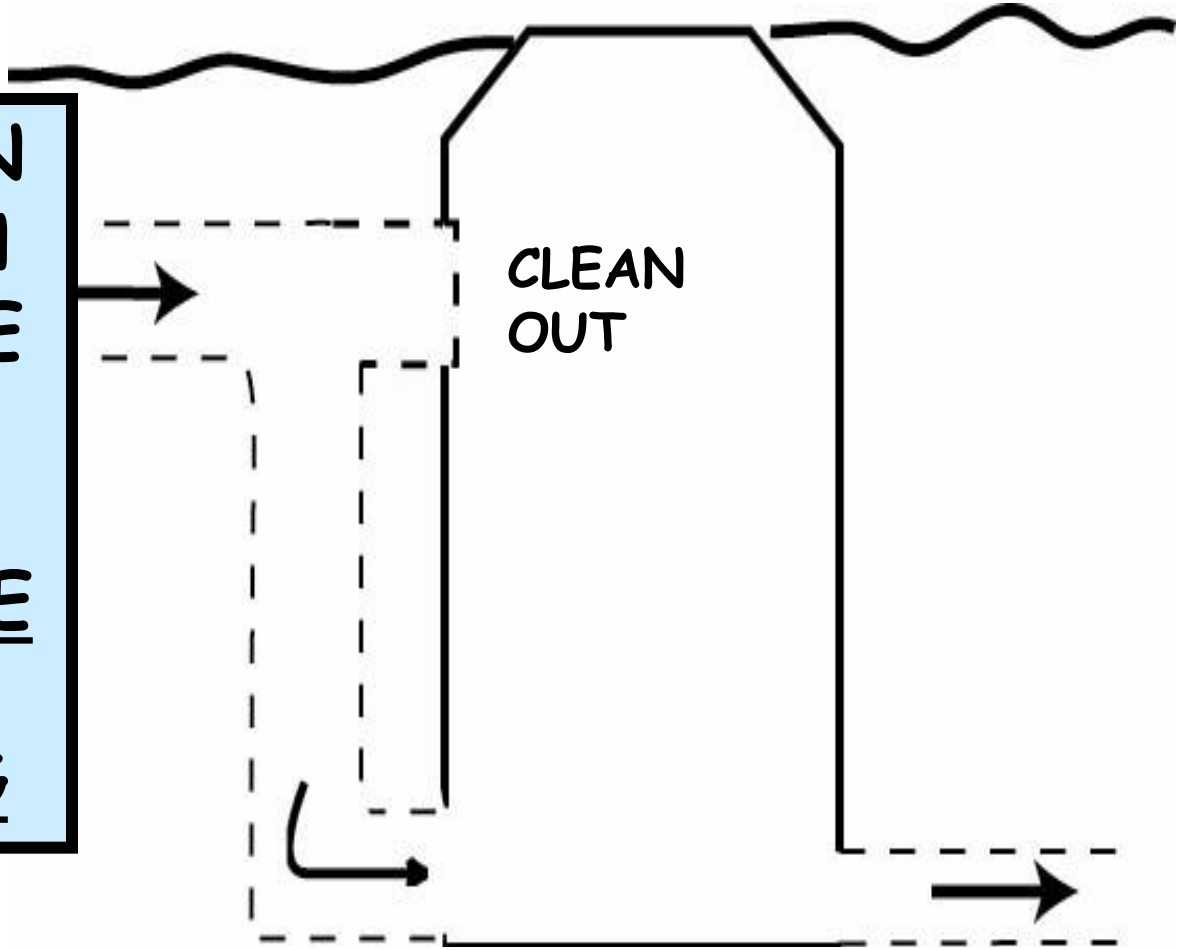
MANHOLE PLACEMENT ON SEWERS

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 AND MATERIALS INTO SEWERS FOR MAINTENANCE, INSPECTING, and CLEANING

MANHOLE CONSTRUCTION

PRECAST CONCRETE

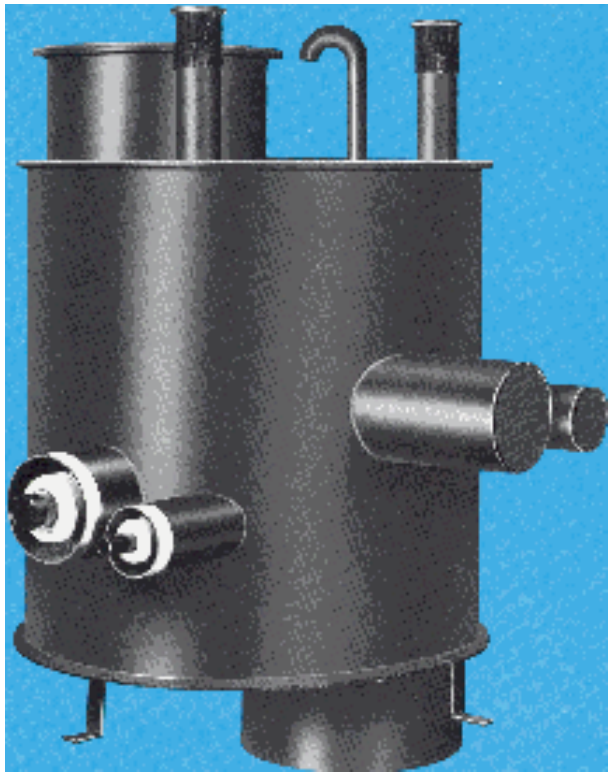
MANHOLE CONSTRUCTION

- 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

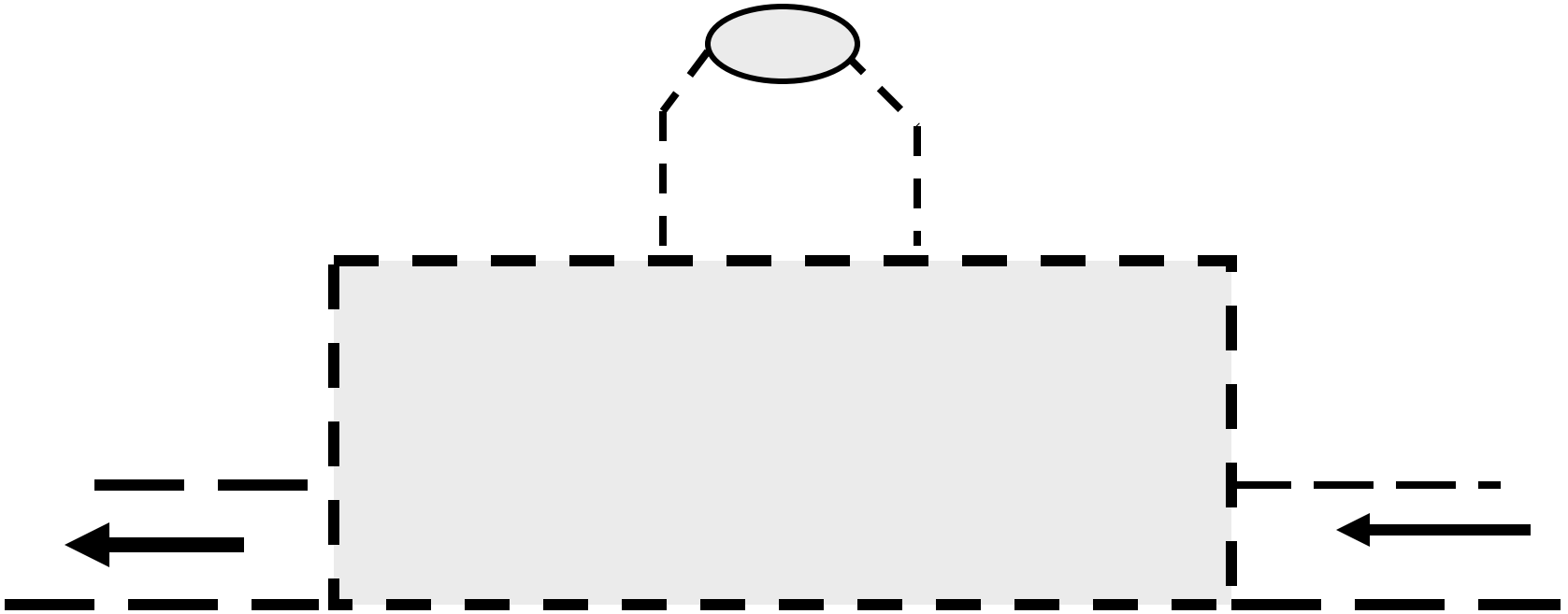
MANHOLE CONSTRUCTION



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)

SIZES OF SEWERS

- LARGE ENOUGH TO USE CLEANING EQUIPMENT

- DESIGNED TO FLOW ½ 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

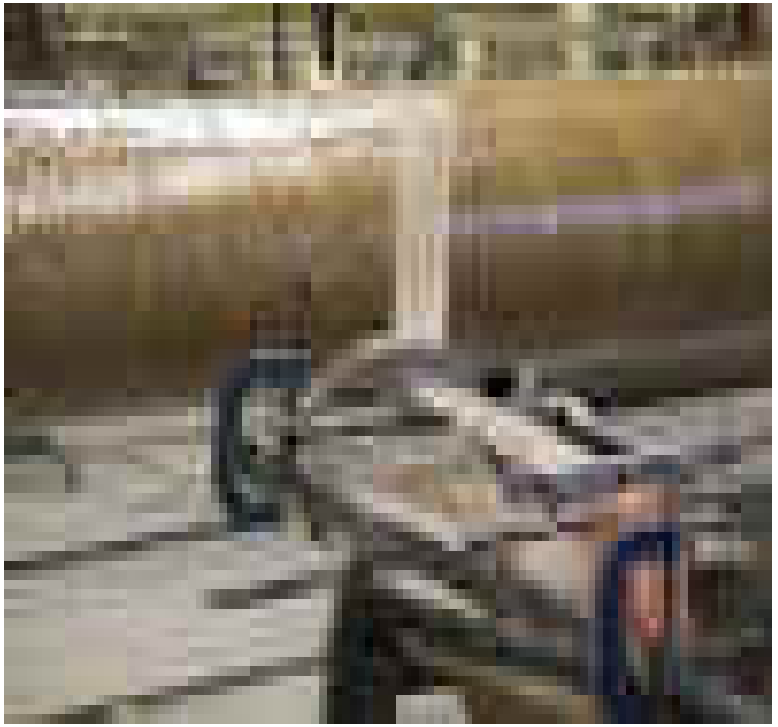
6. REINFORCED CONCRETE (RCP)

RIGID;
CORRODED BY ACIDS; LEAKS IF INSTALLED IMPROPERLY

TYPES OF PIPE MATERIAL

7. FIBERGLASS REINFORCED (FRP)

FLEXIBLE;
RESISTANT TO MOST CHEMICALS/ACIDS;
DAMAGED BY H_2S;
LOW CRUSHING STRENGTH



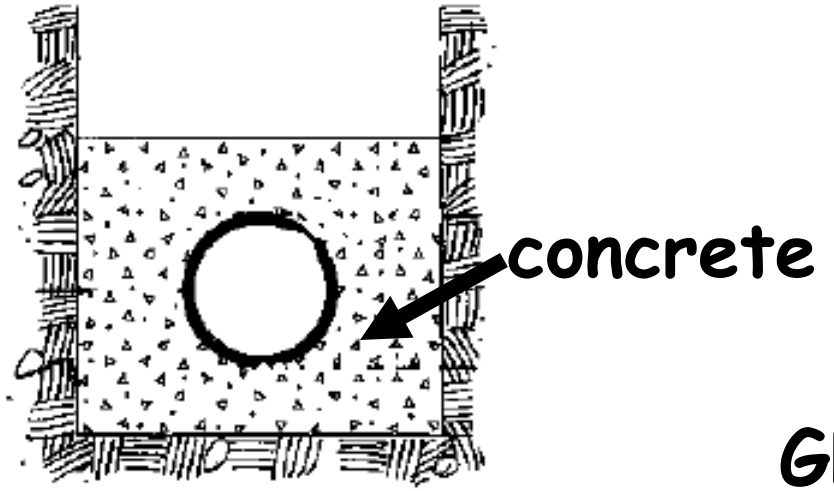
TYPES OF PIPE MATERIAL

8. VITRIFIED CLAY PIPE (VCP)

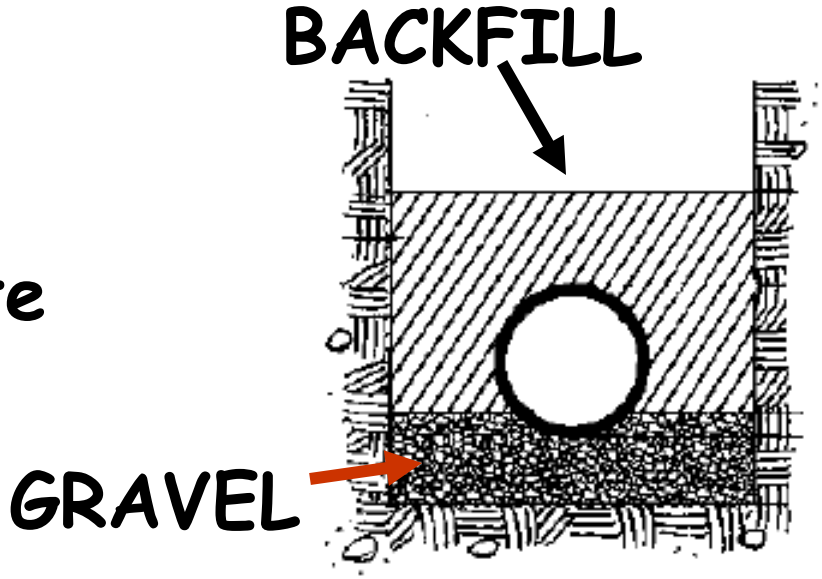
RIGID;
RESISTANT TO DETERIORATION;
COMPRESSION JOINTS HAVE REPLACED OLD MORTAR JOINTS;
EASILY BROKEN
(BE CAREFUL)

TRENCHING, BEDDING & BACKFILLING

"BEDDING": THE PIPE'S FOUNDATION

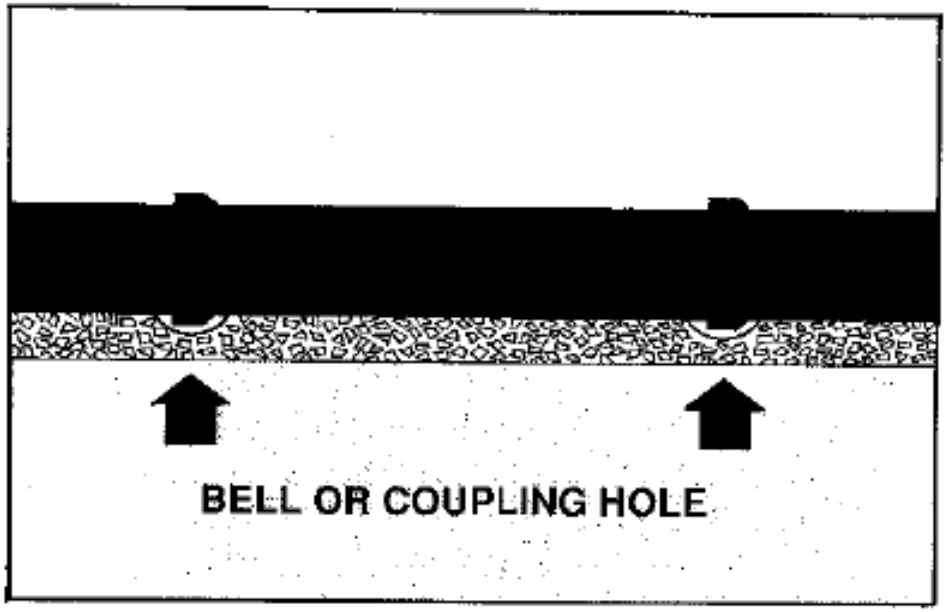


CLASS A



CLASS C

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

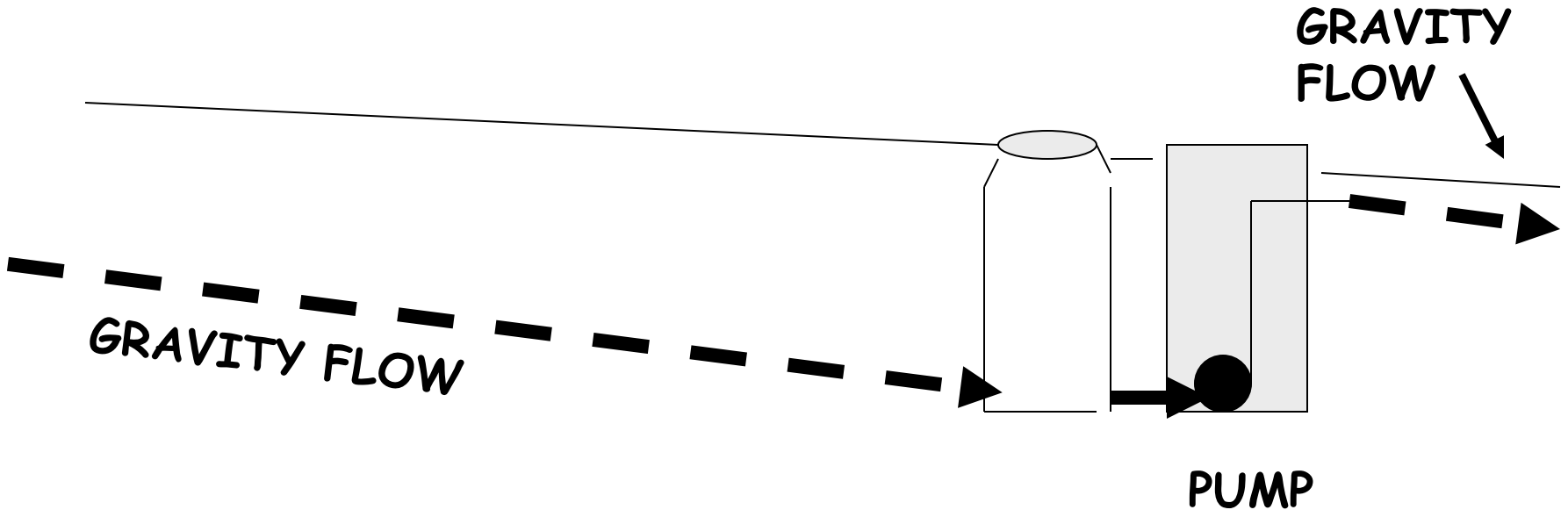
TRENCHING, BEDDING & BACKFILLING

DEWATERING:

NEED TO CONTROL <u>SURFACE WATER</u> RUNOFF; <u>GROUNDWATER</u> INTRUSION

LIFT STATIONS

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



LIFT STATIONS

TYPES:

- WET WELL

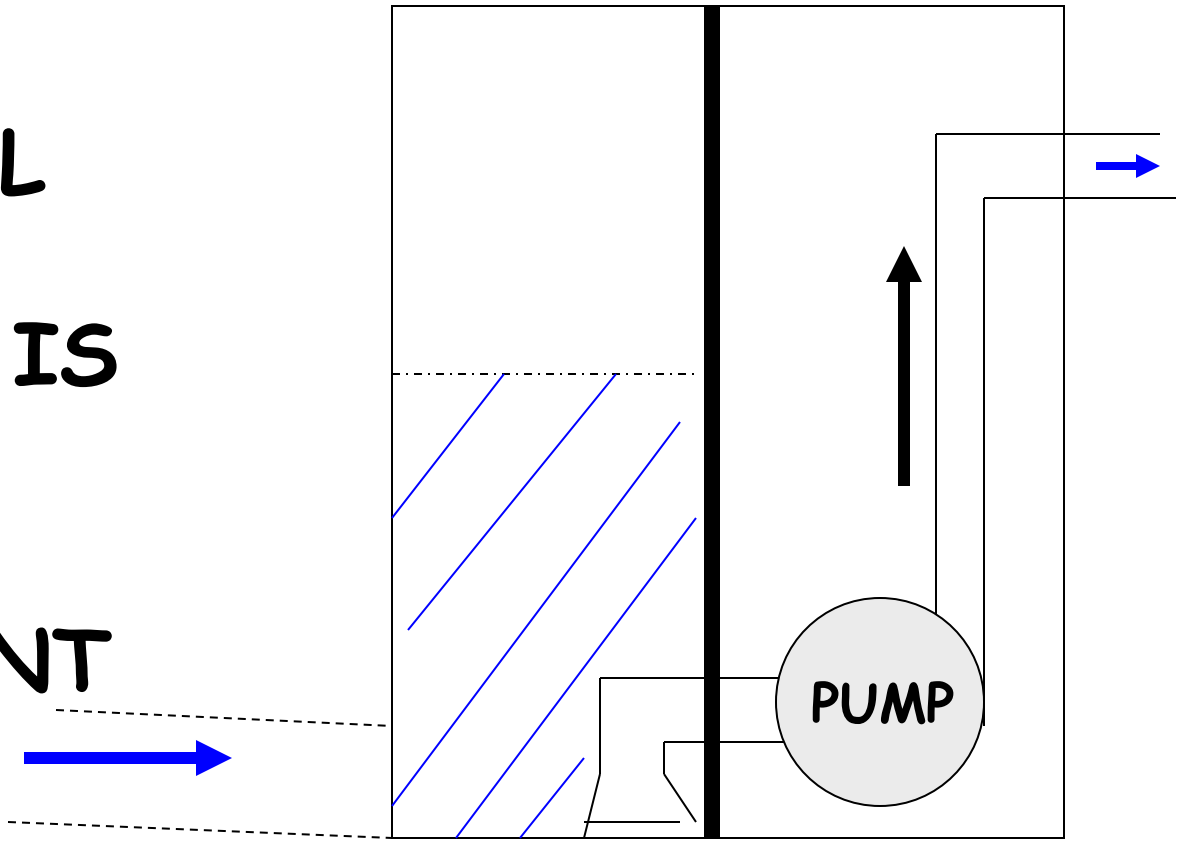
PUMPS ARE SELF PRIMING; 3-5 min BETWEEN STARTS

LIFT STATIONS

TYPES:

- DRY WELL

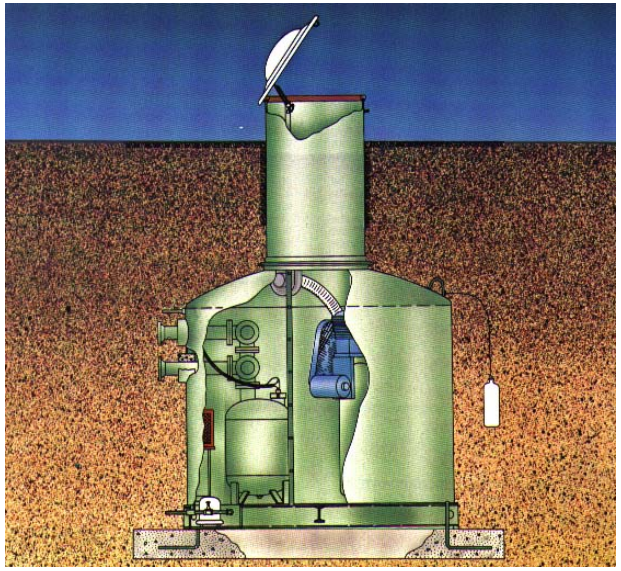
EQUIPMENT IS LOCATED IN THE "DRY" COMPARTMENT



LIFT STATIONS

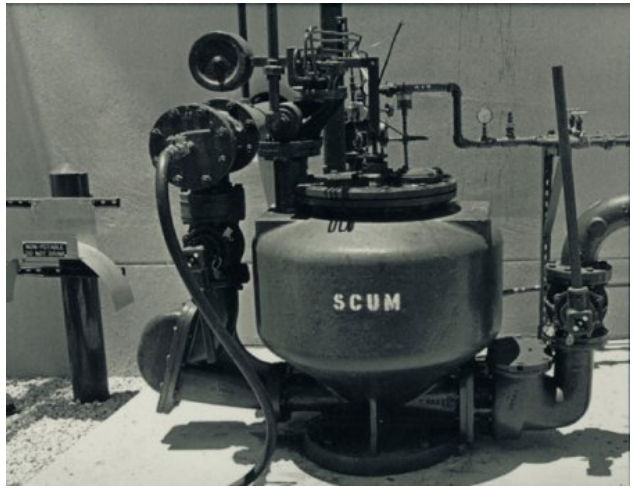
TYPES:

- 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

WETWELL ACCESS

BE CAREFUL WITH "BUILT-IN" LADDERS

RUNGS MAY BE CORRODED

WHAT IS THE LD50 FOR LADDERS?

ANS: <u>11 feet</u>

WET WELL ACCESS

MOST IMPORTANT: SAFETY

THESE ARE "CONFINED SPACES":

- OXYGEN DEFICIENCY
- SLIPPERY SURFACES
- POISONOUS GASSES??

TAKE A BUDDY WITH YOU!

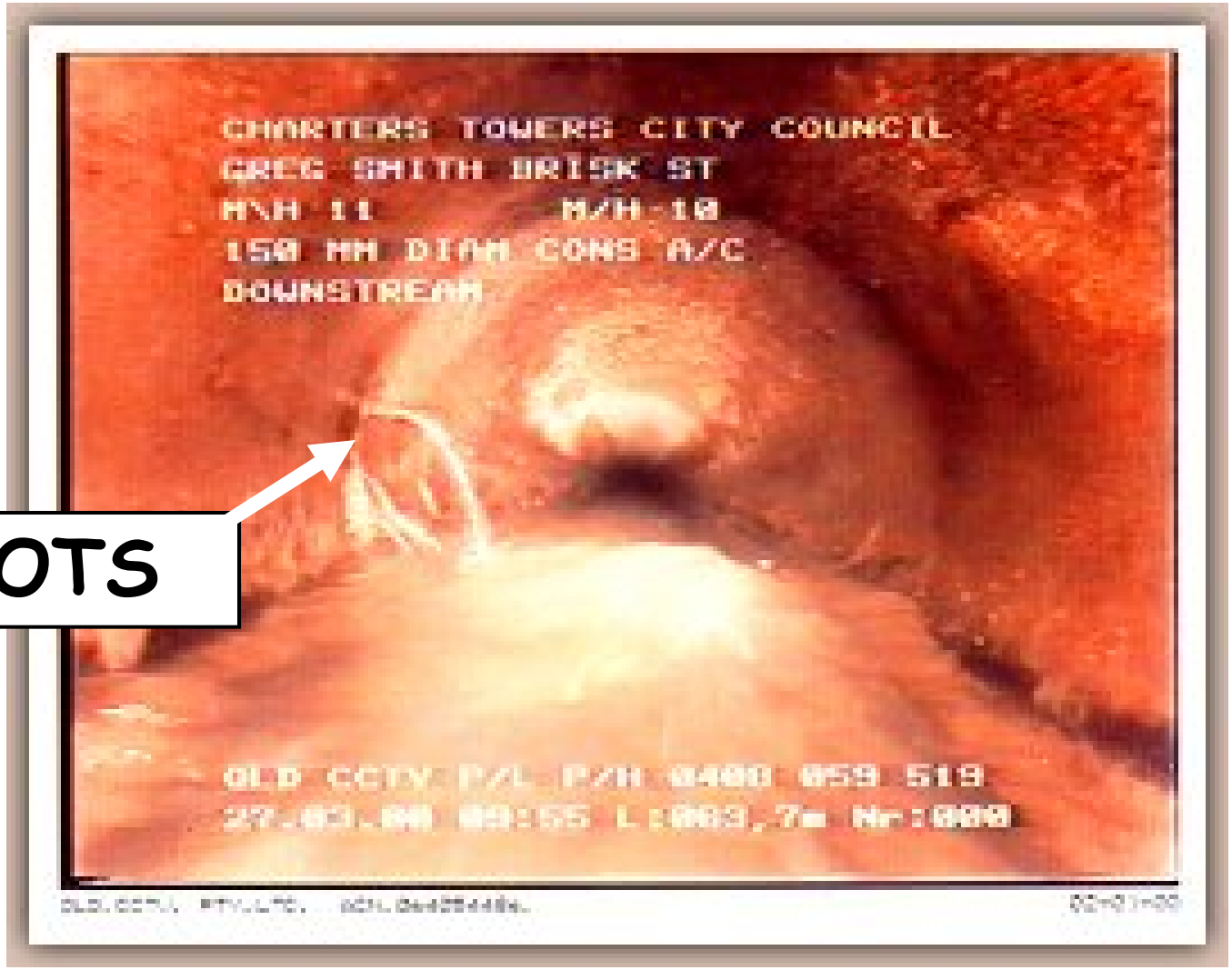
SEWER INSPECTIONS

CLOSED CIRCUIT TV EQUIPMENT

SEWER INSPECTION

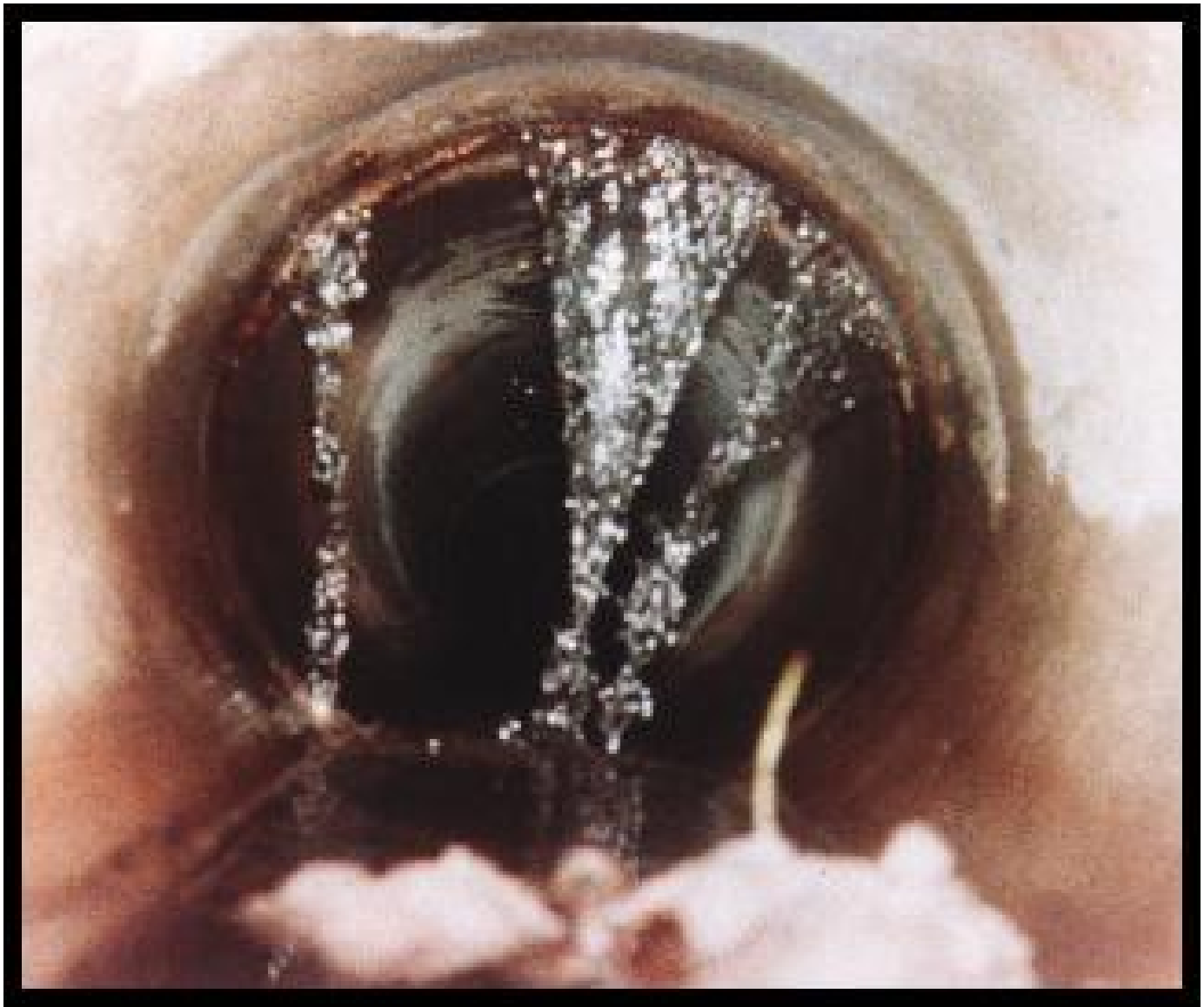
TV CAMERA

NOTE ROOTS



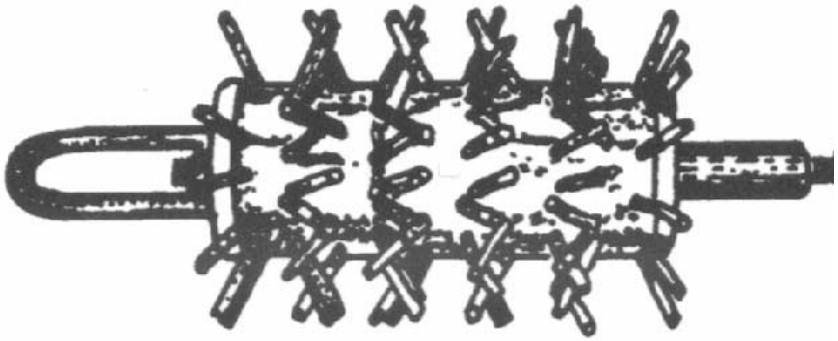
TV CAMERA SHOWING COLLAPSED PIPE

TV CAMERA SHOWING INFILTRATION



SEWER CLEANING

SEWER RODS

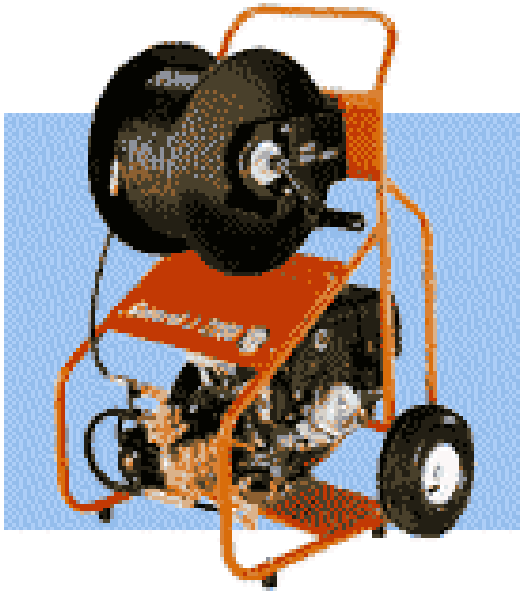


PORCUPINE

(USED FOR SCOURING SEWERS)

SEWER CLEANING

HYDRAULIC (JET) CLEANERS



SEWER CLEANING

BUCKET CLEANERS

(USE AT LOW FLOWS or UPSTREAM DIVERSION)

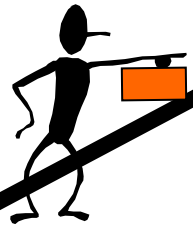
WORKING SAFELY IN TRAFFIC

PUBLIC UTILITY WORKERS DO NOT ADEQUATELY PROTECT THEMSELVES FROM TRAFFIC HAZZARDS

WORKING SAFELY IN TRAFFIC

FLAGMAN AHEAD

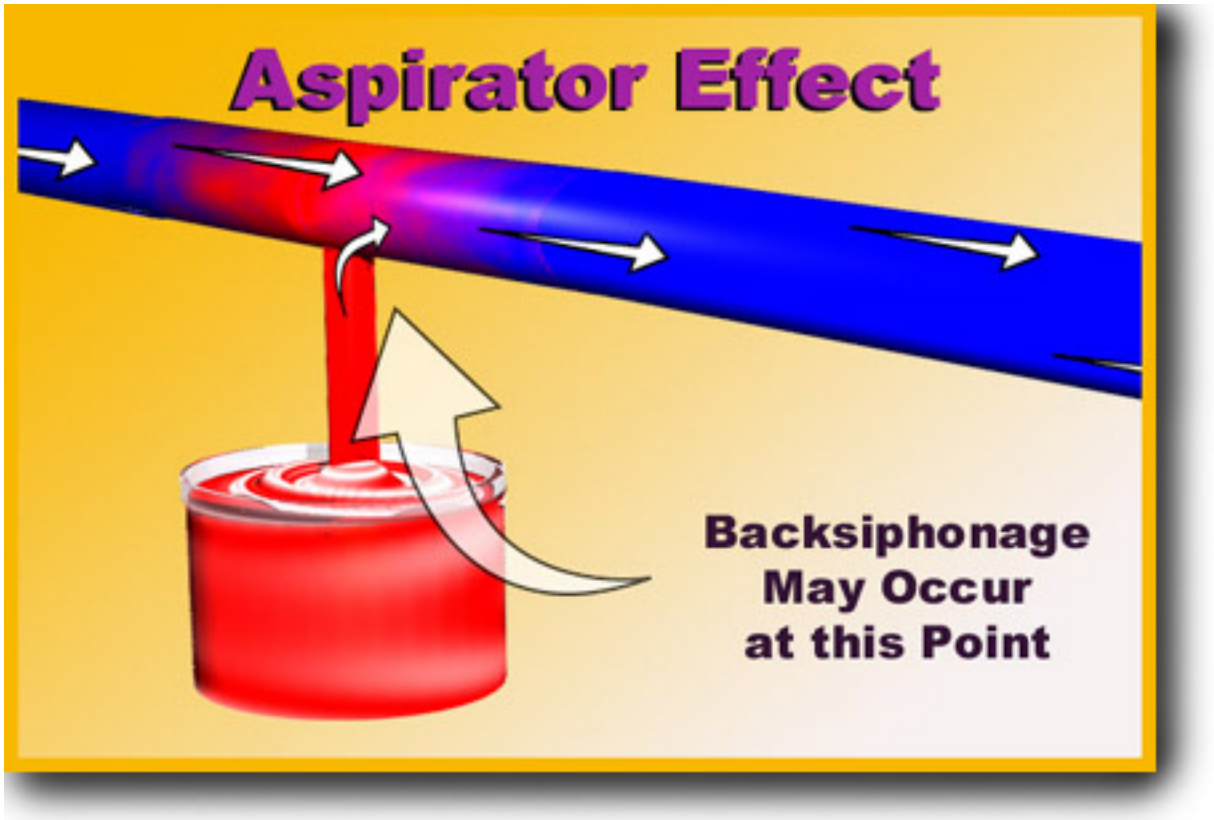
500 FT



WEAR YOUR REFLECTIVE CLOTHING, ETC.

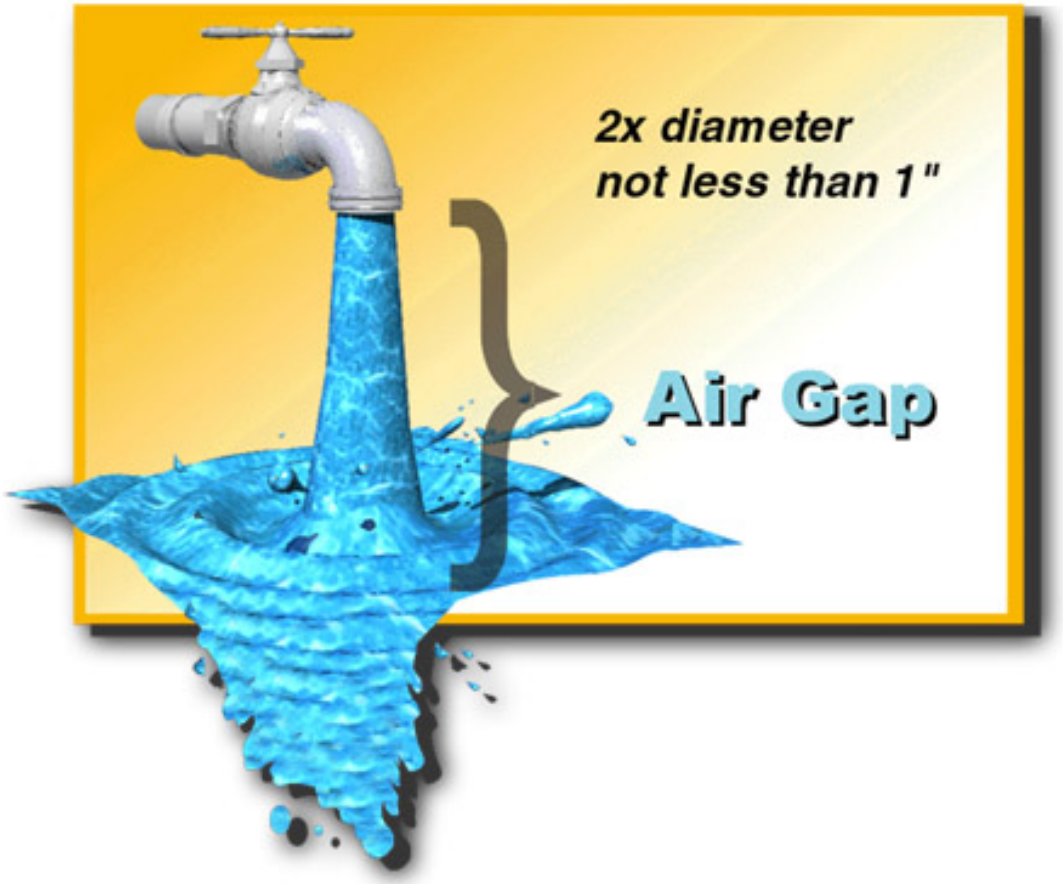
CROSS CONNECTION AWARENESS

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



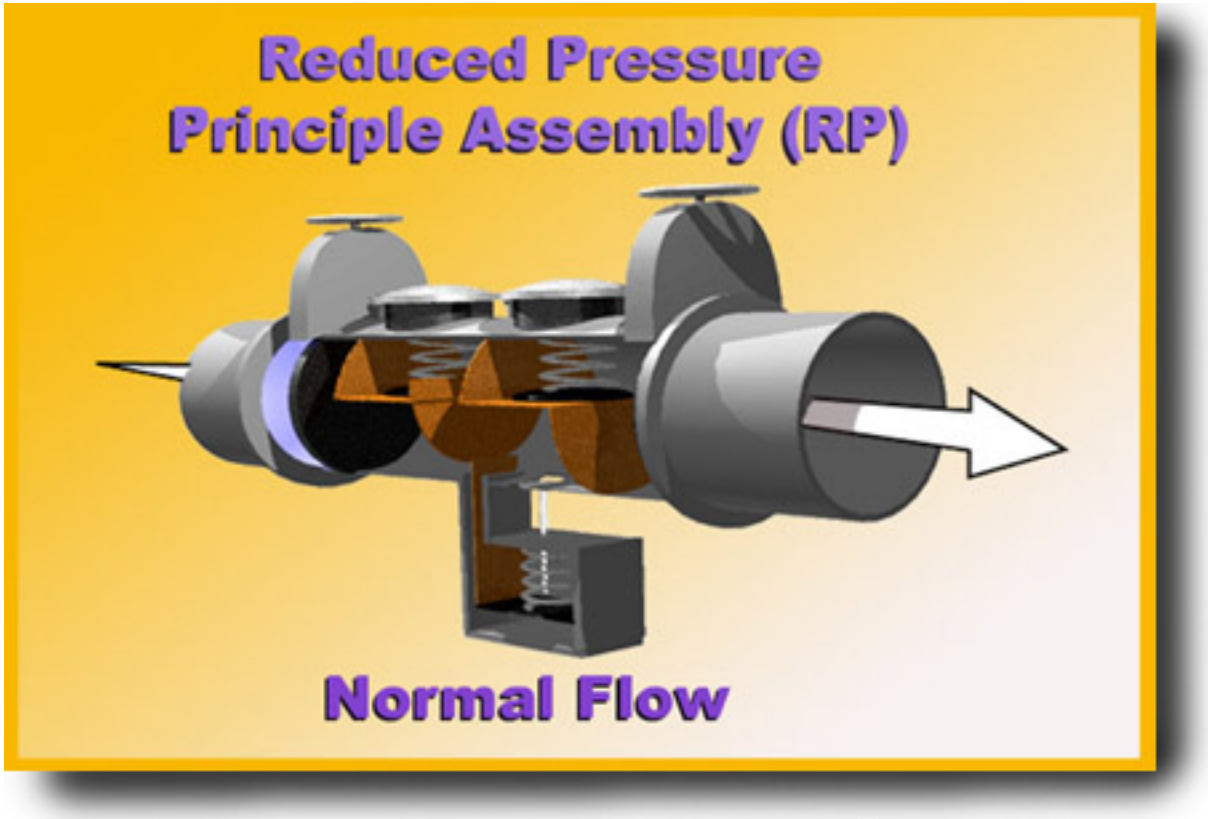
CROSS CONNECTION PROTECTION

SHOULD USE AN "AIR GAP"



CROSS CONNECTION PROTECTION

AN "RP" DEVICE IS USED FOR BACKUP PROTECTION



MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

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

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

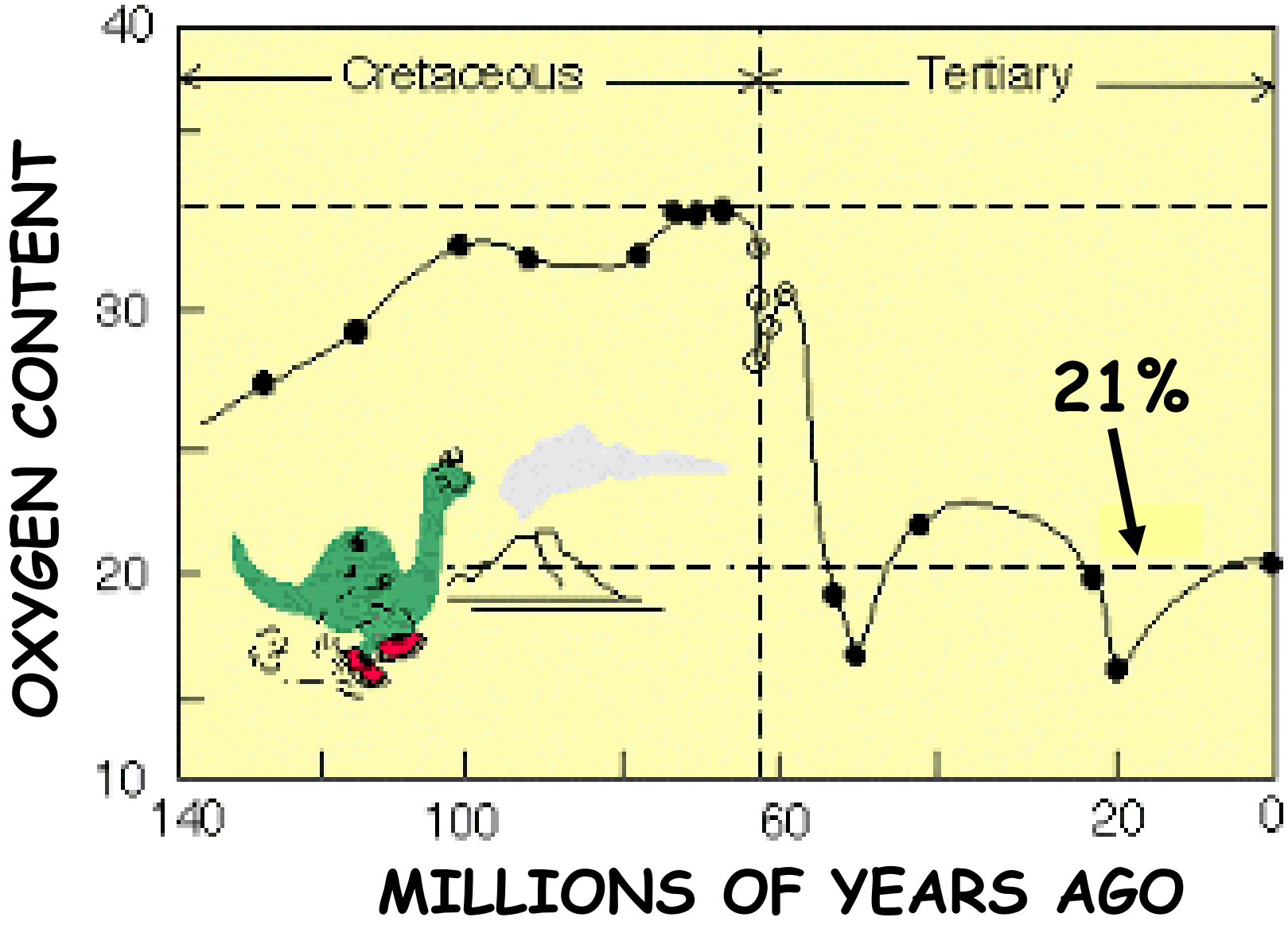
1. ATMOSPHERIC

   - OXYGEN DEFICIENCY
   - TOXIC GASSES
   - EXPLOSIVE

OXYGEN DEFICIENCY

NORMAL AIR CONTAINS **21.5%** OXYGEN: DANGER WHEN O_2 LEVEL DROPS TO **19.5%**

OXYGEN LEVEL IN ATMOSPHERE HAS VARIED OVER THE YEARS


40
30
20
10
Cretaceous
Tertiary
21%
140
100
60
20
0
OXYGEN CONTENT
MILLIONS OF YEARS AGO

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

1. **ATMOSPHERIC**

   - OXYGEN DEFICINECY
   - **TOXIC GASSES**

TOXIC GASSES

MAIN PROBLEM IS HYDROGEN SULFIDE (H_2S)

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

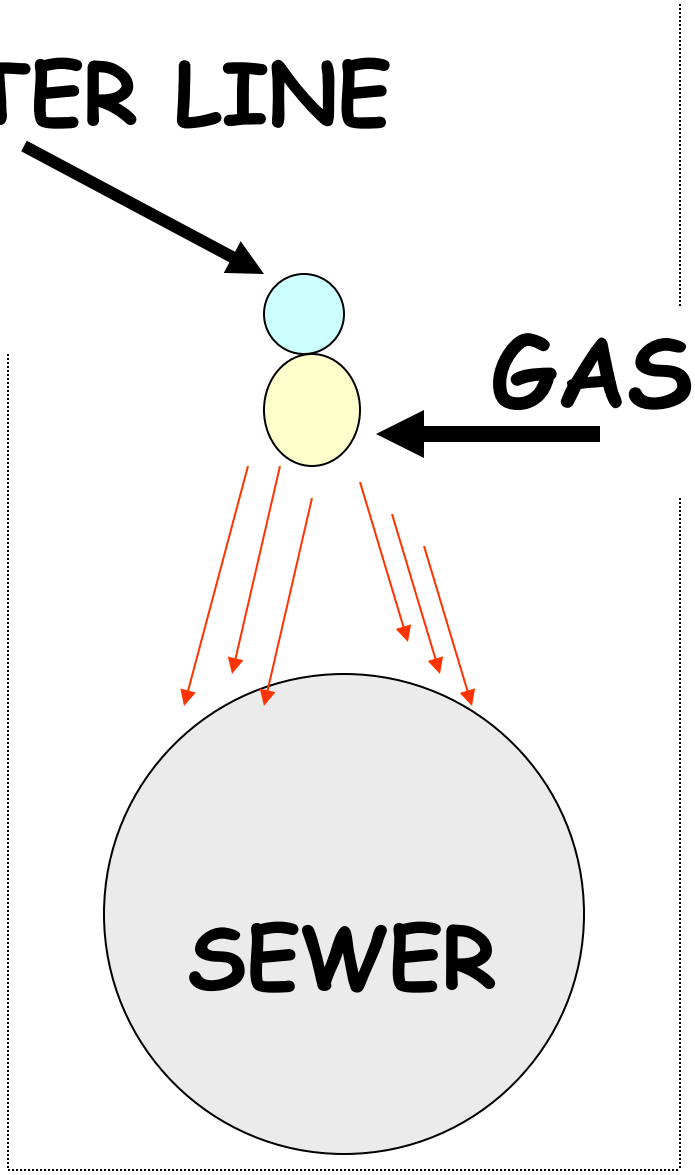
METHANE (CH_4) GASS IS LIGHTER THAN AIR SO WILL ESCAPE IF SEWER/MANHOLE IS VENTILATED

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

- EXPLOSIVE or WILL DISPLACE O_2

GASOLINE CAN COME FROM:

- STORAGE TANKS
- GAS STATIONS
- SPILLS
- PIPELINES



OVER $32 MILLION IN DAMAGES

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

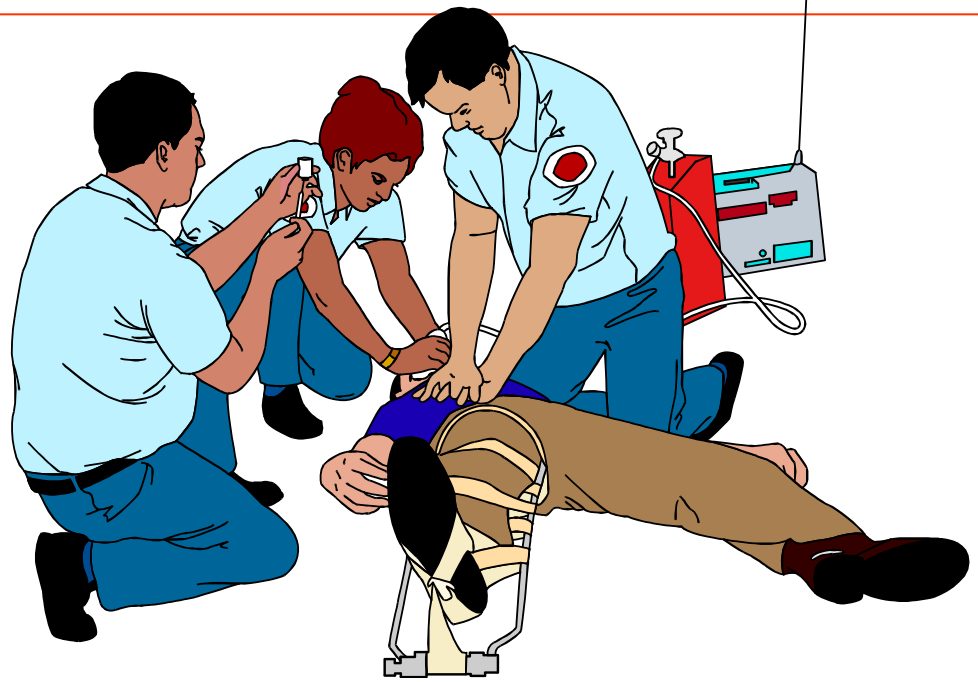
2. PHYSICAL INJURY

- 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

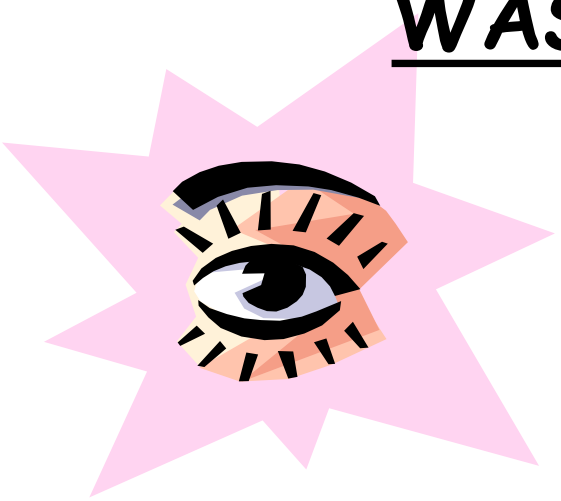
LEPTOSPIROSIS CAN BE TRANSMITTED BY RAT FECES AND URINE

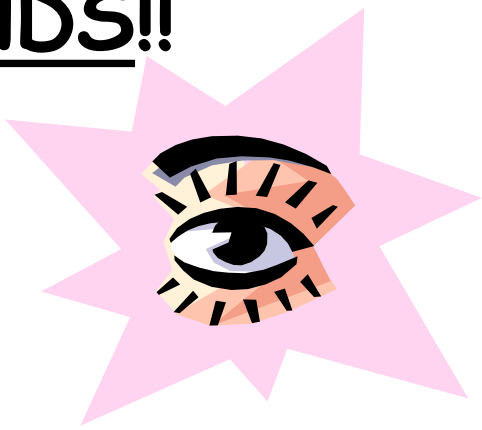
…CAUSES FEVER, HEADACHES, NAUSEA, VOMITING, AND THIRST. GET ANTIBIOTICS

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

1/4 INCH

BROWN RECLUSE (AKA FIDDLE SPIDER)

MANHOLE HAZARDS

(SHOULD BE TREATED AS A CONFINED SPACE)

5. TOXICANTS

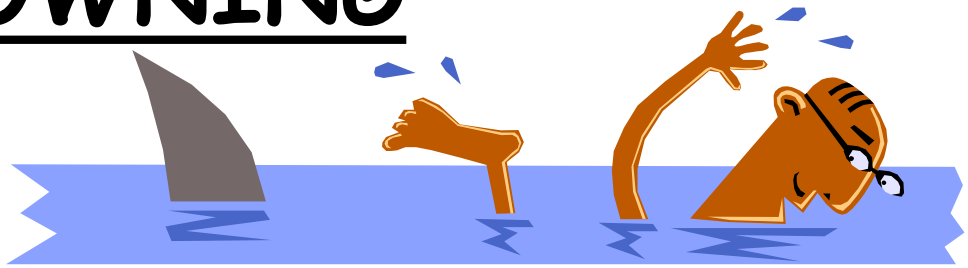
ANY SUBSTANCE THAT CAN BE POISONOUS.

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)

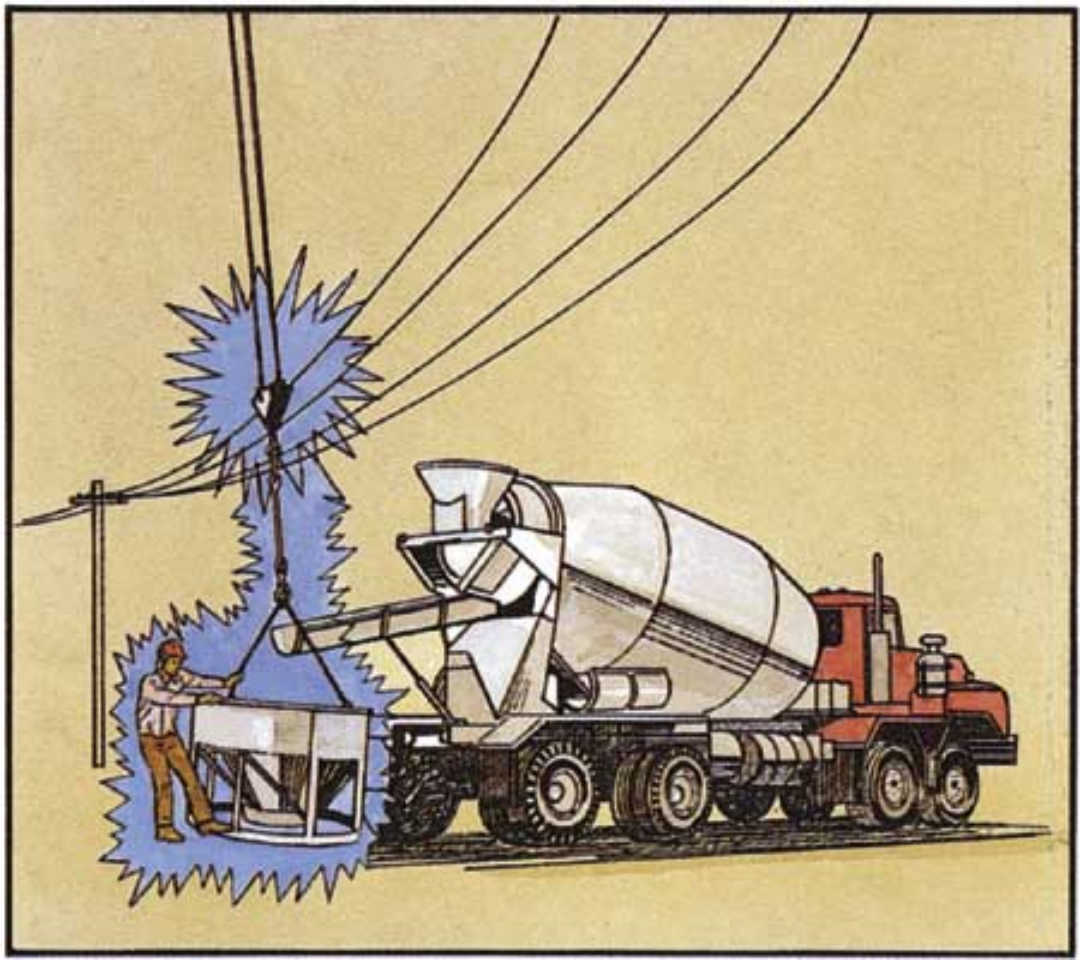
1. ATMOSPHERE
2. PHYSICAL INJURY
3. INFECTIONS & DISEASES
4. SPIDERS, INSECTS, & RODENTS
5. TOXICANTS
6. DROWNING

DO NOT ENTER A MANHOLE WITHOUT:

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

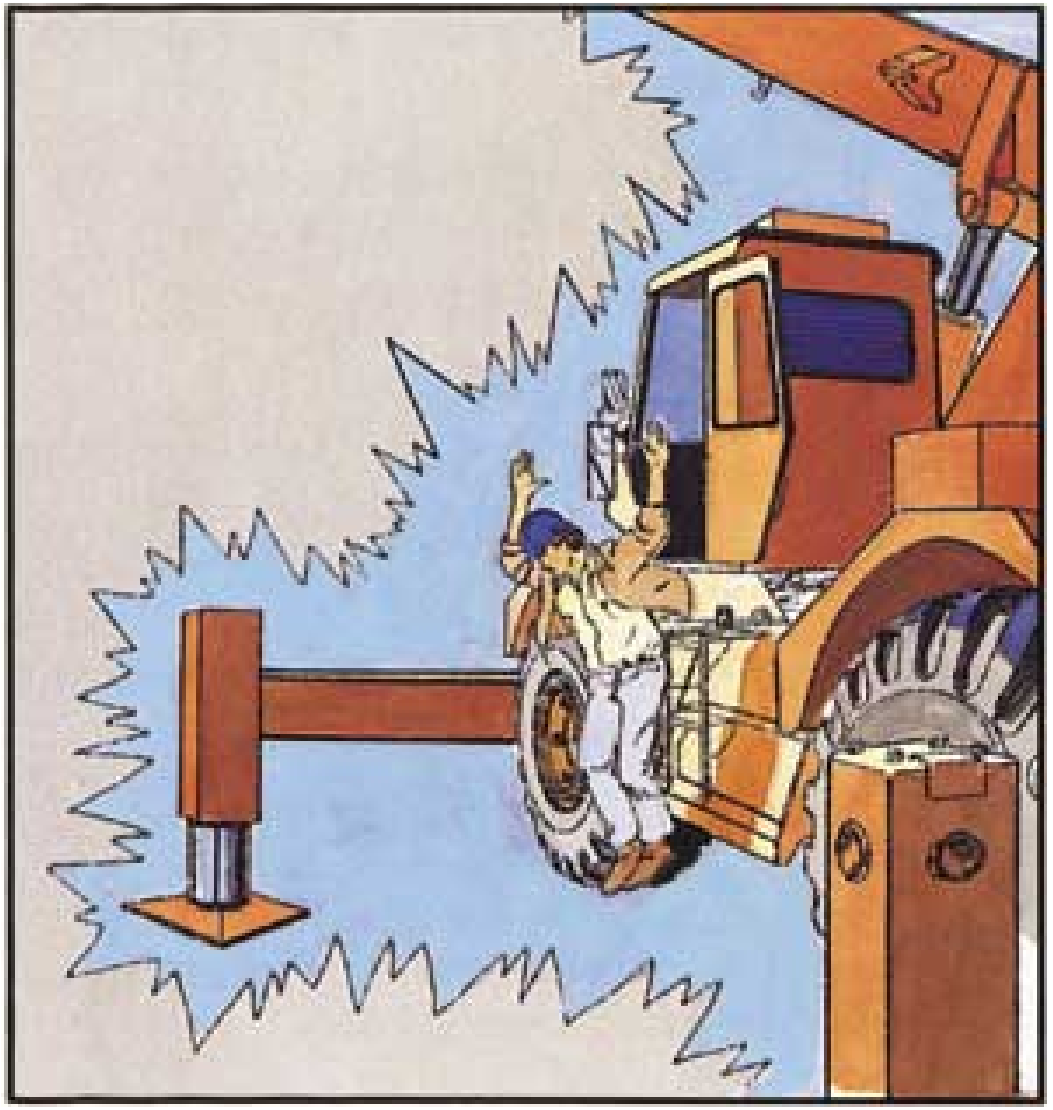
VENTILATION BLOWER

SELF CONTAINED BREATHING APPARATUS (SCBA)

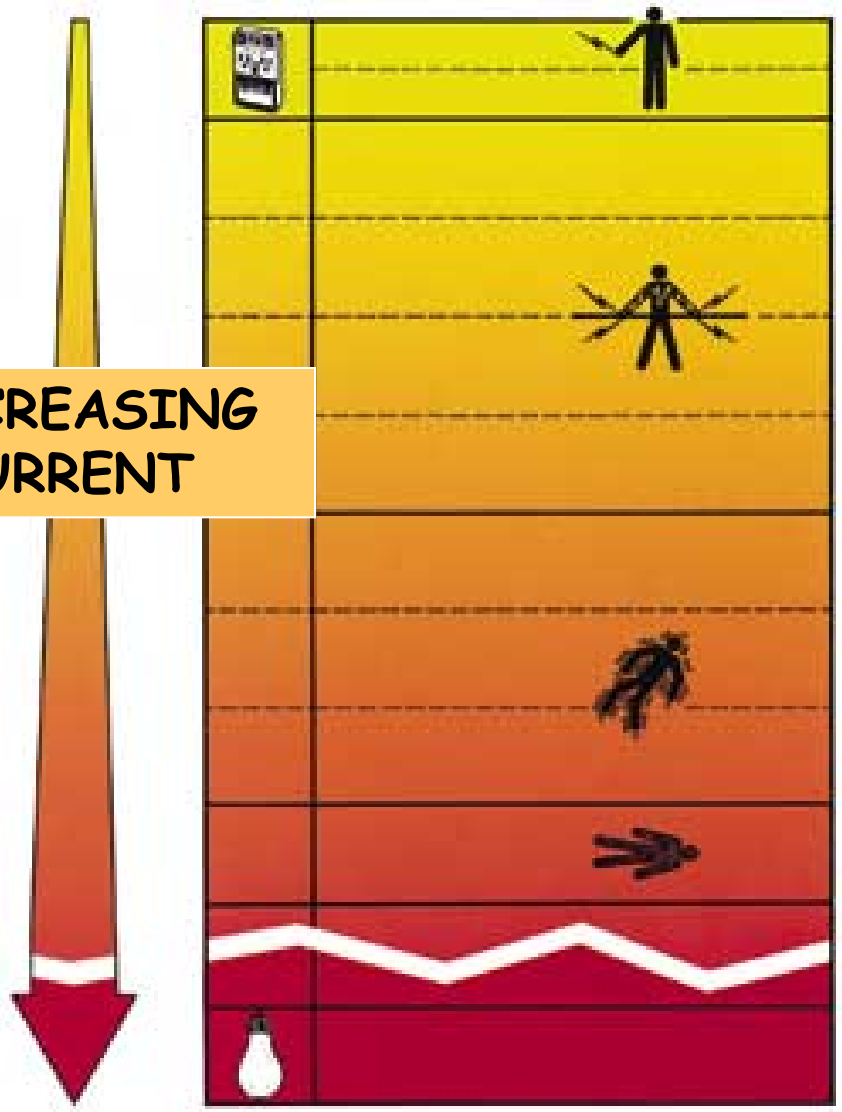


HEADS UP AROUND ELECTRICAL POWER: USE A "GFI"

REMEMBER TO "JUMP CLEAR"



1 MILLIAMP



30 MILLIAMPS

1000 MILLIAMPS

ELECTRICITY CAN "KILL"

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

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

DO NOT EXPOSE YOUR FAMILY TO ???