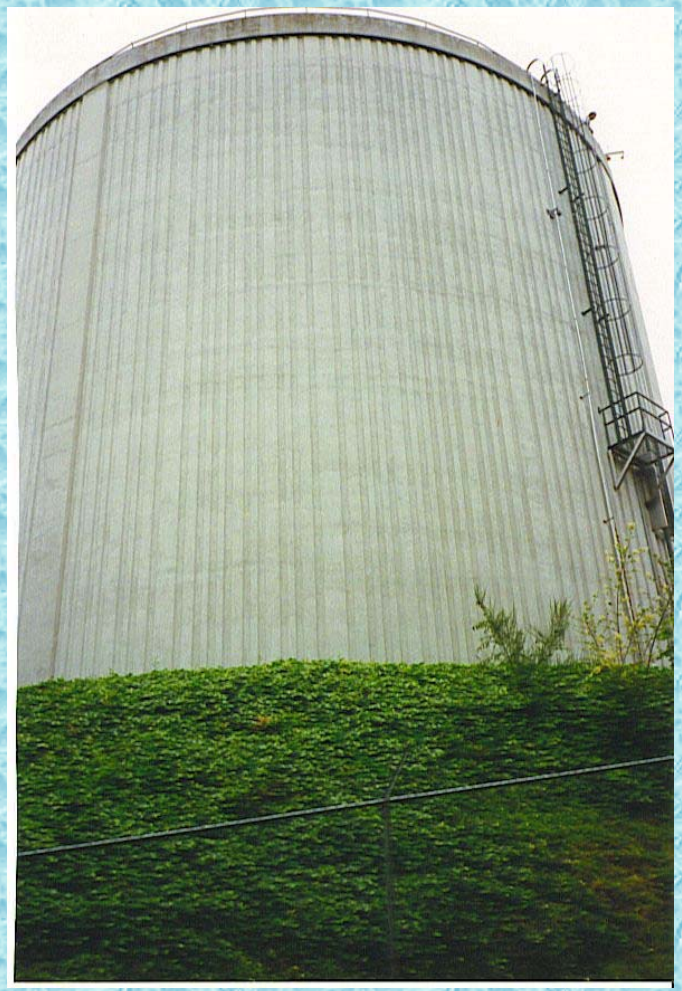
Water Facility Maintenance

Using Diving Operations



For years Aquatech Diving Services has been performing potable water facility maintenance projects such as inspections, cleanings, valve repairs, line isolation & repairs and install fill line extensions.

We have worked in over 800 locations since 1993.

The proper operation of any treated water storage facility involves some type of maintenance program.

The frequency and type of maintenance that is necessary can vary depending on:

- water quality and type of source water (ground water-surface water)

- proper facility design (no short circuiting problems)

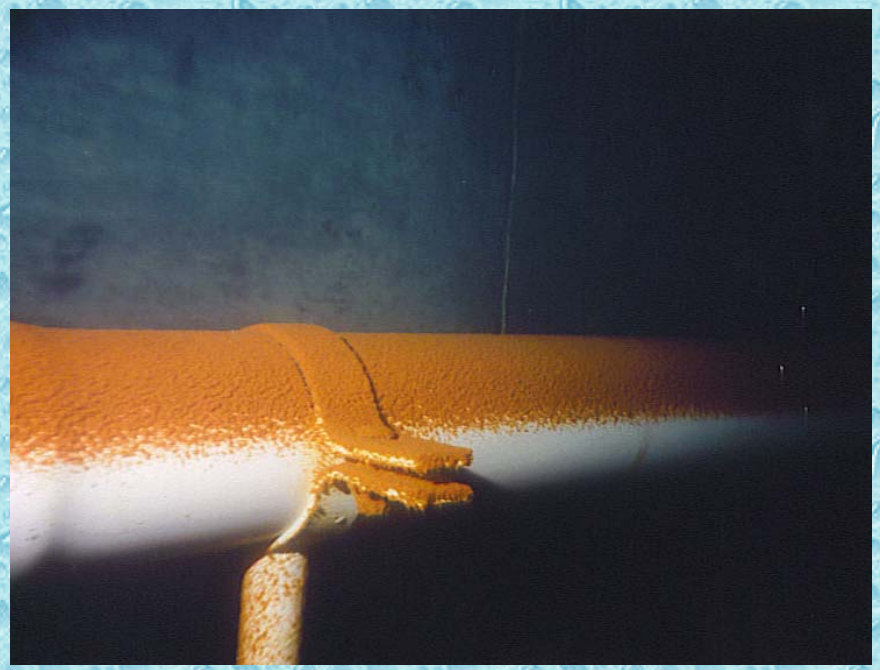
-treatment processes required (coagulant chemicals added, filter performance)

-facility operation (adequate filter backwash rates)

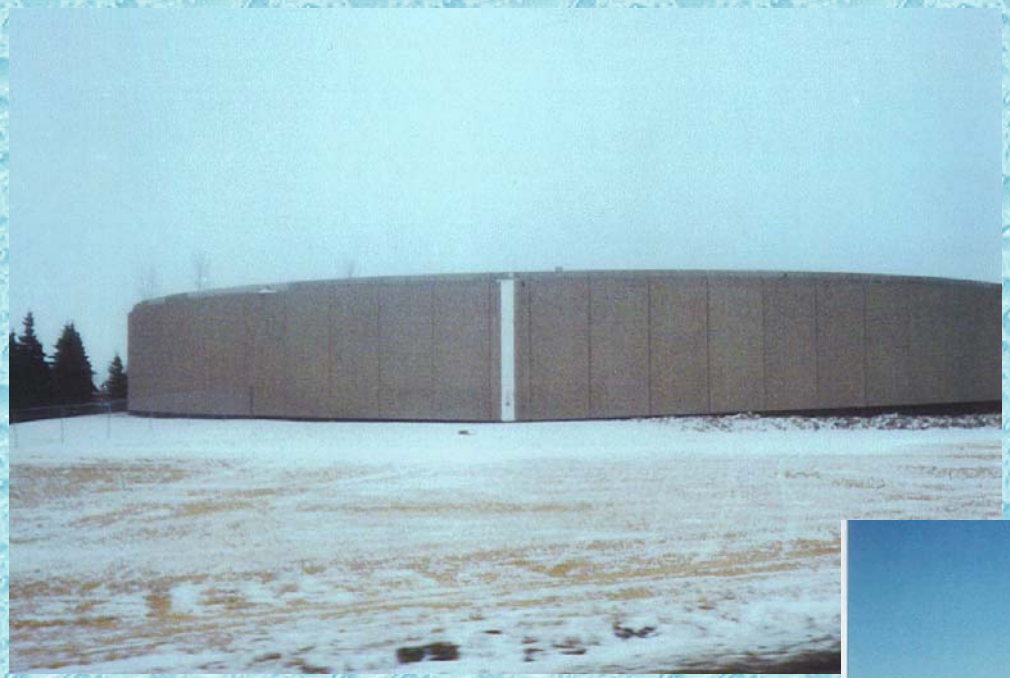
When writing up a facility maintenance program, we have found that all four items must be considered.

EXAMPLE

One community in Alberta had such a high iron content in their well water (no filtration) that the water storage reservoir contained a red layer of sediment material six inches deep every six months. To avoid diving at 35 below we vacuumed this facility out in the spring and fall every year.



Types of Water Facilities



← Large Round Reservoir

Small Cistern →

← Large Rectangular Reservoir

Elevated →

Standpipe

← Grain Bin Type

Importance of Potable Water Diving

In 13 years of providing potable water diving services we have discovered two important things:

1) If water facility maintenance is inconvenient it is not performed in many locations. Draining a water facility and leaving customers without water or creating a situation where water for fire protection is unavailable, are now major issues.

2) Operating a water distribution system at zero pressure is also never desirable. Possible system contamination, water hammer during system start-up, can happen.

Many water facilities we've worked in have never been entered since their day of construction. Some of these are 25 years old or more and built in the 1970's. In many situations, the need for diving teams to perform required maintenance projects does exist.

Potable water diving will remain a viable alternative in the water industry for years to come. Some water reservoirs equipped with inadequate sumps were obviously not designed to be pumped out and drained.

Robotics in the Potable Water Industry

In 2002 we researched the possibility of rigging up a robot or ROV (Remote Operated Vehicle) to perform the underwater duties that our divers now complete. Eliminating the human factor with respect to safety issues, reducing the size of the crew, etc. could make a significant change in our daily routine.

Unfortunately, the robots that might work for water facility cleaning are not equipped with vertical movement. Therefore, they would be useless in cleaning pillar support bases, sumps, walls, reservoir lines, etc.

ROVs that might work in the facility inspection application and possibly are equipped with vertical propulsion would definitely stir up any light sediment material the facility might contain. An increase in turbidity could then be expected. Only a small percentage of the water facilities we have worked in were found in clean condition. (About 6%)

A robot or ROV depends on cameras mounted on it for direction, location, etc.

A diver can comprehend possible problems in the reservoir. If a reservoir line is broke, cracked or just marked, a diver can determine if a line repair is required or if the line is in good condition.

In 1997, a central Alberta town performed an expensive, unnecessary dig to expose a reservoir discharge line that appeared thru a camera to be broken. This line was found in good condition with only a pen mark on the inside surface.

When technology develops a robot that can adequately perform all aspects of reservoir maintenance and replace a dive team, we will again research this possibility.

Hiring of Potable Water Divers

The performing of potable water diving work is a specialty. If performed properly, strict guidelines and regulations are in place and must be followed to:

1) Ensure the water remains safe for consumption.
2) Maintain a safe work site for divers and surface personnel by following proper procedures and using required equipment.

Unfortunately, on a very regular basis, recreational scuba divers or sport divers are used to perform maintenance in some water reservoirs in Western Canada.

Scuba is defined as: Self Contained Underwater Breathing Apparatus

- This type of diving is independent (self contained) and does not involve safety lines, communication lines, etc.
- The use of scuba in a confined space water facility diving is strictly prohibited. It must never be used unless in an emergency situation.
- One diving association is trying to write provisions to their regulations for the use of scuba provided, “it is a short duration dive.” If Murphy’s Law had a part two we are sure it would read, “Any job that is expected to be a short one will, without a doubt, be long.”
- If a scuba diver enters a confined space and becomes caught up on something with no communication line the dive suddenly becomes a long one.
- If a diving contractor showed up at my water plant and wanted to use scuba to perform confined space diving work, I would tell him, “No, my insurance policy does not contain a stupidity clause.”

Many sport divers use wet suits (not dry suits) which allows potable water to be in contact with the divers bodily fluids (sweat, etc.). The liability problems that a municipality could face by hiring recreational divers are enormous. Low cost is the only advantage that sport divers can provide.

In conversations with government officials about this problem, they say it's up to the municipalities to police themselves. When we usually hear about a scuba diver performing work in water facilities it is always 30 days too late.

Also, many water operators are not aware that scuba equipment and recreational divers must not be used for this type of work.

Don't open your hatches to scuba divers!!

When hiring divers, first ask the diving contractor if they are knowledgeable and equipped to perform potable water work.

When hiring divers to work in your potable water facility, make sure they have:

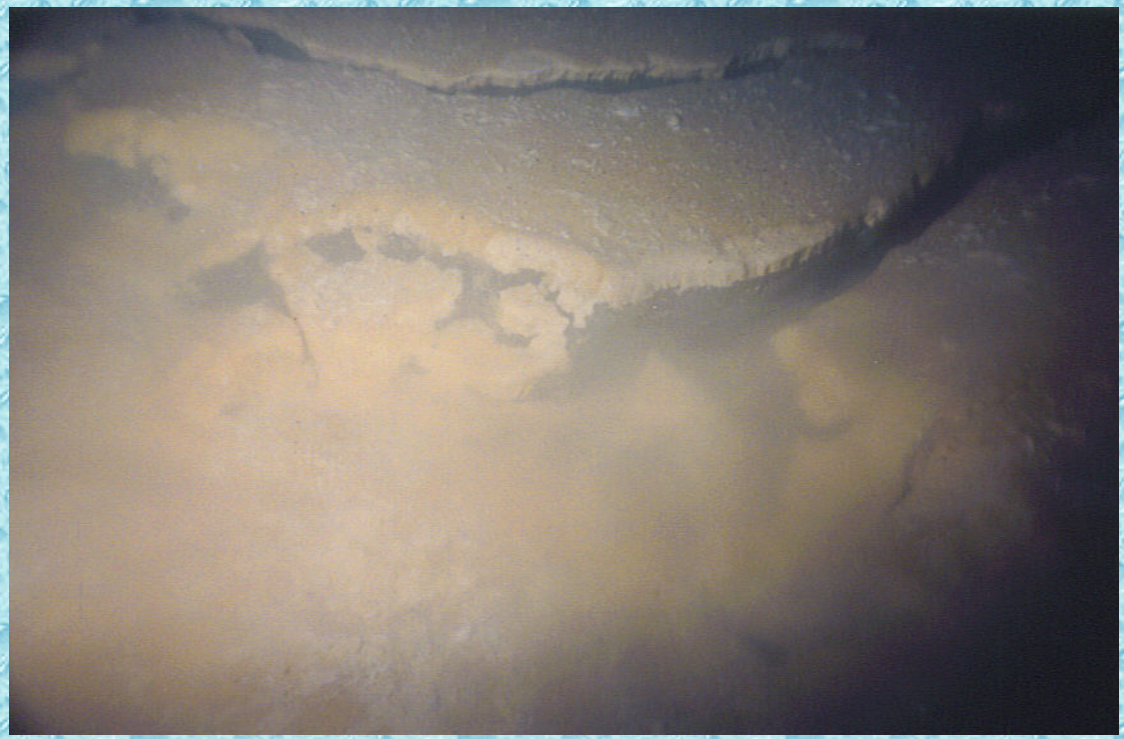
- Commercial diving certification
- Confined space training
- WCB and Insurance coverage
- Crew of four members
- Surface-supplied air diving equipment
- Hard wire communication equipment
- Dry suits and proper diving equipment
- Recovery equipment (tripods, winches, etc.)
- Disinfection procedures
- Reservoir entry procedures
- Emergency O2 & certified in O2 administration
- Notification of project (if required) local WCB regulations, OH & S regulations
- AWWA Guidelines for diving in potable water facilities. C652-92
- 'Safe Work Plan'
- Potable water designated diving gear
- Hazard assessment/tailgate meeting documentation
- Copies of commercial diving regulations on site

One idea for potential employers of diving contractors is when the diving contractor arrives to perform potable water work at your location, they remove their dive suits from the dive bags, ask them where those suits were last used. If they take an unreasonable amount of time to answer, it might be an indication their equipment is used for more than potable water and they are trying to remember back to the last potable water job application.

In conversation with a diver that works for a large diving contractor, he tells us that they perform work in sewer plants and water plants. I asked him if they have separate gear for each type of plant. He said, “No, we just hose the equipment off as good as we can.”

This is very unacceptable!!

When our diving crew performs potable water diving we also boost and maintain chlorine residual to 1.0 mg/L for the day we are working. This addition to our reservoir entry procedures will not be found in the AWWA guidelines. We feel that with the significant layers of sediment material we find in water facilities, this is a required procedure.



Water Facility Maintenance Projects Divers Can Complete

- Reservoir/Water Plant Clearwell Inspections
- Reservoir/Water Plant Clearwell Cleanings
- Valve Work
- Facility Isolation
- Fill Line Extensions
- And Many Others

Reservoir/Water Plant Clearwell Inspections

Water facility inspections are the first step in proper maintenance. Water facility inspections can be performed by potable water divers with excellent results. Camera inspections can produce exceptionally good photos of the facility floor, walls, roof, pumps, reservoir lines, overflow piping, etc. Video equipment can also be used to show the condition of all types of water storage facilities. If the reservoir contains a layer of sediment material, divers can be used to sample this material. If inadequate blueprints exist, divers can be used to provide accurate measurements of the facilities dimensions.

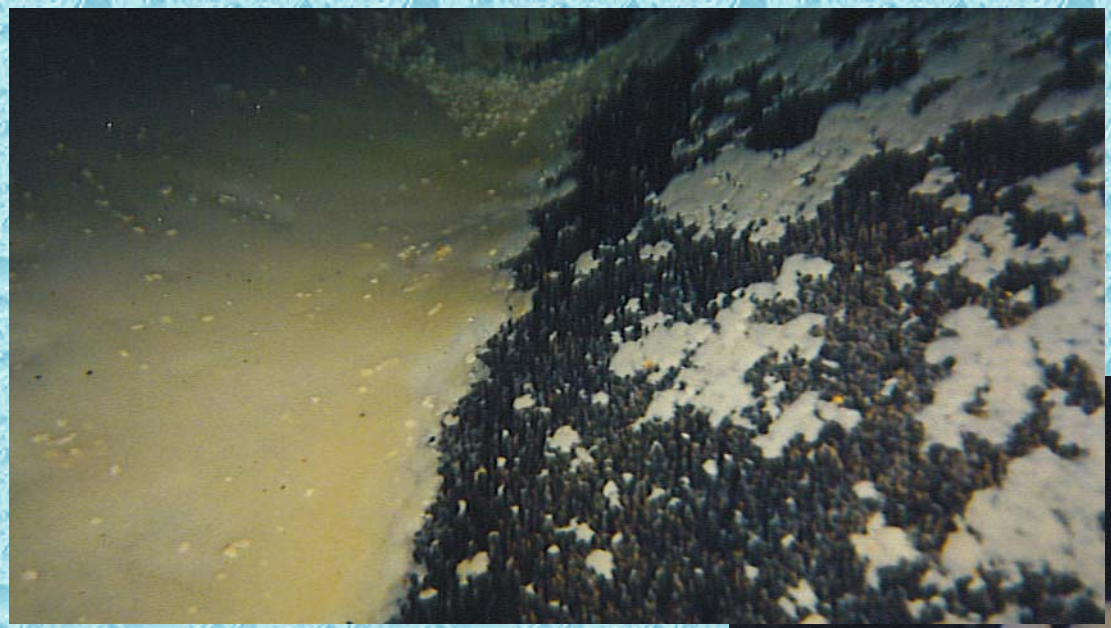
Inspections are important to determine facility conditions and any potential operational problems.

Reservoir/Water Plant Clearwell Cleanings

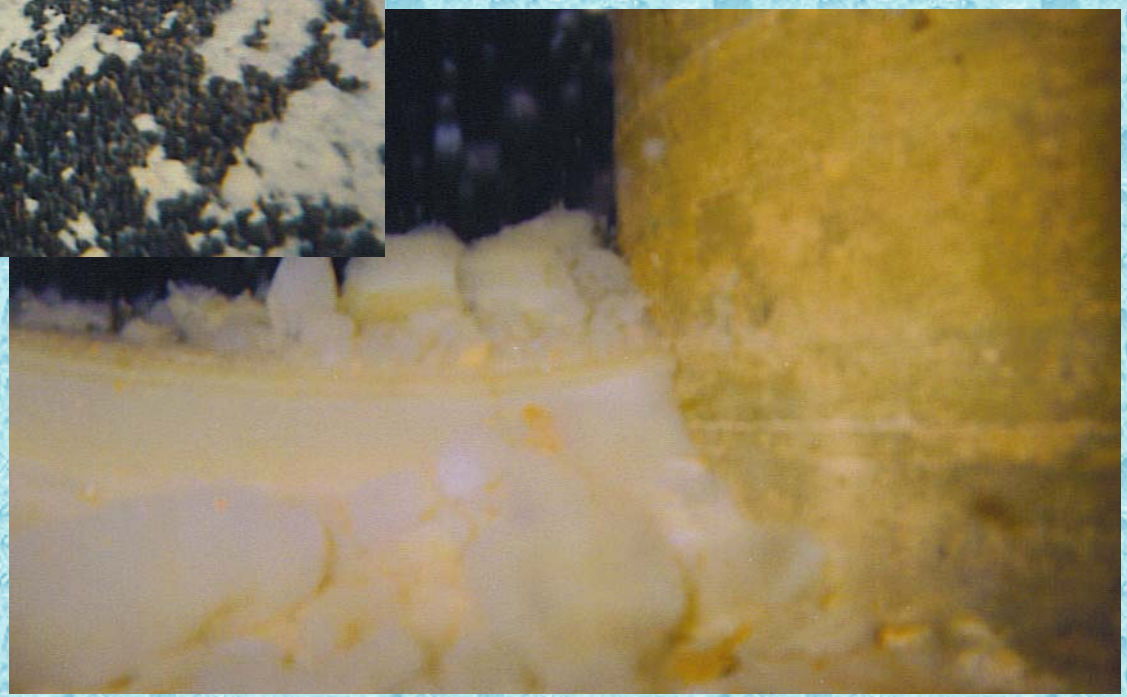
Once a water facility is inspected, commonly a layer of some type of sediment material is found (in about 94% of reservoirs; 752/800). The diver method of facility cleaning is an alternative to draining and disrupting the water services. The time involved in completing a cleaning project is determined mainly by the size of facility, type and amount of sediment material found and depth of water.

Example:

Heavy filter media vacuums out slower than lightweight post filter floc.



Filter Media



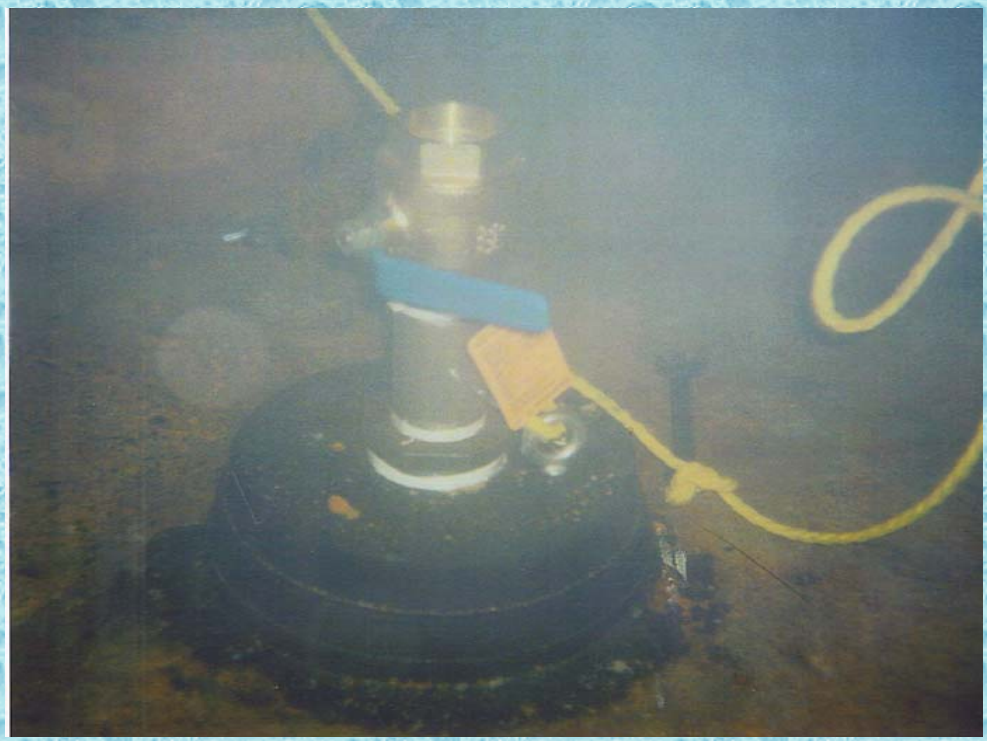
Lightweight Floc

Valve Work

If pump chamber/reservoir valves are not functioning properly, divers can also be called upon to replace or repair water facility valves.

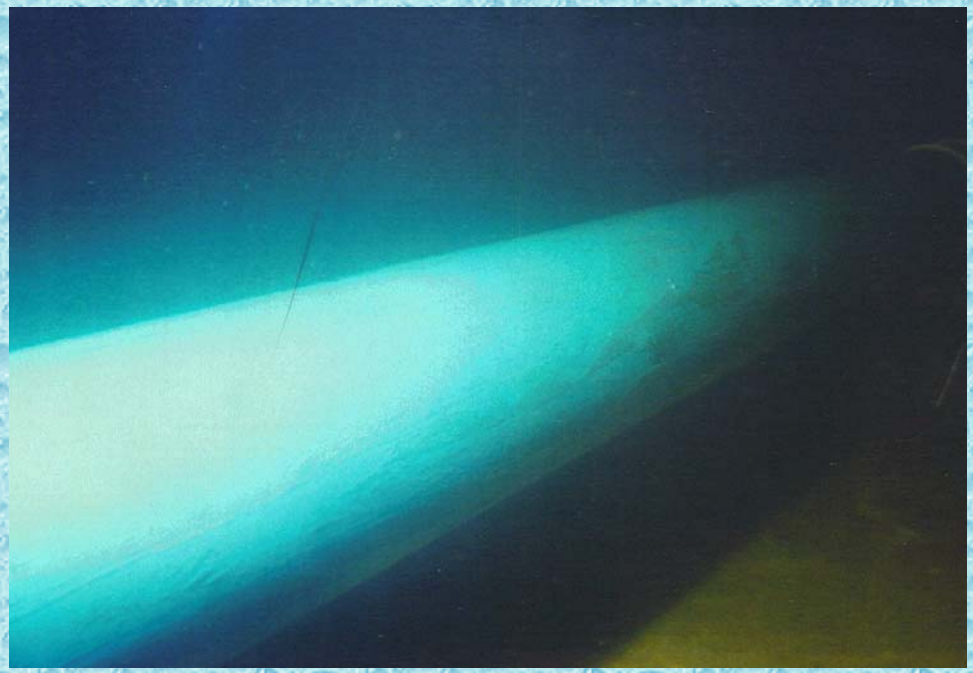
Facility Isolation

Divers can be useful in isolating certain water facilities. Inflatable or mechanical plugs can be installed to isolate parts or complete reservoir or pump chambers to facilitate repairs or new facility tie-ins.



Fill Line Extensions

When poorly designed water facilities are found to contain ‘dead zones,’ where little or no circulation of fresh incoming water is determined, in many situations an extension on the fill line can be installed by divers to help eliminate this problem.



Numerous other potable water diving projects can be completed by divers.

Rodents in Water Facilities

Dead rodents have been found in an alarming number of water storage reservoirs.

How are the rodents gaining entry?

Four possible entry points are most common:

1) Hatch or access openings

- the easiest way for rodents to gain entry
- check for openings and repair

2) Vent pipes

- check vent pipes for proper screening
- eg. A vent four feet about the reservoir is an entry point if there is four feet of snow outside

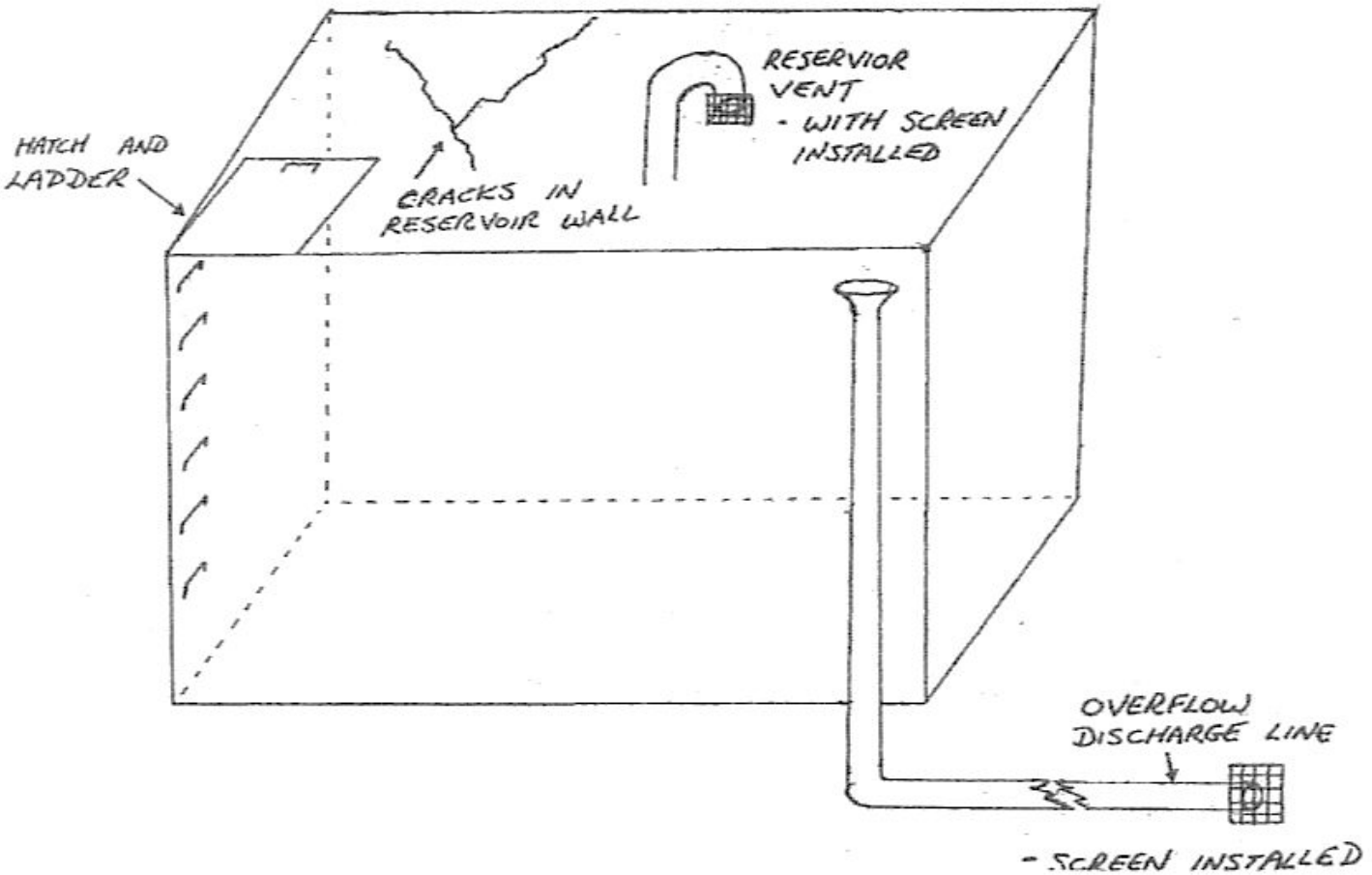
3) Cracks or structural damage

- repair cracks and openings to prevent rodent entry

4) Overflow pipes

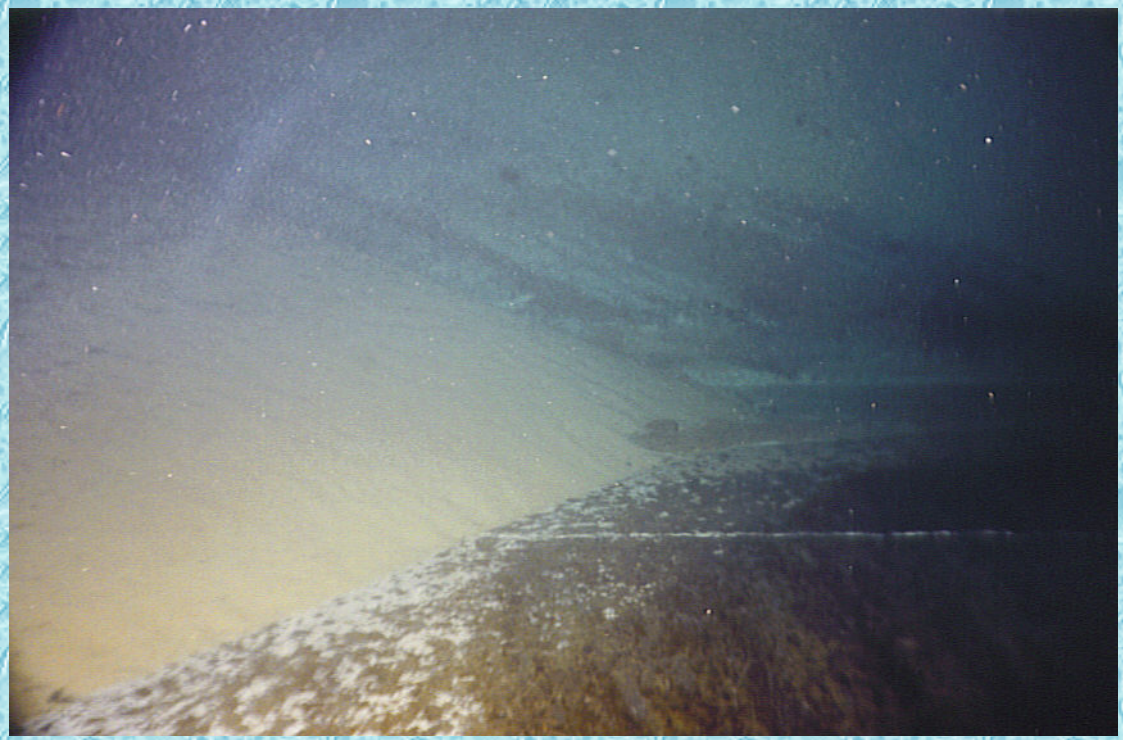
- a mouse or rat is capable of a vertical climb if the overflow piping becomes rusty inside
- screen the overflow discharge line (outside) to prevent rodent entry

DRAWING OF WATER RESERVOIR.



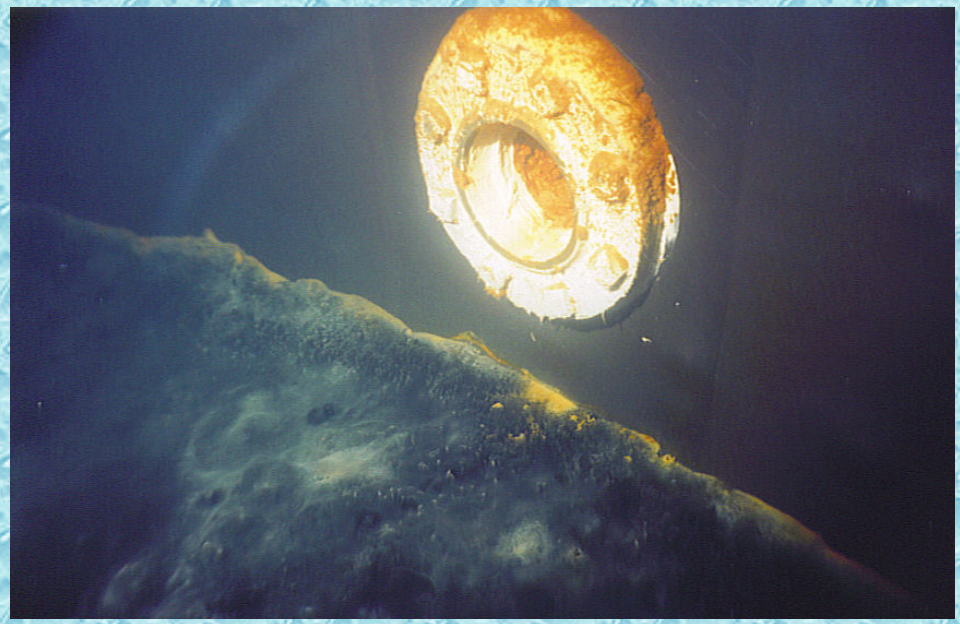
Present Condition of Water Facilities in Western Canada

We have performed diving work in over 800 treated water storage facilities located in towns, cities, villages, penitentiaries, provincial & federal parks and water co-ops. Ninety-six percent (752/800) were found to contain a layer of some type of sediment material.

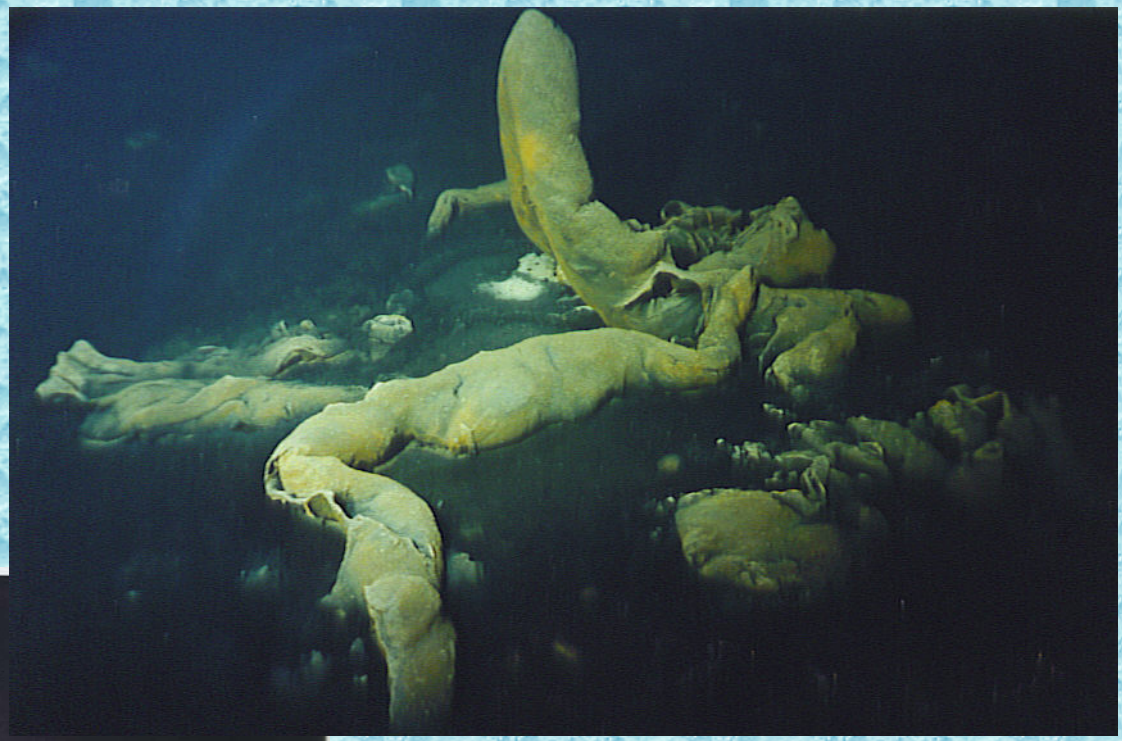


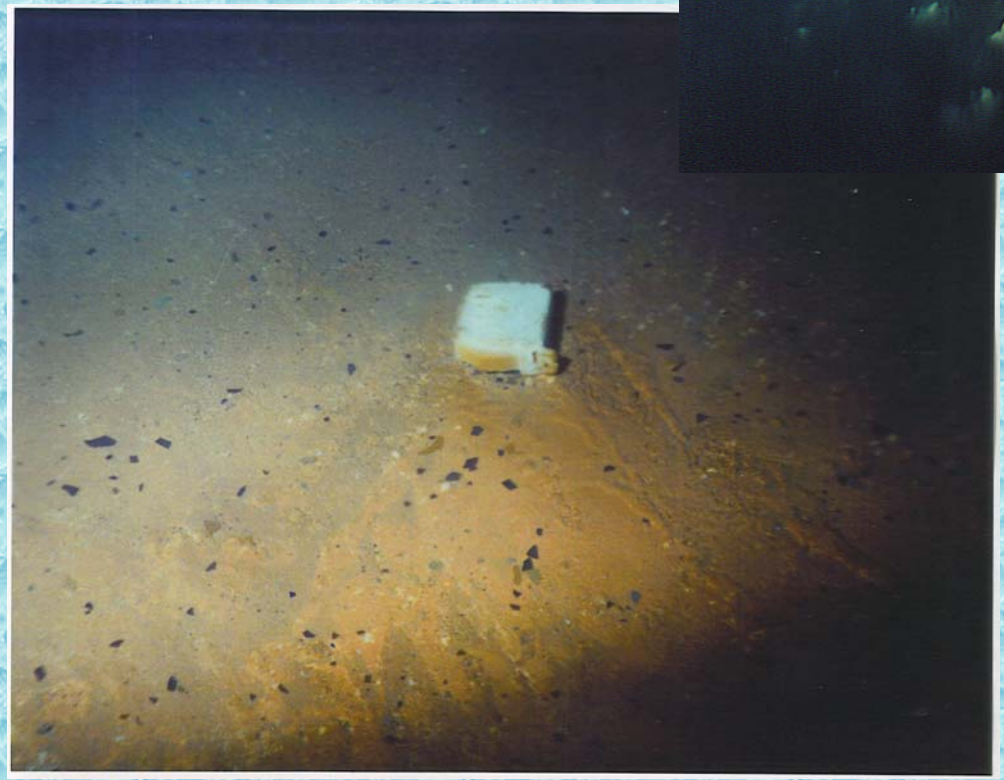
This sediment material could be:

- Organic growths or iron bacteria
- Filter media – sand, coal, garnet, etc.
- Post filter floc
- Well sand
- Gravel
- Foreign objects – 8’ step ladder, hard hats, flashlights, tape measures, shovels
- Dead rodents – mice, rats, birds



Upright Organic Growth





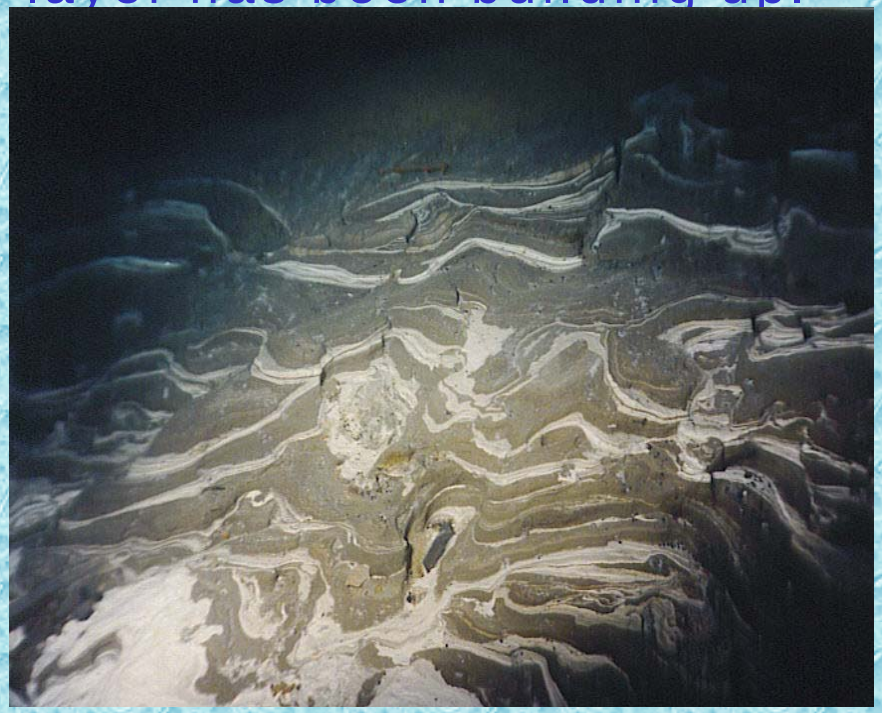
Tape Measure

About 4% (48/800) were found in clean condition. How do we define ‘clean condition?’ These facilities were found to contain no sediment material at all.

In our opinion, water facilities should contain only water but we generally report the condition of the reservoir to the municipality or facility owner and they usually decide if cleaning is required.

In some water facilities, the sediment material build-up was found to be significant. A layer of six inches or deeper.

Surprisingly, three water plant reservoirs built in about the same year located 100 kilometers from each other, each contained 26'' of sediment. The layers of grey and white material should work like the rings inside a tree and indicate how many years this layer has been building up.



Since 2001, we've noticed a significant increase in the number of water operators that plan and carry out routine maintenance in their water plants and reservoirs.

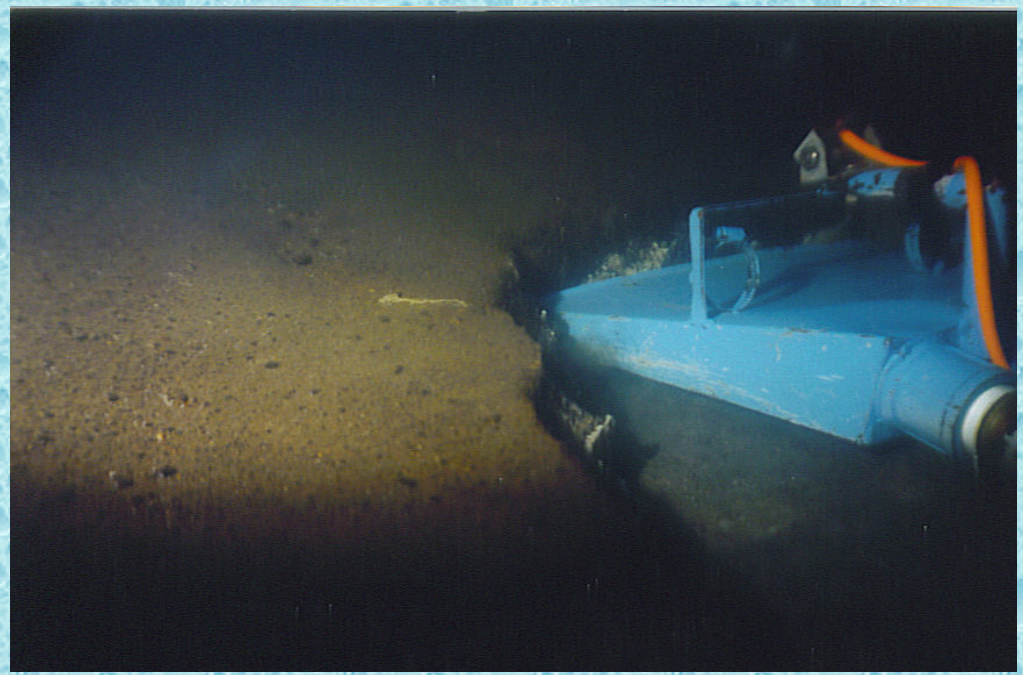
Previous to 2001, surprisingly, very few water facilities had any planned, written maintenance program in place.

Fact: Municipalities will not usually spend funds on any project until a need can be verified.

With many municipalities proving that water facility maintenance is required can be extremely difficult. We provide photos or video that shows a reservoir in need of cleaning and the municipality shows us water sample reports that they feel tell a story of their system being in good shape.

Chlorine is useful in helping to maintain safe water, but if the chlorinator quits and the reservoir contains a deep, significant layer of black septic sediment/sludge, water quality problems could be created.

Sediment layers can produce fluxuating chlorine demand. One additional benefit to regular facility cleaning could be a saving in expensive chlorine use.



Can certain symptoms show up that will help troubleshoot potential problems in water systems?

Yes.

1) If a drastic increase in turbidity readings are noticed on Wednesday morning after a Tuesday evening fire practise, this might be an indication of a build-up of bottom sediment in the reservoir which is entering the distribution system from a high volume water flow the fire pump creates.

2) During hydrant flushing a small amount of sand was found. This could be an indication that well sand or filter sand has entered the reservoir and distribution system. A well could be sanding off or a filter underdrain may have collapsed. This sand is usually noticed in the lower elevation parts of the community first.

Condition of Reservoir Walls

In the water facilities we've entered, the reservoir walls are usually found in good, clean condition. Iron bacteria has been found in a few of these reservoirs and can be removed in some situations. Stains from iron and manganese have also been found. If these stains are dark and have been building up for years, the scrubbing of the walls is not always successful.

A telescopic rod is sometimes useful in reaching areas of the walls.

Structural Problems

We have seen structural damage and/or problems in only a few of the water facilities in recent years. Structural problems would include major cracking, etc. Quite commonly, we will find minor cement chipping but this does not usually affect the structure's strength. Any photos with possible structural problems are submitted to the municipality and dealt with by engineering specialists.

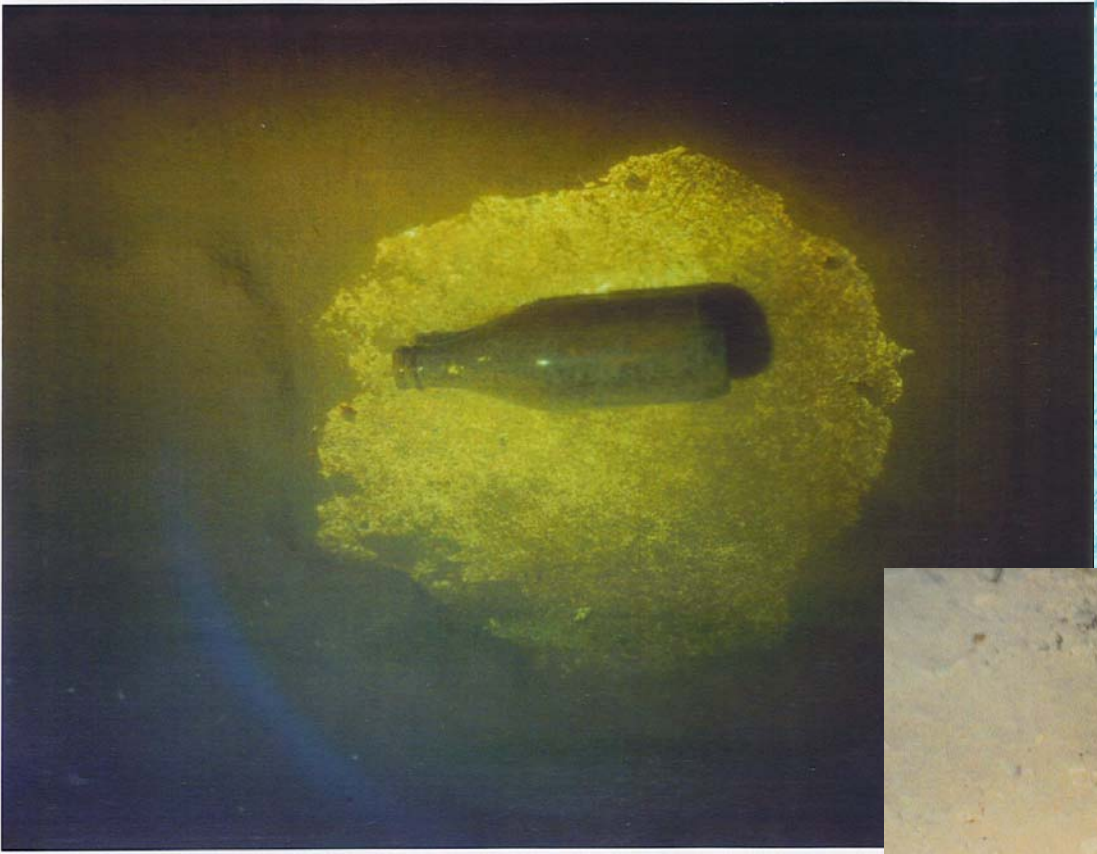
Recently, we have been using approved potable water patching material to repair cracks in reservoir walls that are leaking. We have had some success with this product.

Reservoir Security

During our travels in nine or so years, we have also noticed a serious problem with security for many of our treated water storage facilities. Thirteen water reservoirs have recently been entered illegally, usually by vandals looking for something to destroy. Quite often, they end up throwing articles into the treated water. Apparently, one case involved the dumping of diesel fuel into the drinking water in northern BC.

Reservoir facilities seem to be a favourite party spot for kids and young adults. Since 9/11, the security of our water systems should be a high priority.

Many reservoirs are lacking proper fences to prevent illegal entry. Three facilities had hatches that fell apart once an attempt was made to open them. Rusty hinges were found to be broken and hatches made from wood were found in rotting condition.



←Beverage Container

Rocks and Sticks →

Iron Fungus

Many of the water reservoirs contain iron fungus growing on metal objects. This type of growth can be found on ladders, pumps, piping, etc. To attempt to scrape iron fungus from metal objects is time consuming but also risky. Loose and soft iron fungus can be vacuumed off the objects. In our experience, the scraping and exposing of the black layer below the iron fungus can weaken the wall of the pipe or metal object being worked on. Until further information is known about the removal of iron fungus from metal objects, we generally remove only the loose or soft material.

Safe Work Plan

All job sites require a ‘safe work plan.’ This gives the project direction and is a written document that, if followed, can produce the safest possible job sites.

When diving is involved in any job site, we feel the ‘safe work plan’ is doubly important.

The ‘safe work plan’ should involve:

- Responsibilities and duties of the personnel

  -dive supervisor -divers -dive tender

- Proper equipment maintenance

- Emergency response procedures

  -involving all possible situations (fire, diver air loss, loss of diver communications, unconscious diver, etc.)

Note: ALL job sites must provide safe evacuation for all personnel. Recovery equipment (tripods and winches) is required.

- Safety meeting/hazard assessment
  - -documented meeting with facility owner
  - -discuss and document diving project and objectives, names of all personnel, emergency phone numbers and location of emergency services
  - -view and discuss facility blueprints for orientation
  - -discuss potential hazards (fire pump lock out, reservoir discharge pipes, etc.)
- Etc.

When designing or constructing water facilities, large access hatches are desirable when diving operations are used.

Instant Reporting

Underwater digital cameras and laptop computers can now be used to perform instant reporting. This eliminates the need to wait for photo development to obtain inspection results.