HOW TO DEVELOP AND TRAIN A WATER SEARCH DOG TEAM

By
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Assuming a wilderness trained dog team, water search training is mostly handler training and it concerns the knowledge and skills needed by handlers not only to search effectively in the water environment but also to keep out of trouble, such as not becoming a drowning victim themselves during a search. The dog is an important part of the team, of course, but by the time teams are working on water search, the dog knows its job -- what to alert on and, when possible, to locate the source of human scent during a search. The dog will do its job if the handler doesn't interfere.

In order to address the subject of developing and training a water search dog team (a single dog and handler), this paper:

- identifies the pre-requisites for water search training
- describes what special safety training for handlers is necessary
- describes the training of the dog and handler in a flat and a swift water search environment
- describes the formal water search training and recommends coordinated training with divers and boatmen

GENERAL PREREQUISITES -

Before commencing formal water search training (detecting scent from under water), it is assumed that the handler has worked and knows the principles of area search on land, because the principles are the same in water search. For instance, the handler must be able to:

- plan an appropriate search strategy (such as grid, perimeter, hasty)
- work down wind of the area to be searched
- be curious and aware of the horizontal and vertical wind patterns that might be expected in various conditions
- be clue conscious
- know his dog's body language
- know her own and her dog's limitations and
- use good handler safety practices (don't become part of the search problem!!)

It is assumed that the dog is eagerly finding people on land both in training and on search missions.

Special Training for Handlers

In this business, sooner or later one's knowledge and experiences from apparently unrelated parts of one's life, such as from work, hobbies, or sports -- you name it -- will be useful in SAR. For instance, experience and training in white water kayaking and canoeing has proved to many dog handlers to be most helpful in water search -- from recognizing water dynamics, hazard identification and self rescue techniques to general safety around the water environment.

The Water Search Training Checklist (Appendix A) was developed to identify the knowledge and skills-required and for individual handlers to keep track of where they are in water training. The Special Training for Handlers and the Dog and Handler Water skills Training can be done before the dog team meets the prerequisites for Dog and Handler Water Search Training.

BOATMANSHIP-

Any handier participating in water searches of any kind should obtain both **in-** and **on-the-water training** in basic boatmanshio and related water skills. This training can be obtained from a local canoe club or river outfitting company, or from various fast water rescue trainers in the country (Appendix B). Both the dog and handler must learn to be comfortable in various kinds of small boats, such as canoes, john boats, Zodiacs, rubber rafts and close-to-the-water power boats. They also must be confident on the various types of water, such as rivers with current (and rapids) as well as on relatively still water, such as lakes and ponds and tidal estuaries. Agility and confidence training for the dog is essential. If a dog is not confident, it won't work. It is also important for the handler to be comfortable in various water search situations. If the handler is not at ease in the boat and is apprehensive about the rapids ahead, the dog will pick this up and reflect the handler's worry or concern. The net effect will be that neither the handier nor the dog will be searching.

It is a good idea for both the dog and handier to be comfortable in water and be strong swimmers. A handler should know how well his dog can handle himself naturally in rapids - just in case. For that matter, while under the supervision of an instructor each iron and handler should swim a safe rapid, practice tipping over in a boat, learn how to enter a boat from the water, and learn first hand about the force of water (see Appendix C). If the handier is not a strong swimmer then he or she should be a skilled swimmer - practice swimming or floating on your back (with a life jacket on) feet first through a safe rapid; learn to use the power of the water to propel or ferry from bank to bank, or from eddy to eddy. Your dog will do this naturally, but the handler should know this ahead of time. In addition to swimming skills, the handler must develop mental control so as not to panic in the water.

The handier also should learn some basic water reading skills, in order to analyze and understand a search situation and to assess the river skills of the boatman. The handler. should know when to refuse a particular assignment, even in the middle of the assignment.

It always helps to know as much as possible about the environment 'in which you are working. What you know, understand, and respect, you don't usually fear; that will help both you and your dog. In addition to the hands-on water instruction, there are a number of helpful video tapes available which can be used to demonstrate the various skills and knowledge noted herein (Appendix D).

SAFETY

Dog handler safety practices on and around water are extremely important.

There is a saying amongst white water boatmen, **"if you don't want to swim In it, don't boat on it"**. it is something to think about. Each handler should make a conscious decision about participating in water searches. An individual handler may want to limit his or her participation to specific types of water environments, such as lakes, ponds, and reservoirs, and leave the rivers, streams, and strong tidal estuaries -- particularly those with fast current and rapids -- to only those with special training. It's your life.

In any case, before getting in a boat think about "what if it capsizes?'. You don't want to lose anything, so **tie your gear to the boat** (not to yourself) and **wear a personal floatation device (PFD)** -- experienced, knowledgeable boaters, particularly on swift water, wear PFDs at all times on the water. In many areas it's required by law, so get used to wearing one.

Watch out for and **secure loose ropes or lines** attached to the boat. Be aware of your dog's leash; it could be a hazard, too. You might want to take off your dog's collar and loop the leash around the dog's neck for control.

You should take only the gear you think you will need with you on the boat. If you don't need gear, don't take it – especially radios. It should be in a waterproof container capable of being tied to the boat. Carry or wear wool sweaters and socks even in late spring and early autumn - **wool when it is wet is warm**. Be very conscious of the potential for hypothermia. It is best to stop operations and make sure the wet searchers are not in jeopardy -- remember that water chill steals body heat 24 times faster than dry air. The American Canoe Association video entitled Cold. Wet and Alive, documents the process of a person getting hypothermia in a recreational setting by making a series of judgmental mistakes (Appendix D). This information easily translates to a search situation. Dogs get hypothermic, too.

SELF RESCUE TECHNIQUES

In both flat and fast water situations, if the boat tips over, the general rule of thumb is **stay with the boat.** Do not try to-swim to shore. Probably the most important thing to do **is stay calm, conserve energy (and body heat) and use your head to survive** -- like Hug-A-Tree -- hug something that floats and get into the fetal position to conserve body heat. Panic is your worst enemy!.

If you should capsize on a river or stream, **let the dog go.** Dogs instinctively seem to know what to do in a current better than we do. Stay with the boat, but **YOU MUST ALWAYS BE UPSTREAM OF YOUR BOAT.** In the water where there is any sort of current, if you get caught downstream of your boat, and between the boat and a rock, you will be injured and possibly killed. The force of relatively slow current can wrap a canoe around a rock. You don't want any part of that package! **DO NOT GET DOWNSTREAM OF YOUR BOAT.**

The Alan Madison Productions video entitled Swept Away ... A Guide to Water Rescue Operations, (Appendix D) is a comprehensive rescue training film which has been developed for emergency personnel who are called upon to respond to water emergencies. Even though water search dog handlers do not respond to swift water

rescue emergencies, many of the demonstrations are most appropriate for handler training.

If you find yourself in a rapid or fast current, you want to relax to the extent possible and **float on your back with your feet first going downstream** until you get to slower water. This way, if you hit rocks, it's your feet that make contact, not your head, and you can also see what is going on. Depending on the exact circumstances, you might want to release your hold on the boat, for reasons stressed above. One exception to the feet first rule is: If you see that you are approaching a **strainer**, you must be in a position to **crawl up and over the strainer** upon contact, so quickly maneuver to approach hands first.

Again watch out for loose ropes floating in the water. If someone throws you a line, hold on with the **line over your shoulder**. Again, you should be on your back in the feet-first-downstream position. In this position, the water flowing over your head will still allow a breathing space.

If you hold the rope under you in fast current, there is no air pocket for breathing space; "climbing" or pulling yourself up on the rope will only tend to force you under the water. Again, if someone throws you a line, **don't tie it around you or wrap it around your hand** - in heavy current you must be able to let go in case the forces at work begin to tow you under the water. These are all things you must remember for self-rescue (Appendix E).

KNOWLEDGE AND RECOGNITION OF HAZARDS -

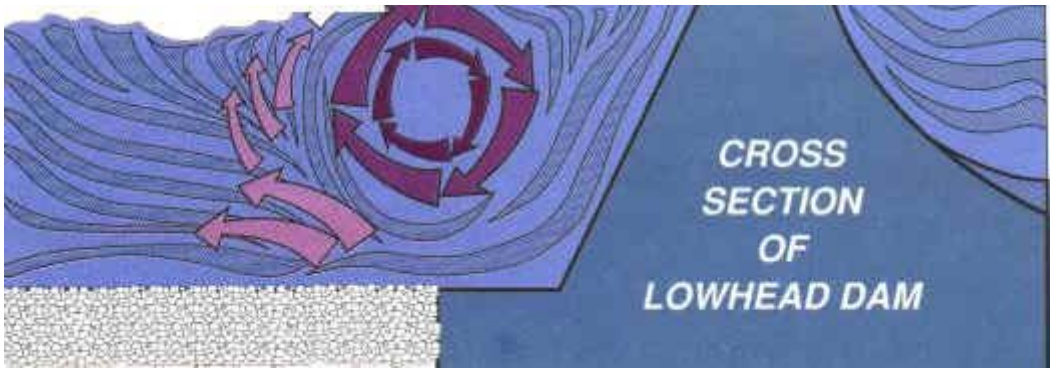
There are a number of hazards found on rivers and streams that must be recognized and understood by handlers who are going to participate in searches in this environment. They include:

- Low Head Dams
- Entrapment
- Ledges
- Strainers
- Eddies

One of the interesting things about these hazards is that **they are also good places to look for the victim**.

Low head dams are often referred to as the "drowning machine". They are usually man made structures - six inches to 10 feet high - across a river or stream. As your boat approaches a low head dam from upstream, the dam may not look like much and you might be tempted to "run it." **DON'T**! Take the time to go to shore and "scout" the situation. It is best to carry your boat

around such hazards. In order to successfully "run " the dam, your boat must clear the downstream backwash and boil and enter the outwash area. As the water level rises, the boil and backwash area move downstream and the potential of becoming trapped in the drowning machine becomes a sure thing.



Cross Section of a Low Head Dam

The above diagram of the cross section of the low head dam shows what is involved. Let's say a dog team and boatman in a john boat try to run the dam for some reason. The boat does not clear the backwash and boil. The boat is pulled back by the backwash to the face of the dam. Water pouring over the dam swamps the boat and capsizes it. The people, boat, dog and gear will be swept down the face of the dam in a vertical eddy, then washed out under the boil, where they will struggle to the surface. Since they are still in the backwash, they will be drawn back toward the face of the dam and continue to be cycled through the drowning machine -- a very efficient, usually man-made, hazard. This process can continue for many hours or days until the water volume over the dam or something downstream changes the character of the backwash.

If you should find yourself is this situation and you are a strong swimmer, try to work your way toward one shore as you are cycled. Hopefully, a knowledgeable rescuer on shore can help you. There have been a few strong swimmers who have escaped by riding the vertical eddy to the bottom of the dam and, while staying close to the bottom, swimming downstream to clear the boil and surfacing in the outwash. This is very difficult; you don't know what sort of debris may catch you at the bottom and you may not have a second chance if you get caught.

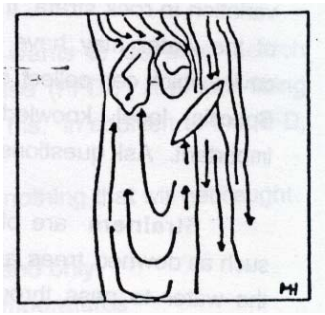
I **mean** to scare you about low head dams. They are deadly! You too can become one of their victims. Avoid the hazard and search the backwash zone from the shore if possible, but **never from a boat downstream of the dam**. Even with a strong motor, the backwash is stronger and you may be sucked upstream into the drowning machine. There are fast water rescue groups who are trained to handle this sort of rescue and know the techniques that work. Let them do it. Unless you know your boatman's skills and experience, remember that discretion is the better part of valor.

Eddies are formed by strong currents and any obstructing rock or exposed ledge -- either at the shore line or in midstream. Eddies are immediately downstream of these

features and are like shadows in the current. In an **eddy the current flows upstream**. A log, for instance, will slowly circulate in an eddy and may be held there for some time.

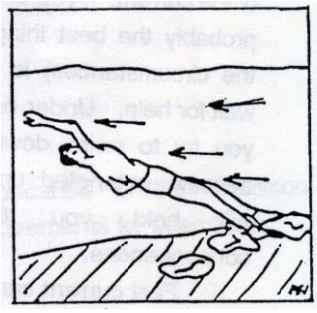
The boundary between an eddy and the fast downstream current is sharp Unless handled properly in a strong current, a boat can get into difficulty at this boundary. Imagine that you are in a boat that either leaves the eddy or leaves the fast downstream current. Either way, there is downstream pressure on one end of the boat and upstream pressure on the other end. If the maneuver is not executed property, the boat may capsize.

While searching, particularly after a flood, be aware that during a flood strong eddies are formed behind large trees in the water. There is some evidence that these eddies may be one of the few places that a body can sink to the bottom during a torrential flood.



Entrapment happens in shallow water, water measuring at least above the knees, when a person who is walking across a current loses his balance perhaps because his foot becomes caught between two stones or clothing becomes caught on an underwater snag. In any case, the current puts pressure on its new victim's body forcing it downstream while the jammed foot becomes a secure anchor.

The victim is helpless as far as being able to free himself and quickly drowns, even as friends nearby watch, helplessly. The American National Red Cross video entitled Uncalculated Risk presents a brief but vivid demonstration of entrapment (Appendix D).



Do not wade swift currents. If you are effecting a self rescue from a capsized boat, try to enter an eddy while swimming -- don't stand up until the depth of the water is knee deep.

Ledges are exposed edges of rock strata in the water that may stretch across all or only part of the river or stream. Ledges are a natural form of a low head dam. In addition depending on the variation in rock strata, the continuing vertical action, of the water may have carved out an underwater cavity which can collect debris, including your victim. Specific local knowledge of these features is important. Ask questions.

Strainers are obstacles in the water, such as downed trees and brush, which allow the water to pass through but do not allow larger objects, such as boats or swimmers, clear passage. If a strainer is approached incorrectly, your rescue boat could swamp and get stranded or pinned against it by the force of the current. If you find yourself in the water, probably the best thing to do (depending on the circumstances) is **try to climb up** and wait for help. Under no circumstances should you try to swim down and under. if you become entangled under water, the current will hold you there, with obvious consequences.

Fast current can carry a boat into over hanging branches, trees, and undercut banks on the outside curves of a stream with. much the same hazard and outcome as, being caught by strainers.

Strainers, however, are probably one of the best places to look for victims, particularly those in flood-related incidents. A number of victims in the **National Water Search Study** (Appendix F) were found in this situation. There are underwater strainers, too. They don't have any effect at the surface, of course, but they are effective collection areas for a submerged body.

One thing to remember is that, in a flood situation, the river has probably exceeded its banks and may have taken a shortcut across the bends and curves of its normal course, so the search area also includes the land areas over which the water flowed. Strainers then might be a riverside forest, fences, hedgerows, buildings, etc...

SPECIAL EQUIPMENT -

In the opinion of -this author, any handler who wants to do water search should invest in his or her own personal flotation devise (PFD). A proper fitting PFD may mean the difference between life and death -- his. In addition to the PFD, the following items are recommended:

- **whistle** -- tied to the jacket on a short string (nothing that will get caught or tangled if the boat upsets)
- **knife** -- accessible and open able with one hand only
- **thermometer** -- to measure air and water temperatures
- **light** -- waterproof and pinned to jacket
- **small map case** -- to enable the recording and documentation of alerts
- **waterproof radio bag** -- only way to protect radio on a boat
- **waterproof bag for gear** -- carry spare clothes, camera, etc..
- **Croakies, Chums', etc..** --for eyeglass retention
- **throw rope** -- small size is adequate
- **buoy** - either home or commercially made

TYPES OF WATER -

The following types of water are grouped because of their common characteristics and the special knowledge and skill requirements for searchers: Lakes, ponds and reservoirs

Flooded valleys

Tidal waters

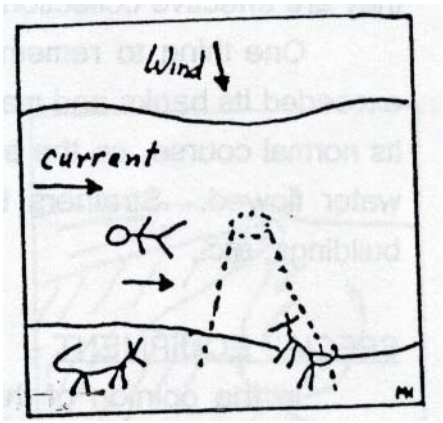
Rivers, streams and creeks (normal flow)
Rivers, streams and creeks (torrential flood)
Quarries, marshes and floating bogs

The handler is referred to Diver Rescue and SAR Canine Units - The odd couple That works for further details (Appendix M).

STRATEGIES -

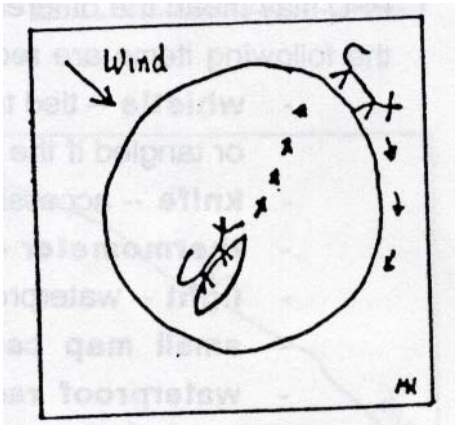
A dog team can work from any accessible shoreline or from a boat. The scent that rises from the victim to the water surface is first acted upon by the various currents in the water and then, if conditions are right, the air currents take over.

The size and depth of the body of water to be investigated, the wind direction and force, as well as air and water temperatures, determine what approach to take, such as searching from a boat, from the shore, or by swimming.



Lakes and ponds can often be covered from the shore. Don't forget to look for clues such as the visible depth, a disturbance in floating duck weed, and algae or shoreline vegetation, footprints, and ease of access to the water, to name a few.

If the body of water is large enough, boats can be used to grid the area. Any alerts should be marked with a buoy of some kind or observed from shore points so that divers will have a reference point from which to start their underwater search operations. Be aware that human scent from the buoy or its line can be detected by the dog, so mark the alert after the last dog has checked the area.



Flooded quarries should be searched from a boat -- the sides of the quarry may be too high, steep or hazardous for a search from the shore. Quarries are usually deep and the water very cold all year around, which may put the divers in jeopardy, especially if they are sports divers and not trained or equipped for deep underwater search and recovery.

Rivers, streams and creeks also can be searched from the shores or from boats. Swimming your dog under some, circumstances is all right, but consider your dog's swimming ability and its experience in currents and be sure of what hazards are downstream -- dogs and strainers are not a good combination; also, dogs can get hypothermic, too.

One thing to remember in any search is that if you can determine where a victim isn't, you have positive information. This is particularly true in a water search -- specifically, the divers will not have to search those areas cleared by dog teams. Areas cleared can be significant when you are dealing with many miles of river or hundreds of acres of a lake, bay or reservoir.

RECORD KEEPING – NATIONAL WATER SEARCH REPORT -

The NATIONAL WATER SEARCH REPORT was developed as a mechanism to systematically collect data about water searches throughout the SAR dog community. The objective was, and still is, to document the fact that dogs have been responsible for detecting drowned victims and to identify some basic rules-of-thumb that might help dog handlers and search managers to identify the most likely areas to be searched.

In 1988, the results of the first National Water Search Study were reported in Dive Rescue and SAR Canine Units. the Odd Couple That Works (Appendix M and summary at Appendix F).

Before starting a water search, you will want to know the answers to a number of questions in the NATIONAL WATER SEARCH REPORT (Appendix G). You will note that the report is interested in three time frames -- the incident, the search (with dogs) and the recovery. These are important because conditions during the search can differ dramatically from those of the incident.

A water search is like any other investigation -- evidence, clues, witnesses, and information about the victim, as well as specific knowledge of the waters involved from local fishermen and water rescue folks, together with the use of topo maps, are all crucial to the solution and should be recorded.

ESTIMATE - WIND FORCE (BEAUFORD SCALE) -

A copy of the Beauford Scale is furnished (Appendix H) and its use is encouraged -- for both water and land search.

MEASURE TEMPERATURE- AIR AND WATER -

Both air and water temperatures are important information when trying to predict where to search, to analyze what happened or to estimate what will happen in a water search. For instance, there is evidence that, if the air temperature is cold, such as 35 degrees F or below, the rate of evaporation as well as wind force and barometric pressure affect the emerging scent from the water and, although the scent may be pooling at the surface of the water, it does not get airborne. In such a circumstance, the dog may pick up the scent only at the water surface while swimming. On the other hand, when the water temperature is 38 degrees F or higher, the victim's body will decompose and form gases, changing its

buoyancy (depending upon the depth), and the body will surface (assuming there are no inhibiting conditions).

ABOUT WATER - CURRENT -

The water in lakes, ponds and reservoirs usually doesn't have current caused by the water's flow, as is found in waters such as a river. The wind, however, acting on the water's surface will make it appear otherwise, especially if your boat is drifting. In fact the force of the wind on the surface is the cause of the circulation and mixing action constantly at work in confined bodies of water such as lakes. There can be reasons for a lake or, particularly, a reservoir having a flowtype current -- for instance, when water is being released from a dam.

In any case, if a person drowns, uninjured or otherwise (a "wet drowning"), the rule of thumb is that the recovery will be made within a circle whose radius equals the water's depth. If the body is not located, it usually means that the reported Point Last Seen (PLS) may not be accurate and the use of dogs could be helpful.

Water flows down hill and it is heavy. The water is contained in a creek bed, stream bed or river bed, as the case may be. Generally, the water in contact with the stream bed flows slower than the water at mid-stream near the surface . because of friction. Its flow may vary at all levels in between.

When water flows through the bend in a river, the weight of the water and centrifugal force cause the water to pile up against the outside bank, sometimes undercutting that bank. Again, friction causes a differential in flow from the bottom and sides to the surface. The main or fastest current also will be closer to the outside curve, whereas the current on the inside of the curve will be slower. Watch out for shallows typically found on the inside curves.

As mentioned earlier, each handler who wants to participate in water search in swift water should have sufficient water reading. knowledge and skill to stay out of trouble. The best way to learn water reading is to do it under supervision on a river. If this can't be done readily, it is recommended that the-handler buy or borrow the Bill Mason video entitled PATH OF THE PADDLE WHITE WATER (Appendix D). You don't have to become a canoeist, but the water reading instruction is excellent, and you will be more able to read the water along with your boat handler and estimate problems that might be ahead. Knowledge of the International Scale of River Difficulty is appropriate (Appendix N).

ABOUT WATER - PHYSICAL LAWS -

Whether a body floats or sinks depends primarily upon its buoyancy (Appendix J) and, in extreme cases, such as torrential floods, upon the magnitude of the surface current.

There are three states of buoyancy: positive, negative and neutral. Positive means a body floats; neutral means the body will remain suspended in the water at any depth; and negative means a body sinks.

The density or weight of a unit volume of fresh water is 62.4 pounds per cubic foot, salt water is 64.4. We don't think of ourselves normally in terms of pounds per cubic foot. but the density of the human body is approximately the same as the density of water; therefore, the human body is almost neutrally balanced in water. There are some variations, however. For instance muscle weighs more than fat, so a lean person will be more negatively buoyant and sink; the amount of air, if any, in the lungs will change a person's "volume" and thus one's buoyancy.

"Wet drowning," death by asphyxiation, is the most frequent type of drowning associated with boating and swimming accidents. During the struggle to breathe, water enters the stomach and lungs, reducing the victim's buoyancy, and the victim alternates between negative and neutral buoyancy.

"Dry drowning" is less frequent; little or no water enters the lungs. The victim suffocates because of an automatic physiological blockage of the breathing passage -- one cannot exchange good for bad air. Dry drowning may be associated with a traumatic incident before entering the water or with the shock of entering cold water. In dry drowning cases, the lung buoyancy is maintained and, if the person normally has positive or neutral buoyancy, he or she will float on or near the surface.

As an individual searching in the water environment, you should be aware of your own normal buoyancy_ I'm sure you can get measured in terms of pounds per cubic foot, but it probably is sufficient to be conscious` of how you float in a pool. If you have trouble floating, make sure that the PFD that you buy gives you adequate support. There are different ratings, for example, 15 or 20 pounds of additional buoyancy can be obtained.

Other inter-related variables contribute to what is likely to happen to a victim who has gone down, particularly to a deep and/or cold resting place. Some of these include: water depth, pressure, temperature and the volume of water displaced by the victim.

We have all heard, "We'll wait until the body floats, if we can't find it soon." What happens to these bodies in relatively deep water? Will they come up? When the water warms, won't the natural processes of decay take over to form gases? Won't the volume of water displaced by the body increase until a neutral state of buoyancy is achieved and the body starts to float? This process is true when the water temperature reaches 38 degrees F or warmer and it isn't very deep. At temperatures below 38 degrees F, we are dealing with

preservation by refrigeration. An understanding of the "pressure principles" will help us understand what to expect.

Water has weight because the force of gravity pulls on each molecule of water. Water pressure is equal in all directions at any given depth and is measured in pounds per square inch (psi). The pressure increases by 0.433 psi for each foot of depth in fresh water (fw) (0.445 psi, in salt water). In other words, at 34 feet, the water pressure, alone, has increased by ' 14.7 psi (fw), or one atmosphere of air pressure at sea level. At 68 feet, the water pressure is two atmospheres, etc. A number of our searches have been in waters 150 feet or more -- close to four and a half extra atmospheres of water pressure holding the victim down.

What this means is that the deeper the victim is, the less likely he is to come to the surface. As the depth increases, the pressure increases and, the body becomes more compact because the body cavities collapse. Boyles Law (Appendix J) essentially tells us that in order to "inflate" the cavities sufficiently to increase the body's buoyancy, the pressure of the gases in the cavity would have to exceed, that of the surrounding water -- not likely to happen naturally.

But what about the water temperature? How does it change? And do we care or need to know about water temperature during our searching -- in the summer it is warm and in the winter it is cold ! So ... wait until summer and the body will rise.

If we think about our lake, pond, and reservoir-type systems, there are two factors which determine how warm the water will become: 1) the amount of solar heat (intensity and duration) received at the water's surface, and 2) the amount of water motion or mixing of the warmer surface water and the colder water below, caused by the wind. Another factor to include is that, as the water temperature changes, its density also changes. Water is most dense (weighs the most) at 39.2 degrees F and, for water temperatures above and below, the water is less dense. What this all means is that is that as the seasons change so do the physical characteristics of the lakes, pond and reservoir systems. For instance, in the winter the surface temperature of the water may be low enough to form ice. The lower temperature ice is "floating" on the heavier, warmer water under the ice. At this time of year the water temperature will be relatively constant, at 39 degrees F, from the bottom to some depth just under the ice. Divers sometimes dive this time of year because the visibility is good - the plankton population is low and the lack of mixing reduces the suspended sediment problem.

As the ice melts, the sun and the wind raise the surface temperature (and therefore density) so it is uniform throughout (39.2 degrees F).

Spring arrives: the increased solar heating and the wind activity continue to warm the body of water.

As the summer months approach, the intensity and duration of the solar heating is maximum. The sun's heat spreads slowly through water, so that only the top layers warm up rapidly; the temperature of those layers near the bottom may never rise much above

39.2 degrees F. The winds up until now have been able keep up with their job -- to mix and stir the warm with the cold water. As the water warms, however, it becomes less dense or lighter in weight. As a result, a sharp division forms between the upper and lower waters of the lake. _ The deeper colder layer is sealed , off from the top by a zone of rapid thermal transition, called the thermocline.

Oxygen cannot diffuse through the thermocline from the warmer layer. In some lakes, hydrogen sulfide, a toxic gas, is formed in the stagnate bottom layers.

As the season changes to fall, the solar heating diminishes and, as the surface temperature cools, the density of the water increases until it approximates that of the lower layer. The winds are able to circulate and mix the surface water with the bottom water again, and the thermocline is destroyed. Usually about November the water is of equal density throughout; the wind produces the "fall overturn", which is the event that allows the bottom layers of water to become resaturated with oxygen. The water continues to cool at the surface, and ice may form again.

Thermoclines are certainly of interest if we are searching for some one through one or more thermoclines in the summer. There is evidence that physical interruption of the thermocline by fish swimming from the lower layers up to the warmer layers (chasing their lunch, for instance), anchor lines or air from a high pressure hose passed through the zone, are all possible techniques to release scent that may be sealed off by the thermocline. Knowledge about thermoclines suggests that, if when you search is an option, searching with dogs may be more efficient in the spring, winter and fall.

ABOUT DIVERS -How to work together -

When working with recovery divers, it is good to know something of their modes of operation and their limitations. For instance, divers also have a three dimensional problem in their search medium. The victim is not necessarily on the bottom of the body of water. A body may well be floating some where between the bottom and the surface. Add to that the visibility problems a diver must contend with, such as an inch to one or two feet at most which, even in daylight, occurs in many underwater operations. As a result, divers often must search by touch and feel in areas containing many hazards, such as submerged trees, bridge rubble, old fences and other sharp cutting obstructions. When making deep dives, a diver is limited in the amount of "bottom time" he can accumulate within a 24 hour period -- this could be only a few minutes at 100, feet, for instance.

When training with divers (or anyone), make sure they understand what you want. They will probably be interested in whether or not the dogs will bite them. Such things as how deep they should be; when they should come up; what should they do when they surface; should they stay in one spot or move around; and how long should they stay under are all important items to discuss ahead of time.

The divers should be briefed on how the scent works and how they are involved in the various steps of the scent training. Making Marcia Koenig's video tape, and other handouts available will be beneficial; after all the divers are an integral part of the training process. We can also learn from them.

KNOW YOUR LIMITATIONS -

Remember, each handler should make an assessment of his or her water skills and knowledge: -Only then can one make a conscious decision about whether or not one wants to participate in water search and to what extent -- i.e. in flat water only or both flat and swift water.

DOG AND HANDLER WATER SKILLS TRAINING

As with most of SAR dog training, it is a game. Sticks thrown in the water are great fun to retrieve -- the water might be a stream with current, the still water of a lake or the surf at the beach (either fresh or salt water). At first, the dog may try to swim in an almost vertical attitude with lots of splashing -- not very efficient, probably due to inexperience and to not being at home in the water. With encouragement such as using stick games, the dog will relax and the swimming position will flatten out and become more efficient. Lots of practice is important Don't fall into the trap of thinking that if your dog (or you, for that matter) can swim some arbitrary distance, such as 150 feet in still water, it means anything The important thing is that you and your dog are comfortable in the water. This is observable. Dogs have been known to swim without touching bottom for an hour while playing keep-a-way and some will even give free rides to their handler, who holds on to the dog's tail for a while. Swimming with your dog can be fun and a good training exercise, but be careful! Don't let your dog climb on you. You will be pushed under water and could get into trouble if there isn't someone to get the dog away.

Continue to practice your basic boatman skills with your dog -- use different types of boats, in different types of water, turn the boats over (it appropriate), practice with a throw rope, estimate the current speed (Appendix K). Have fun, but learn and respect the water environment. This is one of the aspects of team readiness in water search.

DOG TRAINING -

As mentioned earlier, the dog can usually search from a boat, the shore, and from the water while swimming. So there are really three parts to the training:

- to detect human scent coming from under the water,
- to work while riding in some sort of boat, and maybe
- to work while swimming in the water.

Any dog trained to tell its handler when it has located generic human scent can do a water search reliably no matter what basic training techniques are used. This includes-, police K -9s and Bloodhounds as well as air scent search dogs. The principle is the

same. You simply make you- dog aware that human scent can come from under water just like other odd places, such as up in trees, under ground, under snow, or under debris .

The method used by most SAR dog handlers to introduce the dog to human scent from under water is with a diver wearing scuba gear. The diver enters the water and lingers at a spot a few feet below the surface. When the dog passes downwind of the scent coming from the diver, the dog will alert in some fashion -by pawing or biting at the water, whining or barking. In a boat, the dog might scratch at the bottom of the boat in frustration, or try to jump into the water. The handier recognizes the alert and immediately signals the diver to surface and together they reward the dog (who will probably be surprised when the strangely dressed person pops up). Thus, both the handler and the diver reinforce the dog's action to alert on human scent coming from the water. The reward and timing is the single most important factor for both novice and experienced water search dogs during training.

Signaling the diver to come to the surface quickly is not easy. Banging on the bottom or side of the boat won't work if the diver is too deep (such as 5 or 10 feet) or if there is motor activity in the water area. The best method we have found is to attach a long piece of fish line to the diver and have an assistant on shore to signal the diver.

Once the dog is aware that a victim's scent might come from under water, it is up to the handler by practice to learn' to read his or her dog's particular body language and to interpret what the dog is detecting under the various water conditions that occur in current, rapids, cold weather, and very deep water, to name a few. Water search is a very active and continuing learning process for the handler. The dog should have no problem -- it only has to react to the presence of human scent. The handler must interpret it. In the different practice exercises with the dog, it is recommended that the **handler always know where the scent target is!!**

Please understand that there are variations to the process of introducing the dog to a diver's scent. We have seen an experienced wilderness search dog, that was internally driven to "find", pick up the concept immediately after one or two passes with the diver. We also have seen less experienced dogs or dogs that were not as internally driven, have to go through a more elaborate step-by-step process.

The process can start with a run-a-way where the diver ends up in shallow water and visible to the dog; then a run-a-way where the diver submerges as the dog approaches either by wading or swimming; then a slightly submerged diver from a boat and so on. The systematic process is recommended as being the most likely approach with which to start. Of course, the dog is rewarded for each success. The dog's reward and the timeliness of it cannot be over stressed! For those who have access to a VCR, Marcia Koenig's video entitled Water Searching With Dogs (Appendix D) presents a step-by-step demonstration of a systematic introduction to the dog detecting scent from underwater.

Things to watch out for In water search training:

Do not take your boat directly to and over the diver's bubbles. Pretend that you don't

know where the bubbles are, but work down wind of them. If you are too close to the bubbles, the scent cone may not be up to your dog's nose level. Give the dog a chance, be flexible, and use your dog as a scent detector. If the dog isn't alerting, it probably is not in the scent pattern. Watch out that you don't do "false alert" training. Remember, the dog knows when it detects human scent. You do not !

After the dog is aware of scent from under water, see how far away from a diver's bubbles the dog will detect. Remember, distance is a function of the scenting conditions at the time. You can do some interesting experiments. For instance, if you take the time and conditions are right, you can find the boundaries of ascent pattern -- practice this during training knowing where your scent source is. so you have an experience bank to draw from on search missions. You should practice with an experienced boat handler who knows about air scent strategy. You may have to instruct an unindoctrinated boat handler assigned to you during a search or during your practice sessions, so be aware of his of her need for your guidance. For instance, the boat handler probably is interested in whether or not the dog will bite, and what kind of boat you want. He needs to know: where to go; how fast; how far away; and to keep the motor exhaust down wind of the dog. Part of your training is instructing your boat handler as to what to do -- you are now a team of three.

Individual dogs may catch on at different rates, so don't be competitive with other handlers or too anxious for your dog to alert -- let it come. If the dog doesn't alert from the boat, meaning the dog hasn't caught on yet, go back to basics, if need be. For the dog who does catch on fast, be careful that you don't bore it with a "training process". On- the other hand, you don't want to make big assumptions about what your dog knows and you don't want to be mechanical in the training, either.

In a training session we conducted recently, there were three law enforcement K-9 teams in a class with Search and Rescue trained teams. The SAR dog teams were trained in area search, but they were not very experienced. The K-9 teams were very experienced in their work and very competent. Yet there was a definite difference in the dogs' responses to the water search training. At the end of the session, all of the SAR trained dogs were alerting on submerged divers, but the K-9 dogs were not yet sure what was wanted of them. We talked about this and came to the conclusion that the training approaches are sufficiently different to make a difference.

SAR dogs are trained to work off leash and are encouraged from day one to be curious and to solve scent problems themselves in the hide-and-seek type games. Their job is to tell the handler about clues and when they "find." The reward system is a game of "stick" and lots of praise. A police K-9 team, on the other hand, because of the nature of their work, may not be able to afford the same type of off lead "play" training given to a SAR dog. Their reward was a bite.

For those who are K-9 officers, adjustments may need to be made to the training process described herein; I suspect that the key is in the reward system. But, in the end, each handler must figure out what rewards his or her own dog.

HANDLER TRAINING -

After the dog is aware that human scent comes from under water, additional training sessions are important for the handler to learn to read the dog. A diver or cadaver material is the best to train on, but may not always be available for training sessions. Additional practice can be run using submerged recently worn clothing, packets of human hair, sunburn peelings, toe nails, blood or anything else with human scent to simulate a body for the dogs to detect.

In 1985, Bill Tolhurst developed a "scent generator" for training his Labradors to do water search. Since that time, several variations have evolved, one of which is shown herein (APPENDIX L). The idea is a container of compressed air is connected with a regulator to a bottle containing a scent source and connected to a long hose. The scent can then be "placed" anywhere. This technique works, by the way, for any scent target, such as drugs, specific animals, human scent, etc. Under water, the bubbles (number and size) can be controlled by a small fish tank aeration stone on the end of the pressure hose and by regulating the rate of air release from the tank.

TRAINING THE FALSE ALERT - Watch out, Don't do it!

One of the problems in training for indirect finds, such as those under water, in collapsed structure situations or under ground where a dog can not actually reach the victim -- is that the handler easily and unintentionally train his or her dog to make false alerts. False alerts are defined here, as alerts cued by the handler's body language instead of the presence of human scent.

In an early training situation, the handler in his or her enthusiasm to reinforce the dog's alert (particularly a weak one), urges the dog to alert where the handler thinks the dog must have picked up the scent. If the scent was not there, the dog could be confused by the handler's urging. If the dog reacts in any way, such as looking closer, the handler further encourages the dog to be more excited - - with praise and a reward. The dog in the meantime is thinking, "This is the process used when I learn a new exercise -- wonder what it is. Maybe it means that when my handler moves in a certain, way, I should react like I did. Let's see if it works." The handler tries the scent problem again. As the boat approaches, the handler uses the same body language and the dog alerts to the handler's motion. There is lots of praise, and the dog now has another response here on the water (or on a rubble pile), for which he gets praised -- but not for what the handler thinks or wants.

Another way of achieving this end is: During a search situation, when the victim's location is not known, the handler may try to get the dog to give a stronger alert. Any encouragement and reinforcement, when you do not know what you are reinforcing, may well result in training a false alert -- not the dog's fault. This confusion may also be associated with a handler's lack of confidence and experience in reading his dog.

Handler experience and confidence is a significant factor.

My recommendation is to let the dog tell you when he has detected human scent on the water or on the rubble pile. The intensity of the alert is nothing more than the level of frustration the dog is expressing because he cannot reach the scent source. The frustration level can be enhanced by training, if it is thought necessary, but only after the you know, the dog has detected. "Trust your dog" is a basic maxim. We humans are not the experts in scent detection

In conclusion, an agency requesting water search dog teams should expect to get teams who can search from a boat or shore for one or more drowned victims in extensive areas of water, such as lakes, ponds, quarries, reservoirs, rivers, streams, estuaries and bays. Dog teams should be comfortable and experienced in searching from various types of boats under various weather conditions. Dog handlers who search rivers and streams with fast currents should be knowledgeable about river hazards and the necessary safety precautions.

The foregoing is a guide to assure that the agency's expectation is met. The checklist is your way to keep track of where you are in your water training.

Appendix A

WATER SEARCH TRAINING CHECK LIST

Name:_____ Start Date:_____
Dog's Name:_____ Breed:_____

Special Training for Handler - Safety skills and knowledge of water environment

a	Boatmanship (independent hands-on course should include * below) :	1)	2) 3)
b.	Safety: *	1)	2) 3)
c.	Self rescue - flat water: *	1)	2) 3)
	Self rescue - fast water: *	1)	2) 3)
d.	Knowledge and recognition of hazards:	1)	2) 3)
e.	Special personal equipment:	Have: Yes	No
f.	Types of water search:	1)	2) 3)
9,	Strategies:	1)	2) 3)
h.	Record keeping - National Water Search Report:	1)	2) 3)
i.	Measure - air and water temperature:	1)	2) 3)
j.	Estimate - wind force (Beauford Scale):	1)	2) 3)
.	About water - Currents: *	1)	2) 3)
l.	About water - Physical laws:	1)	2) 3)
m.	About divers - How to work together:	1)	2) 3)

Dog and Handler Water Skills Training -

a	Swimming - calm water - some current: *	1)	2) 3)
b.	Swimming - fast current and/or waves:*	1)	2) 3)
c.	Boating - canoe:*	1)	2) 3)
d	Boating - rubber boat:*	1)	2) 3)
e.	Boating - flat bottom (john boat, bass boat):	1)	2) 3)
f.	Boating – other	1)	2) 3)

<u>Dog and Handier Water Search Training - Scent from Water</u> - Dog and handler must meet prerequisites before starting the following -

a	Run-a-way into water (with diver):	1)	2)	3)
b.	Run-a-way and submerged (with diver):	1)	2)	3)
c.	Search from dock or structure in water ("):	1)	2)	3)
d.	Search from boat (with diver):	1)	2)	3)
e.	Search from shore (with diver):	1)	2)	3)
f.	Search while swimming (with diver):	1)	2)	3)
g.	Search from boat (using other targets):	1)	2)	3)
e.	Search from shore (using other targets):	1)	2)	3)
f.	Search while swimming (using other targets):	1)	2)	3)

Note:
1)_____ Date of formal instruction (completion of course, read this paper, etc..)
2)_____Date of in/on-water activities
3)_____Dates of continuing practice/experience/study

Appendix B:

List of Fast Water Rescue Trainers

NASAR Education Department (703) 222-6277 www.nasar.org
4500 Southgate Place, Suite 100
Chantilly, VA 20151

Pennsylvania Fish Commission Bureau of Boating
P.O. Box 1673 Harrisburg, PA 17105-1673
Virgil Chambers (717) 657-4392

Ohio Department of Natural Resources Division of Watercraft
Fountain Square Columbus, OH 43224-1387
Emily King (614) 265-6504

Rescue 3
10519 East Stockton Blvd, #175 Elk Grove, CA 95624
Jim Segerstrom (916) 685-3066

Indiana River Rescue School
701 West Sample St. South Bend, IN
Sgt. Michael Mc Gann (219) 284-9144

Appendix C:
Force of Water

The force of water against an obstacle such as your legs or a swamped boat, increases in proportion to the square of the velocity of the current.

Current Velocity (cubic feet per second)	Average Total Force of the Water (foot pounds)		
CFS	on legs	on body	on swamped boat
3	16.8	33.6	168
6	67.2	134.0	672
9	151.0	302.0	1512
12	269.0	538.0	2688

Trying to stand in hip deep water would be very difficulty even at a current velocity of 3 cfs, particularly if you were trying to cross a stream with a slippery uneven rocky bottom.

Appendix D: Video Tape References

Swept Away... A Guide to Water Rescue Operations *
produced by Alan Madison Productions 1990
This all-new and comprehensive rescue training film has been specifically developed for emergency personnel who are called upon to respond to water emergencies. Based on the most up-to-date technical source, this film provides an in-depth look at the essentials of water rescue and can serve as an invaluable training resource for both new and experienced emergency personnel. 30 Minute Video Tape

Path of the Paddle White Water
produced by Bill Mason 1984
"Join the experts for a day of thrilling white water wilderness canoeing. Learn the tricks of the rocks, waves and rapids and experience the sheer joy and exuberance of white water adventure. In Path of the Paddle: White Water you'll learn how to read the rapids and their ever-changing moods. You'll see how to apply specific paddling strokes to keep canoeing exciting and dry. ... Whether paddling alone or with someone, you'll learn clearly how to locate deep water channels and steer the canoe where you want to go. And if you should blow it and "wipe out" in a turbulent rapids you'll even learn how to survive the swim." 54 Minute Video Tape

Water Searching With Dogs *
written and produced by Marcia Koenig 1990
This videotape is designed to assist search dog handlers in developing a training program to teach their dogs to locate underwater subjects. Shows several kinds of water exercises and different dogs' reactions to those exercises -- from strong alerts to weak alerts. Covers problems such as hesitant dogs, bubbles, timing, and using only live subjects to practice on, and suggestions for correcting these problems. 45 Minute Video Tape

Cold, Wet and Alive *
produced by the American Canoe Association, Inc.
Along with covering the traditional topics, "Cold, Wet and Alive" documents the process of a person getting hypothermia in a recreational setting by making a series of judgmental mistakes. Utilizes stop action computer enhanced diagrams depicting thermograms which graphically show the physiological changes in the body occurring from hypothermia. 23 minutes.

Uncalculated Risk
produced by the American National Red Cross
The skills and knowledge needed by boaters in the river environment are demonstrated. Various hazards are discussed, and a vivid demonstration of entrapment is included.

Other tapes of interest produced by the American National Red Cross in cooperation with the U.S. Coast Guard are:
White Water Primer (1978) and **Margin For Error (1979)**
* Available from the NASAR Bookstore P.O. Box 3709 Fairfax, VA 22038

Appendix E:
Check List For Self Rescue

- Plan ahead -- When water temperature is 50 degrees or below, wear cold water protection such as a wet suit or wool.
- wear your PFD and hard hat
- stay calm
- stay with boat
- stay up stream of boat
- stay calm and conserve energy
- let dog go -- do not try to control him
- float on back, feet first down stream
- crawl over strainers
- hold line - do not tie or wrap around hand
- float on back with line over shoulder (forms air pocket)
- stay calm

Appendix F
WATER SEARCH FACT SHEET

Marian Hardy
Mid-Atlantic D.O.G.S., Inc.

This Fact Sheet (1988) is based on 122 water search reports sent to the National Association for Search and Rescue (NASAR) from the Search and Rescue (SAR) dog units around the country. Twenty-six different SAR dog units - from Maine to California and from Washington to Georgia as well as one in Canada - were involved. Of the 130 victims involved, 84 were found by dogs, 24 were recovered out of the area searched and 22 have not yet been recovered. Also of the 22 victims not recovered or found, the dog alerts in 9 instances could not be followed up by divers or draggers because the location was too hazardous to the divers, too deep (150 feet)- or, in the case of flooded valleys, the remaining trees, buildings and bridges underwater were not suitable for dragging.

In order to analyze the data collected, and the elements of information were tabulated from the information sources against seven water types. The results are detailed in Figure A.

You will note in Fig. A that the rate of success using dogs is at least 84% in the lake, pond, reservoir situations. You will also note that 68% of the victims found were recovered by divers (or in some cases by dragging operations) from the bottom.

When looking at the statistics for flooded rivers and streams, at least 42% of the victims are found outside the area searched by dogs or others. Forty-two percent compared to 16% (normal flow rivers) and 14% (lakes) may be significant. The "finds" in the flooded river situations were at 23, 40, 10, 13, 12, 17, 3/4 and 1 /2 miles, respectively.

One thing to remember in any search is that, if you can determine where the victim isn't, you have positive information. This is particularly true in water search -specifically, your divers will not have to search those areas cleared by dog teams. Areas cleared can be significant when you are dealing with many miles of river or hundreds of acres of lakes or reservoirs.

A Bibliography of all articles written on the subject of water search with dogs is available from the NASAR Bookstore as are the articles themselves. The next iteration of the study should be available in early 1992. For further information or contributions to the study, please contact:

Marian Hardy, 4 Orchard Way North, Rockville, MD 20854 (301) 762-7217.

		Rivers, Creeks, Streams Normal Flow	Lakes, Ponds, Resirviors Contained	Rivers, Creeks, Streams Flooded	Catastrophic Floods	Flooded Valley	Tidal Areas	Other, Floating Bog, Marsh, Quarry	Totals
Searches		59	27	16	4	5	8	3	122
Units Involved		20	14	9	4	2	5	2	26
Victims		64	29	19	2+?	5	8	3	130
Found by dogs		44	21	6	2+?	1	7	3	84
Found out of Search Area		10	4	8	?		1	0	24
Not Found		10	4	5	?	3	0	0	22
Found:	On the bottom	27	17	9			3	1	57
	Floating	26	7	5			5	1	44
	Other	2	Alive					Alive	6
Max Days between incident and dog search		192	26	48		30	2	48	-
Maximum depth found		60’	75’	41’		80-150’	10’	80’	-
Worked with divers		20	21	3		2	2	1	52
Distance from PLS	Max distance	8 miles	500yrds	40 miles			4.5 miles		-
	Number of reports	26	16	8			4		-
	Average distance	1.1 miles	50 yrds	13.3 miles			1.3 miles		-
Success rate by dogs (at least)		82%	84%	55%		25%	100%	100%	79%
Recovered by divers		50%	68%	64%		-	38%	33%	53%
Found outside of area		16%	14%	42%		20%	13%	-	18%

Appendix G
National Water Search Report

The Incident -

Show PLS, location of containment techniques, location of clues, and areas of water recovery activities(#)on copy of too map or diagram.

Date:_____Time:_____ Weather: Clear___; Stormy____ Other ____
PLS:_____

Type of incident: boating____ swimming ___; storm related___; other___

Type of water: lake/pond _____ marsh/swamp ____ tidal water ___ quarry ____
creek/stream ___ ; river ____; Other _____

Normal flow____; in flood_ ___ rising stage_____ receding stage_____
High tide_____; low tide_____; slack_____; current strong____; other_____

Bottom characteristics: mud/muck____; snags____ rocky/ledges_____;
sand/gravel_____ ; other_____
Water temperature: _____
Clues found: shoe(s)_____; hat_____; clothing_____; other_____
Containment techniques: Monitor downstream dams_____, water falls____"holes"___
Set cross stream/river traps_____ Other_____
Recovery attempts#: divers___; dragline____; sonar_____other_____

Previous drowning history of area:_____

The Search -
Show location of alerts and clues found on copy of topo map or diagram.
Unit Name:_____
Date(s):_____ ; Time:_____; Weather: Clear___; Stormy_____;other_____
Water temperature:_____; Thermocline(s)? :_____ Depth(s)_____
Air temperature:_____ Estimated wind force:_____ (Beaufort Scale)

Dog alerts and wind direction:
alert#1, bearing _____; alert#2, bearing_____; (continue on back).
Dog alerted: from boat_____; from shore_____; swimming_____; other_____
Alerts on clothing: yes____; no_____ Clothing found on surface ____;
on bottom_____; on snag_____; other_____
Follow up recovery activities: divers_____, dragline_____ other_____
Distance searched from PLS: by shore_____ by boat_____

The Find -

Show where body found on copy of topo map or diagram.

Date:_____; Time:_____; Weather: Clear_____; Stormy____; other____
Location:_____ Distance from PLS_____
Body found: on surface____; floating between surface and bottom____;
Snagged____; on bottom____ depth____
Found by: divers_____ dragline_____; other_____

Distance of alert to location of body _____

Prepared by:_____ Date:_____

Enclose: Copy of annotated topo map or diagram
Send to: NASAR, c/o Marian Hardy 4 Orchard Way N. Rockville, MD 208.54

Rev. 2/88

The Search -
Show location of alerts and clues found on copy of topo map or diagram.
Unit Name:_____
Date(s):_____ ; Time:_____; Weather: Clear___; Stormy_____;other_____
Water temperature:_____; Thermocline(s)? :_____ Depth(s)_____
Air temperature:_____ Estimated wind force:_____ (Beaufort Scale)

Dog alerts and wind direction:
alert#1, bearing _____; alert#2, bearing_____; (continue on back).
Dog alerted: from boat_____; from shore_____; swimming_____; other_____
Alerts on clothing: yes____; no_____ Clothing found on surface ____;
on bottom_____; on snag_____; other_____
Follow up recovery activities: divers_____, dragline_____ other_____
Distance searched from PLS: by shore_____ by boat_____

Prepared by:_____ Date:_____

The Search -
Show location of alerts and clues found on copy of topo map or diagram.
Unit Name:_____
Date(s):_____ ; Time:_____; Weather: Clear___; Stormy_____;other_____
Water temperature:_____; Thermocline(s)? :_____ Depth(s)_____
Air temperature:_____ Estimated wind force:_____ (Beaufort Scale)

Dog alerts and wind direction:
alert#1, bearing _____; alert#2, bearing_____; (continue on back).
Dog alerted: from boat_____; from shore_____; swimming_____; other_____
Alerts on clothing: yes____; no_____ Clothing found on surface ____;
on bottom_____; on snag_____; other_____
Follow up recovery activities: divers_____, dragline_____ other_____
Distance searched from PLS: by shore_____ by boat_____

Prepared by:_____ Date:_____

Appendix H:
Beaufort Scale

Beaufort Number	Name	Miles Per Hour	Description
0	calm	Less than 1	Calm, smoke rises vertically
1	light air	1-3	direction of wind shown by smoke but not by wind vanes
2	light breeze	4-7	wind felt on face; leaves rustle; ordinary vane moved by wind
3	gentle breeze	8-12	leaves and small twigs in constant motion; wind extends light flag
4	moderate breeze	13-18	raises dust and loose paper; small branches are moved
5	fresh breeze	19-24	small trees in leaf begin to sway; crested wavelets form on inland waters
6	strong breeze	25-31	large branches in motion; telegraph wires whistle; umbrellas used with difficulty
7	Moderate gale (or near gale)	32-38	whole trees in motion; inconvenience in walking against wind
8	fresh gale (or gale)	39-46	breaks twigs off trees; generally impedes progress
9	strong gale	47-54	slight structural damage occurs; chimney pots and slates removed
10	whole gale (or storm)	55-63	trees uprooted; considerable structural damage occurs
11	Storm (or violent storm)	64-72	very rarely experienced; accompanied by wide spread damage
12	hurricane*	73-136	devastation occurs

' The U.S. uses 74 statute mph as the speed criterion for hurricane.

Appendix J:
Buoyancy and Boyle's Law

Buoyancy was first described by Archimedes as follows:

"A body immersed in a liquid, either wholly or partially, is buoyed up by a force equal to the weight of the displaced liquid." Which means that -

- If the weight -of-displaced liquid is * greater than the weight of the immersed object, buoyancy will be positive and the object will-float.
- if the weight of the displaced liquid equals the weight of the object, the buoyancy will be neutral, and the body will remain suspended in the liquid at any depth.
- If the weight of the displaced liquid is less than the weight of the immersed object, buoyancy will be negative and the object will sink.

Boyle's Law states, "The volume of a gas varies inversely with the absolute pressure, while the density varies directly with the absolute pressure provided the temperature remains constant."

In other words, if you double the pressure, the volume is reduced to half and the density of the gas is doubled.

Absolute pressure in water means the sum of air and water pressure (i.e.. three atmospheres at 68 feet). In the case of the body, the volume reduced would be the cavities which would fill with gases.

Appendix K:
Estimating Current Speed

An estimate of the current speed can be made by first measuring a 100 foot length of a river's downstream flow and then observing the time it takes a stick to travel this distance.

Time for Float to Travel 100 Feet	Current Speed	
Seconds	**Feet Per Second**	**MPH**
5	20.0	13.60
10	10.0	6.80
12	8.3	5.64
15	6.7	4.56
16	6.3	4.28
17	5.9	4.00
18	5.6	3.81
20	5.0	3.40
21	4.8	3.26
23	4.4	2.99
25	4.0	2.72
29	3.5	2.43
37	2.7	1.84
50	2.0	1.36
80	1.3	.884
140	0.7	.676

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