CONFIDENTIAL: DRAFT FOR COMMENT
28 September 2007

Guide Book:
Planning and Implementation of
“Point of Entry” and “Point of Use”
Water Treatment Systems
in British Columbia

Appendices

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September 2007

List of Appendices

Appendix 1.1: Legislation in British Columbia

Several legislative initiatives have been undertaken in recent years to improve the protection of drinking water in British Columbia. The Drinking Water Protection Act (DWPA) and the Drinking Water Protection Regulation came into force in May 2003. The Regulation was subsequently amended in 2005.

This legislation requires that suppliers do the following[1]:

- Provide water which is safe to drink;
- Hold valid construction and operating permits; some small systems may be exempted from the requirement for a construction permit;
- In some cases, test their water quality more frequently;
- Undertake increased reporting;
- Inform the public of water which is not deemed potable;
- In some cases, ensure that their operators are certified to operate the system[2];
- Prepare emergency response and contingency plans
- Prepare source-to-tap assessments and response plans if required.

[1] It should be noted that this is just a generalized summary, and the reader should refer to the relevant sections of the legislation. It should also be noted that this is not an exhaustive list of obligations.

[2] Small systems are exempt from the requirement of having an EOCP certified operator unless otherwise required by the DWO in the Terms and Conditions of the Operating Permit. This evaluation is done on a case-by-case basis depending on the complexity of the small water system.

Appendix 2.1: Outline of Technologies Used in POE / POU

This section provides an outline of technologies that are frequently used in POE / POU systems. Further information about these technologies is available by referring directly to the references listed at the end of this report. The technologies covered in this appendix are:

❑ Ultraviolet Disinfection	❑ Greensand
❑ Filtration	❑ Activated Carbon
❑ Ion Exchange	❑ Flocculation
❑ Reverse Osmosis	❑ Adsorptive Media
❑ Chlorination	❑ Slow Sand Filtration
❑ pH Adjustment	❑ Ozone
❑ Aeration	

Ultraviolet (UV) Disinfection

The germicidal energy of UV light destroys harmful microorganisms by attacking their genetic core (DNA). This powerful dose of UV light eliminates the micro-organisms' ability to reproduce, and the organisms simply die. Water is purified by running it through a watertight chamber which contains an ultraviolet lamp. As water flows past, microorganisms are exposed to a lethal dose of germicidal UV energy.

Figure 0-1: Ultraviolet Unit

Disinfection by using ultraviolet (UV) radiation works by inactivating microorganisms. The UV light penetrates the DNA of a microorganism altering it such that the microorganism is unable to reproduce.

UV dose is a function of UV light intensity, water clarity and exposure time and is expressed in mJ/cm^2 or mWs/cm^2. NSF International has established a UV dose of 40 mJ/cm^2 as the minimum UV dose required to inactivate bacteria, most[3] viruses, Giardia and Cryptosporidium.

UV devices often are equipped with the following additional features which form an integral part of the UV solution:

- Intensity monitor – An intensity monitor tells you in real time that the UV light intensity is sufficient for providing the full lethal exposure required. The monitor will alert the user to a "fading" lamp or that there has been a detrimental change in the water clarity.
- Elapsed time meter – Automatically monitors lamp usage and reminds the user when the unit is due for service.
- Automatic shutoff – UV systems can be attached to solenoid valves to automatically shutoff the water in the event the UV system goes into alarm mode or during power outages.

Advantages:

UV is capable of providing disinfection without the addition of chemicals. It also avoids the potential of generating harmful chemical disinfection byproducts such as Trihalomethanes (THMs). UV is more effective against cysts such as Cryptosporidium and Giardia than common chemical based treatment (e.g.,. chlorine). It is compact and easy to maintain and it does not change the taste, odour, or colour of the water.

Disadvantages:

No residual in distribution piping (less of a concern in POE than centralized treatment due to length of piping to POU from treatment). Some double stranded viruses may be able to withstand doses of 40mJ/cm^2.

[3] Some double stranded viruses may be able to withstand doses of 40mJ/cm^2.

Table 0-1: UV Energy Required to Inactivate Selected Microorganisms With UV Energy

The following generalized information is not intended to be used for the design of treatment systems. It includes microorganisms such as Cryptosporidium and Giardia which occasionally found in water sources in British Columbia.

Microorganism	Common Name	UV energy (microwatt-seconds per square centimeter)	Microorganism	Common Name	UV energy (microwatt-seconds per square centimeter)
		BACTERIA			
			Bacillus anthracia	Anthrax Spore	40,000
Agrobacterium tumefaciens	Crown Gall Disease (plants)	8,500	***Bacillus Megatherium***	Wet wood Disease	5,200
Bacillus subtilis	vegetative	11,000	***Clostridium Tetani***	Tetanus/Lockjaw	23,000
Corynebacterium diphtheria	Diphtheria	6,500	***Escherichia coli***	E. coli	7,000
Legionella bozemanii	Pontiac Fever	3,500	***Legionella pneumophila***	Legionnaires Disease	3,800
Leptospira interrogans	Infectious Jaundice & Leptospirosis	6,000	***Mycobacterium tuberculosis***	Pulmonary Tuberculosis	10,000
Moraxella catarrhalis	Meningitis, Endocarditis, Pneumonia, Bronchitis, Otitis Media, Sinusitis, Bactoremia	8,500	***Proteus vulgaris***	Urinary Tract Infection, Bacteremia, Pneumonia and Focal Lesions	6,600
Salmonella paratyphi	Para-Typhoid Fever, Enlargement of Spleen	6,100	***Salmonella typhimurium***	Gastroenteritis	15,200
Salmonella typhose	Typhoid fever, Enteric fever, Typhus Abdominales	6,000	***Sacina lutea***	Reproductive Problems	26,400
Shigella flexNeri	Dysentery	3,400	***Shigella sonnei***	Enteric Infection	7,000
Enterococcus faecalis	Urinary Tract Infection and Bacterial Endocarditis	10,000	***Streptococcus hemolyticus***	Various Infections	5,500

			CYST		
Giardia Lamblia	Giardiasis (Beaver Fever)	5,000 - 10,000	***Cryptosporidium***	Diarrheal Disease	5,000 - 10,000
Vibrio cholera	Cholera	6,500			
			MOLD SPORES		
Mucor ramosissimus	Sinuses, Brain, Eyes, Lungs, & Skin Infections	35,200	***Penicillium expansum***	Blue Mold	22,000
Penicillium roqueforti	Fungi	26,400			
			ALGAE		
Chlorella vulgaris	Green Algae	22,000			
			VIRUSES		
			Hepatitis Virus	Hepatitis	8,000
Influenza Virus	Influenza	6,600	***Polio virus***	Polio	21,000
Rota virus	Rota Virus	24,000	***Small Pox Virus***	Small Pox	9,000
			YEAST		
Trichosporon	Bakers Yeast	8,800	***Brewers yeast***	Brewers Yeast	6,600
Common yeast cake	Yeast Cake	13,200	***Saccharomyces var. ellipsoideus***	Saccharomyces	13,200
Saccharomycs	Saccharomyces	17,600			

This table is for general illustration only.

Filtration

Filtration involves the removal of particulates by flowing water through a porous media. Contaminants that are larger in diameter than the pores will be trapped by the media. Filtration is considered the most practical treatment process for removing suspended particles hence reducing turbidity from a drinking water supply. The most common method of filtration is through bags and cartridge filtration media. These media are commonly made from synthetic fibers designed with a specific pore size. The type of filter media most suited for an application depends mainly on the impurities present in the source (raw) water. The particle size of the impurity present in the raw water typically dictates the type of filter media. Other methods of filtration include slow sand filtration (outlined separately below) rapid sand filtration, diatomaceous earth filtration, direct filtration, and membrane filtration (outlined below).

Figure 0-2: Filtration Unit

If the source water contains large sized particle impurities, pre-filtration is generally applied in front of bag or cartridge type filters. Pre-filtration removes the larger particulate material from the water stream by using coarse, typically back-washable granular media. The pre-filters protect the more expensive bag and/or cartridge type units from frequent plugging. Other forms of pre-treatment for particle removal and pre-filtration without granular media are also available.

A water source may contain particles, organic material, and/or have high turbidity. These materials consume and compete for chemicals used in some treatment processes, such as chlorine. Operators should therefore find a mechanism to filter the particles, turbidity or organic material out of the water. Filtration can remove certain types of particulate matter down to any micron size. Special micro filtration devices or sub micron filters are also capable of removing various bacteria, viruses, and protozoa.

Options include:

- Micron rating
- Filtration type (cartridge, bag, media, etc.)
- Cartridge/bag/tank size (Sized according to flow rate).

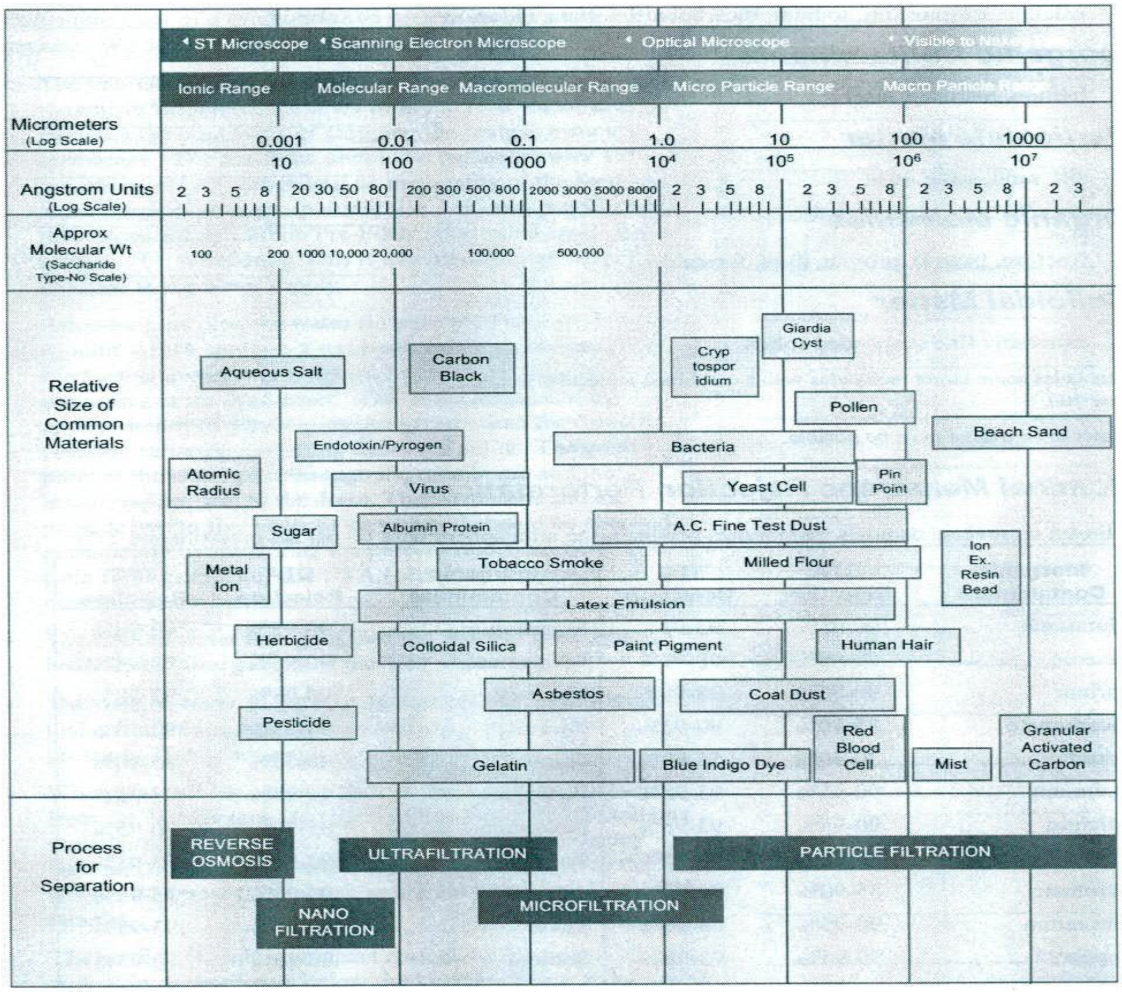
Advantages:

Simple, straightforward installation and maintenance. Low capital cost.

Disadvantages:

Not suitable for microbial treatment without further disinfection.

THE FILTRATION SPECTRUM



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Source: Taken from the "Product and Application Training Program" published by USF Water Group.

Ion Exchange

Ion exchange is a process where a treatment system removes unwanted charged particles (anions and cations) by “swapping” them for other, harmless charged particles. The most common example of this process is a water softening. A water softener will swap Calcium and Magnesium ions, which are associated with “hardness” of water, for sodium ions. Iron and manganese ions can also be swapped in this process.

Regeneration is a process used in many ion exchange units. In the softening example, the softening resin can only hold so many sodium ions so there comes a time when the resin has traded back all of its initial stock of sodium ions and none are left to soften the water (exhaustion of the resin bed). The sodium ions must be replenished if the conditioner is to continue to soften the water. The restocking of the softening resin with its sodium ions is called regeneration. This is accomplished by passing a sodium chloride solution (salt) through the resin beads which reverses the ion exchange process and recharges the beads with sodium ions.

Options for Regeneration:

- **Time- or Meter-control**: A time-controlled system will backwash and regenerate the resin based on a preset timer, regardless of actual water use. A metered system will measure actual water usage and regenerate when a certain volume of water has been used. The system is calibrated according to water conditions and system capacity.
- **Regeneration Brine**: Either potassium chloride or sodium chloride can be used for regeneration.

Advantages:

Most straightforward means of treating hardness. Will also remove low-moderate levels of Iron/Manganese.

Disadvantages:

Can result in elevated sodium concentrations which could be harmful for people on low-sodium diets. The installation of an under-counter reverse osmosis system can solve this problem.

Reverse Osmosis (RO)

The process of reverse osmosis uses water pressure to force water through a semi-permeable membrane, leaving dissolved and suspended contaminants behind. A waste stream is created to wash away the contaminants to ensure adequate membrane life. Pretreatment is required to remove any suspended material as well as excessive hardness and iron which can cause premature membrane fouling.

Figure 0-6: Reverse Osmosis Unit

This is generally done with 5 micron sediment filtration and carbon filters and a water softener (when required). There are two membrane types – Cellulose Triacetate (CTA) and Thin Film Composite (TFC) with some important differences that are worth noting.

Of most importance is that a TFC membrane, while having higher rejection rates for all contaminants cannot tolerate any chlorine whereas a CTA membrane has some chlorine tolerance. TFC membranes are most commonly used with a pretreatment carbon filter to remove chlorine.

It is also important to note that RO treated water will have a low pH which is often outside the recommended range of 6.5-8.5. To compensate, pH adjustment should be done after membrane treatment as explained in this guide. There are a number of factors that will affect an RO's performance including water temperature, Total Dissolved Solids (TDS), water pressure, etc.

The "rejection rate" for any particular contaminant is the expected removal rate of that contaminant, expressed as a percentage. For example, the rejection rate for sodium in most RO systems is in excess of 98%. The "recovery" of an RO system expresses the total amount of incoming water that is retained as treated water. For example, with a recovery rate of 33%, one third of incoming water ends up as treated water.

Two other similar membrane based technologies are nanofiltration (NF) and ultrafiltration (UF). They use semi-permeable membranes as in reverse osmosis, but have some important differences worth noting. NF and UF membranes' pores are larger than reverse osmosis, allowing more dissolved material to pass through, but also significantly lowering the waste water used. For example, UF units will allow dissolved salts and metals to pass through, but will still remove organic material, turbidity, bacteria, cysts, and viruses. A backwash cleaning cycle is initiated periodically to rinse the membranes of the unwanted particles. There is little waste water in this type of system. These systems can also be used inline without the need for extra storage tanks or pumps, reducing installation space and time.

Table 0-2: Example Rejection Rates[4] for RO

Contaminant	% Nominal Rejection	Contaminant	% Nominal Rejection
Aluminum	96-98	Ammonium	80-90
Bacteria	99+	Borate	30-50
Boron	50-70	Bromide	90-95
Cadmium	93-97	Calcium	93-98
Chloride	92-95	Chromate	85-95
Copper	96-98	Cyanide	85-95
Fluoride	92-95	Hardness Ca & Mg	93-97
Iron	96-98	Lead	95-98
Manganese	96-98	Magnesium	93-98
Mercury	94-97	Nickel	96-98
Nitrate	90-95	Orthophosphate	96-98
Phosphate	95-98	Polyphosphate	96-98
Potassium	93-97	Radioactivity	93-97
Silica	80-90	Silicate	92-95
Silver	93-96	Sodium	92-98
Sulfate	96-98	Thoisulfate	96-98
Zinc	96-98		

Options:

- Auto membrane flushing will periodically rinse the membrane removing some contaminants that adhered to the membrane thus prolonging the life of the membrane.
- Integrated TDS meters which will measure real-time membrane performance for the removal of the total dissolved material.
- Concentrate re-circulated water. This will decrease your waste water volumes by taking a portion of the waste stream and mixing it with the raw water.

Advantages:

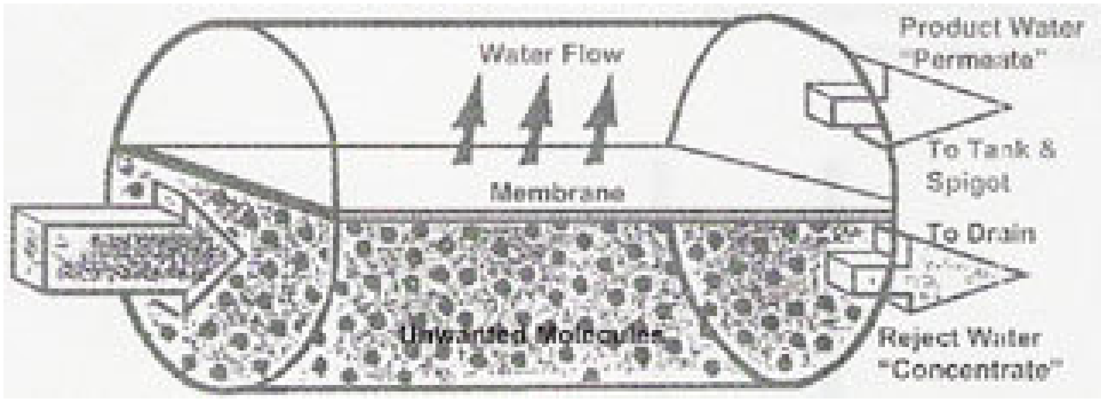
Removes dissolved material that no other POE treatment can.

Disadvantages:

[4] Low range is for CTA membranes, high range is for TFC membranes.

High capital cost for POE, high volume of waste water (50-75%), requires sufficient level of operator training.

Figure 0-7: Reverse Osmosis Process



Chlorination

Chlorine is the most commonly used disinfectant for treating drinking water in municipal applications. It is a powerful oxidant that is highly corrosive. Properly administered, chlorine is effective at inactivating bacteria and viruses (but is less effective at treating cysts such as Cryptosporidium) and a residual level of chlorine can be maintained in the distribution system to prevent re-growth of certain microorganisms. Common forms are sodium hypochlorite (liquid bleach) and calcium hypochlorite (pellets). Chlorination has other uses – it can cause iron to precipitate as a solid (which can then be removed via filtration). While carcinogenic disinfection by-products may be formed when chlorine reacts with natural organic compounds in water supplies – especially surface sources, their effects over lifetime exposure are quite small.

Advantages:

Can be used to maintain residual disinfection after the water is treated. Can be used when power is unavailable.

Disadvantages:

Requires higher level of operator skill and handling of chemicals. Can produce harmful (carcinogenic) byproducts in circumstances when high levels of certain organics are present in the water. Alters taste and odour of water. Is not effective on cysts.

pH Adjustment

Low pH in source water can contribute to corrosion of pipes, plumbing fixtures and appliances and in addition, can inhibit the full removal of other contaminants in the water treatment system. pH adjustment can be performed in a variety of ways. The most common way is either via a replacement Calcite filtration cartridge or chemical injection (Sodium Carbonate/Soda Ash or equivalent). Injection can either be done directly into the existing plumbing with a mixing tank to ensure proper mixing and contact time or directly into an unpressurized holding tank.

Excessively high pH can contribute to scaling or encrustation within pipes and in appliances. Treatment involves injecting an acid (e.g. Muriatic Acid) to neutralize the alkalinity.

Chemical injection systems involve the handling and storage of chemicals as well as close monitoring of concentrations to ensure that the final pH is in the desired range.

Advantages:

Reduces corrosion and scaling effects that water may have on plumbing materials.

Disadvantages:

Typically requires handling of chemicals; not the case for filter cartridges.

Aeration

Aeration is a method for oxidizing certain contaminants in source water and aids in off-gassing certain gases found in water supplies (e.g. Hydrogen Sulfide, Methane, etc.). It can also be used to remove Volatile Organic Compounds (VOCs). A common way to perform aeration is via a Hydrocharger (air injector) or by pumping water into an unpressurized storage tank through a spray nozzle. An aerator can be used to further enhance the effectiveness. Aeration tanks should be vented to the outdoors to avoid buildup of potential harmful or flammable gases.

Advantages:

Low maintenance requirements. Little to no maintenance costs.

Disadvantages:

Can require a second pumping system if using an unpressurized tank.

Greensand

A "Greensand" filtration system is used to treat Iron, Manganese, and Hydrogen Sulfide. As the water passes through the filter bed, it comes in contact with oxygen-charged Manganese Greensand. This causes Iron, Manganese and Sulfur to oxidize into particles which can then be trapped in the filter bed. Eventually the Manganese Greensand loses its oxygen charge and regeneration is necessary. The filter bed is cleaned and then a measured quantity of potassium permanganate is drawn from the feeder through the filter bed, recharging it with oxygen

Backwashing Options:

- Time-controlled: The system will backwash and regenerate based off a preset timer, regardless of actual water use.
- Metered: The system will measure actual water usage and regenerate when a certain volume of water has been used. The system is calibrated according to water conditions and system capacity.

Advantages:

Will treat H_2S in addition to Iron and Manganese.

Disadvantages:

Requires the use and storage of chemicals.

Activated Carbon

Activated carbon is a form of elemental carbon whose particles have a large surface area with high adsorptive qualities. A variety of substances such as coal, coconut shells, nutshells and wood are exposed to a high temperature to produce carbon which is then activated by high pressure steam, leaving behind carbon etched with a complex pore structure. Here, adsorption is defined as the adhesion of a gas, vapor, or dissolved organic compound on the surface of the activated carbon. Activated carbon can be used to remove dissolved organic compounds such as decaying vegetation and run-off which can create unpleasant tastes odors and colour. Activated carbon will also remove chlorine, VOCs, THMs, and chloramines. Backwashing or replacing spent cartridges must take place periodically to prevent channeling, pressure loss and bacterial growth in the media.

Advantages:

Simple to install and maintain. Low installation and maintenance costs.

Disadvantages:

Can cause an increase in the level of typically non-harmful bacteria after the filter. UV disinfection is generally recommended as secondary treatment (after a carbon filter) for this reason.

Flocculation

Flocculation refers to a process where a solute comes out of solution in the form of floc or “flakes.” The term is also used to refer to the process by which fine particles are caused to clump together into floc. The floc may then float to the top of the liquid, or settle to the bottom of the liquid where it can be filtered out.

A flocculant (e.g. Aluminum Sulphate) is added via a chemical metering pump and mixed through a contact tank. It should then be settled or filtered to be removed from the water.

Flocculation is commonly used in the presence of Collodial Silt or “Rockflour.” This extremely fine powdery substance gives water a “milky” look and will pass through normal filtration, including submicron filters.

Advantages:

Relatively simple maintenance procedure.

Disadvantages:

Involves handling of chemicals, including dosing and storage requiring some care and experience.

Adsorptive Media

Adsorption is a process that occurs when contaminants accumulate on the surface of a treatment resin. Adsorption is done with Activated Carbon, Activated Alumina, and other resin beds. Raw water is passed through a filter bed with a particular resin targeted to remove problem contaminants in the water sample. They are often used in large-scale treatment plants for contaminants such as Arsenic and Fluoride.

Advantages:

Simple to operate

Disadvantages:

Disposal requirements can be challenging.

Slow Sand Filtration

Slow sand filtration involves percolating untreated water slowly through a bed of porous sand. Influent water is introduced over the surface of the filter, and then drained from the bottom. Properly constructed, the filter consists of a tank, a bed or layers of fine sand (often Quartz), a layer of gravel to support the sand, a system of underdrains to collect the filtered water, and flow control to regulate the filtration rate. No chemicals are added to aid the process.

Slow sand filtration can be used or modified to remove a wide range of contaminants such as turbidity, bacteria, Iron, Manganese, H_2S and other gases.

Advantages:

No chemicals are required, and can be entirely gravity fed. Minimal waste water is created.

Disadvantages:

Requires more space, and a second pumping system to pressurize distribution lines.

Ozone

Ozone is a powerful oxidizing gas and disinfectant. This treatment method oxidizes organic contaminants in much the same way that chlorine does. An ozone generator converts the oxygen found in air to O_3, or ozone. As with chlorination, proper concentrations and contact time is essential for disinfection. An air dryer is used to supply dry air for Ozone Generation as humid air will result in damaging acid formation.

As ozone is such a powerful oxidizer, it must be removed from the water lines and equipment and vented from the treatment space (e.g. pump house).

Advantages:

Powerful oxidizer and provides disinfection.

Disadvantages:

Requires high operator skill level. No residual disinfection; therefore, only useful by itself for just-in-time usage. Can react with Bromides in the water to create potentially harmful by-products.

POE / POU Guidebook Appendices Part 2

Appendix 2.2: Applicability of Selected POE / POU Technologies

Tables 2-6, 2-7 and 2-8 below show those contaminants that can be addressed with POU and POE technologies. Even though the tables show some treatment technologies as being able to remove a particular contaminant, only those technologies that have been through the Environmental Protection Agency’s (EPA) extensive regulatory review are listed as a Small System Compliance Technology (SSCT). The table shows when POU or POE devices are:

- Listed or being considered as an SSCT by the US Environmental Protection Agency; or
- Considered technologically capable in the literature, but not listed as an SSCT by rule or in the *Federal Register*.

Technologies denoted by an “x” as being able to remove a particular contaminant will not necessarily represent the most technically or economically feasible approach to the removal of that contaminant. A thorough evaluation of all factors is required before selecting a treatment technology.

Table 0-3: Applicability of POU Treatment Technologies

Treatment Technology	Contaminant							
	Arsenic	**Copper**	**Lead**	**Fluoride**	**Nitrate**	**SOCs**	**Radium**	**Uranium**
Activated Alumina (AA)	SSCT			UI				X
Distillation[5]	X	X	X		SSCT		?	?
Granular Activated Carbon (GAC)						SSCT		
Anion Exchange (AX)	X				SFI			SSCT
Cation Exchange (CX)		SSCT	SSCT				SSCT	
Reverse Osmosis (RO)	SSCT	SSCT	SSCT	SSCT	SFI		SSCT	SSCT
Other Adsorption Media[6]	X							

Notes:
- SSCT = Treatment technology has been identified by EPA as an SSCT (*Federal Register*, Volume 63, No. 151, August 6, 1998).
- SFI = Treatment technology has been suggested to receive further investigation for the listed contaminant (*Federal Register*, Volume 63, No. 151, August 6, 1998); anion exchange for nitrates is not currently recommended. See page 3-9.
- UI= Under investigation; even though EPA continues to investigate the use of POU AA treatment, the preliminary view of treatability data indicates that it is effective.
- X = Treatment technology can remove the noted contaminant, but is not listed as an SSCT in the *Federal Register* or in a rule.
- ? = Treatment technology is questionable for the listed contaminant.

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5 Large device size is not suitable for installation under the sink and has limited production capability, typically under 10 gallons/day.
6 Such as iron-, aluminum-, or titanium-dioxide-based media.

Table 0-4: Applicability of POU Treatment Technology

Treatment Technology	Contaminant						
	Antimony	Barium	Beryllium	Cadmium	Chromium	Selenium	Thallium
Anion Exchange (AX)	SSCT				SSCT	SSCT	
Cation Exchange (CX)		SSCT	SSCT	SSCT			SSCT
Reverse Osmosis (RO)	SSCT	SSCT	SSCT	SSCT	SSCT	SSCT	SSCT

Notes:
- SSCT = Treatment technology has been identified by EPA as an SSCT (*Federal Register*, Volume 63, No. 151, August 6, 1998).

Table 0-5: Applicability of POE Treatment Technologies

Treatment Technology	Contaminant										
	Arsenic	Copper	Lead	Fluoride	Nitrate	SOCs	VOCs	Radon	Radium	Uranium	Microbial
Activated Alumina (AA)	X			X							
Aeration: Diffused Bubble or Packed Tower							Q	Q			
Granular Activated Carbon						UI		PR			
Ion Exchange (IX)											
Anion Exchange (AX)	X				X					X	
Cation Exchange (CX)		X	X						X		
Ozonation											X
Reverse Osmosis (RO)	X	X	X	X	X	X			X	X	X
Other Adsorption Media	X										
Ultraviolet Light (UV)											X

Notes:

- PR = Treatment technology is identified as an SSCT in the proposed Radon Rule for systems serving fewer than 500 people.
- UI = Treatment technology is being investigated by EPA for the listed contaminant (*Federal Register*, Volume 63, No. 151, August 6, 1998).
- Q = Questionable for residential use due to off-gas emissions; see discussion of limitations on page 3-13
- X = Treatment technology can remove the noted contaminant, but is not listed as an SSCT or in a rule and may not be economically viable in certain situations.
- Currently, POE is excluded from NSF/ANSI 58 for RO devices; issues include the generation of large quantities of reject water and potential incompatibility of product water with copper pipes.
- Other adsorption media includes iron-, aluminum-, or titanium-dioxide-based media.

Appendix 2.3: Selecting POE / POU Technologies

Selection of appropriate POE / POU technologies for a particular application is influenced by several factors. Some of these factors can impact the effectiveness of the technology. These factors are summarized in the following bulleted list and are discussed in more detail in later sections:

- Site-specific water quality issues;
- Annual maintenance costs;
- Operator skill required;
- Current regulations and guidelines on the use of POE / POU devices; and,
- Operating experience in other jurisdictions.

Tables 2-1 to 2-3 below provide summary information on POE / POU technologies. A more detailed outline of these technologies is provided in subsection 2.3.

Comparative Summary of Available Technologies

The following table (Table. 2.1) summarizes characteristics of available POE / POU technologies. The table provides a brief overview of the costs of each option. Further technical information is provided in Appendix D.

Table 0-6: Characteristics of POE / POU Technologies

This table is intended to show general characteristics only of the technologies listed.

	Equipment Costs & Installation Time		Annual Maintenance Costs	Operator Skill Required	Environmental Footprint
	Equipment	Installation			
UV	$700-$2,000	½ day	$150	Low	Low
Ion Exchange	$1,200-$1,600	½ day	$50	Low	Low
Greensand	$1,200-$1,600	½ day	$120	Medium	Low
Reverse Osmosis **(POE-only)**	$4,000-$7,000	1-2 days	$300-$600	High	Medium
Chlorination	$800-$1,200	½ day	$150	Medium	High
Flocculation	$800-$1,200	½ day	$80-$150	Medium / High	Medium
Carbon	$200-$1,400	2 hours-½ day	$40-$100	Low	Low
Filtration	$150-$1,500	2 hours- ½ day	$0-$150	Low	Low
Adsorptive Media	$2,000-$4,000	½ day	$400	Low / Medium	Low – High
Slow Sand Filtration	$2,500-$3,000	1-2 days	$0	Low / Medium	Low
Ozone	$2,000-$4,000	½-1 day	$0	High	Low
pH adjust	$250-$1,200	2 hours – ½ day	$80-$150	Medium	Low
Aeration	$800-$1,500	½ day	$0	Low	Low

Notes:

- Sources for pricing above are taken from unit list prices from suppliers in BC. The equipment shown may not necessarily conform with applicable standards for the type of equipment indicated. Data is based on retail prices with no discount applied. Source for installation time is from perspective of an experienced installer performing the work; estimates do not include travel time.
- Costs shown above are for illustrative purposes only. They reflect typical costs in British Columbia in 2006. Actual installation times and costs will vary according to water quality, volume requirements, existing equipment such as storage tanks, and health authority requirements.
- Environmental footprint refers to disposable waste/discharge chemicals and associated requirements and permits.
- Required operator skill categories:
    - Low – No formal training required; operator can be trained by installers in under one hour, most technical support can be done over the phone or email. Minimal risk to person or property.
    - Medium – Some additional operator training is useful. May involve basic testing of water, adjusting dosage, etc. Additional technical support often by trained personnel. Moderate risk to person or property.
    - High – Operator training required. May involve advanced water testing. High degree of experience required for troubleshooting. Highest risk to person or property.

Water Quality Issues that Affect POU and POE Devices

The use of specific types of POU and POE technologies is influenced by site-specific water quality issues. The presence of high concentrations of competing contaminants can significantly reduce the removal efficiency of these devices, making water quality testing and pilot testing important first steps in selecting a POU or POE technology. The following table shows the water quality parameters that may reduce the efficiency of POU and POE devices.

Table 0-7: Water Quality Parameters of Concern for POU and POE Technologies

When using this Technology…	…the following contaminants can interfere with treatment…	…in the following way.
Ion Exchange	Iron, Manganese, Copper	Fouling, Competing Ions
Adsorptive Media	Silica, Fluoride, Phosphate, Sulfate, Dissolved Iron and Manganese	Interfering/Competing Ions
Reverse Osmosis	Hardness, Iron, Manganese	Fouling
Granular Activated Carbon	Organics, multiple SOCs or VOCs present	Competing Ions
Aeration	Hardness, Iron, Manganese	Fouling, Scaling

Source: United States Environmental Protection Agency. Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems, 2006.

Maintenance Considerations for POU and POE Technologies

All POU and POE devices require maintenance if they are to continue removing contaminants effectively. Table 0-8 summarizes the maintenance requirements for various POU and POE installations.

Table 0-8: Maintenance for Selected POU and POE Technologies

Treatment Technology	Operation and Maintenance
Adsorptive Media: **Activated Alumina (AA)[7] and Specialty Media[8]**	POU: Replacement[9] of spent cartridges and particulate pre-filters (if used). POE: Typically periodic backwashing. Replacement of spent media and particulate pre-filters (if used). Maintenance and cleaning of storage tank (if used).
Aeration: **Diffused Bubble or Shallow Tray**	Only appropriate for POE Replacement of particulate pre-filters. Replacement of air filters for fan intake and for exhaust. Maintenance of fan, motors, and re-pressurization pumps. Replacement of post-treatment GAC polishing filters. Maintenance and cleaning of storage tank. If UV is used for post-treatment disinfection, replacement of UV bulb and cleaning bulb housing. If ozonation is used for post-treatment disinfection, maintenance of ozonation unit.
Granular Activated Carbon (GAC)	POU: Replacement of spent cartridges and particulate pre-filters (if used). POE: Periodic backwashing. Replacement of spent media and particulate pre-filters (if used). Maintenance and cleaning of storage tank (if used). If UV is used for post-treatment disinfection, replacement of bulb and cleaning bulb housing. If ozonation is used for post-treatment disinfection, maintenance of ozonation element.
Ion Exchange (IX): **Anion Exchange (AX) and Cation Exchange (CX)**	POU: Replacement of spent resin cartridges and particulate pre-filters (if used). POE: Regular regeneration and periodic backwashing. Replacement of salt used for resin regeneration. Replacement of lost or spent resin and replacement of particulate pre-filters. Maintenance and cleaning of storage tank (if used).

[7] The regeneration process for AA is complex and requires the use of strong caustics and acids. Therefore, to avoid potential health risks associated with the storage of these chemicals in residences, POE AA should only be considered for use on a throwaway basis unless systems can provide offsite regeneration and/or vessel exchange facilities.
[8] Regeneration of specialty media is generally not effective due to the high affinity of the media for the contaminant(s) of concern and is typically a complex operation. Therefore, specialty media installed at the POU or POE should only be considered for use on a throwaway basis.
[9] Currently spent filter cartridges for most adsorptive media used in POU systems are classified as household waste and can be discarded in the trash as such.

Reverse Osmosis (RO)	POU and POE: Replacement of exhausted membranes, particulate pre-filters, and pre- and post- treatment GAC filters. Maintenance and cleaning of storage tank. Maintenance of (re) pressurization pumps (if used).
Ultraviolet Light (UV)	POU and POE: Replacement of UV bulbs and sensors. Cleaning quartz sleeve separating bulb and water. Replacement of sleeve but not as often as bulb. Replacement of spent resin cartridges and particulate pre-filters (if used).

▪

Appendix 2.4: Examples of Treatment Approaches for Groups of Contaminants

Following are examples of possible applications of POU and POE devices in British Columbia. The treatment solution selected for a particular location will depend on specific circumstances. In many cases it will be advisable to seek advice from an experienced water quality professional before finalizing the choice of treatment technology.

Certain contaminants that are treated by POU devices may also be treated by POE devices under certain circumstances. For example, even though arsenic treatment is discussed under POU technologies this does not mean that POE technologies might not be applicable in certain circumstances for treating arsenic. Depending on the contaminant, economic factors and technical issues may influence whether a POE or POU approach is the most advisable choice.

System 1: Low turbidity, high UV transmittance (clear water), acceptable metals/minerals, total / fecal coliforms present

System: 5 micron sediment filtration and UV.

Features/options: UV: audio/visual alarms, auto-shutoff, UV intensity monitor, remote monitoring, lamp usage timer (replacement reminder), power surge protection.

Maintenance: change filter as needed (average – once per year) and bulb once per year; clean sleeve at time of bulb change.

System 2: Moderate levels of Iron/Manganese/H_2S, pH between 6.5 to 8.5, Bacteria present

System: Greensand, 5 micron sediment filtration and UV.

Features/options: Greensand: metered or time controlled backwash/regeneration. UV: audio/visual alarms, auto-shutoff, UV intensity monitor, remote monitoring, lamp usage timer.

Maintenance: change filter as needed (average – once per year) and bulb once per year. Clean sleeve at time of bulb change. Add Potassium Permanganate as required.

System 3: Clear, Excessively Hard water, no bacteria present

System: Water softener.

Features/options: Softener: metered or time controlled backwash/regeneration.

Maintenance: Add salt to brine tank as required.

System 4: Surface water, tannins, high turbidity, low pH, and bacteria present

System: One option is POE Reverse Osmosis and UV. Note, when tannins are involved there are a number of solutions with varying effectiveness.

Appendix 2.5: Framework for a Design-Build Request for Submissions

The following outline provides a suggested framework for the contents of a Request for Submissions (RFS) for a Design Build approach. . This outline should be modified as required for each project situation.

I. Design-Build Project Overview/Selection Process Overview

a. Description of Project (size and nature of system, approximate budget, anticipated schedule)
b. How selection process will be conducted

2. Mandatory Criteria for Prospective Proponents

a. Appropriate experience (technically similar projects and design-build)
c. Licensing requirements
d. Financial strength (bonding capacity)
e. Organizational resources and depth
f. Lack of litigation/disputes history
g. Bonding capacity

3. Project-Specific Qualifications for Proponents

a. Team and company experience with related system and technology types
b. Team performance record (quality, schedule and cost)
c. Proposed team composition /past experience working together
d. Current capacity to manage the project
e. Proposed key project personnel
f. Project references

4. Qualifications Statement Evaluation

a. Pre-established rating system
b. Any Pre-Submission briefing session/formal question and answer process
c. Approach to Evaluation (E.g. Analyze qualifications submissions and select the 3 most qualified teams)

Appendix 3.1: Further Information on Financing Options

This appendix provides information on the following financing options:

- Purchasing using your existing funds
- Using a loan or through issue of equity
- Obtaining a grant from government
- Leasing the equipment.

Each of these options is outlined in the following sections.

A4.1 Purchase using existing funds

It is good practice for all water supply organizations to maintain several different accounts. These include an operating account, an equipment replacement account, a capital expenditures account and a contingency fund. The operating account is the account from which all routine expenditures, such as operator wages and utility bills are paid. The equipment replacement account is, as its name suggests a source of funds for replacing equipment when the equipment is worn out or made obsolete. The capital expenditure account is the source of money for large expenditures on system expansion or large-scale replacement. The contingency fund is set aside to pay for unpredictable and urgent expenditures not covered by other funds.

You may have funds available from these accounts that can help pay for new water treatment equipment. Some water suppliers are able to anticipate the need for treatment some years in advance, and to accumulate funds in the appropriate place. If you have been aware of the need for new water treatment for some years, your system may have begun to accumulate funds in your capital expenditure account, your contingency fund or less likely, your operating account.

A4.2 Using a loan or through issue of equity

Obtaining a Loan

Another source of funds for the purchase of a POE / POU system is through a loan from a lending institution. Banks and credit unions may be willing to provide a loan to your organization to cover part of the costs of system purchase. In providing improved treatment for your customers you are improving their quality of life, and strengthening your local community. Several lending institutions in BC have policies that aim to support local organizations, particularly those whose activities encourage a more sustainable society.

Lending institutions will want to ensure that any loan they make is appropriately secured. This is straightforward process in the case of a loan advanced, for example, for the purchase of real property. A tangible asset, the property itself, is used as the security for the loan. The lender can take possession of the asset if the terms of the loan are not met. The same is true of certain kinds of equipment and other tangible assets which can be removed from the possession of the lender if it is in default, and sold on the open market.

Financing of components of a water system may be more complicated. It is not easy for a lender to take possession of a piece of the infrastructure like a reservoir or pumping station. Certain items of off-the-shelf treatment equipment, such as an ozone disinfection unit may be used in POE / POU systems. These can be removed from a site, and have some resale value. Some lenders may consider these components as collateral for the loan.

A typical water supply organization has several factors in its favour when obtaining financing. Clearly its customers cannot go without water. They are obliged to continue to purchase the product, potable water, in almost all circumstances. The water supplier therefore has an assured and predictable revenue. Utilities in general are considered to be stable investments. Very few water suppliers experience significant loss in revenues from defaulting customers.

A water supplier will increase its chances of securing a loan if it can demonstrate a sound management approach. These include appropriate planning and management activities. Most lenders, for example, will want to see a business plan, as it will demonstrate the financial condition of the water supply organization and show how the loan will be repaid. It may be necessary to increase revenues in order to pay for your improved water treatment system. How you plan to do this should be demonstrated in the financial section of the business plan. There are resources available to help you complete a concise business plan which you can use when approaching a funding agency.

Borrowing from Your Customers

In certain cases you may be able to borrow money from your customers through the issuance of a bond or other security. This will allow you to raise funds from your customers to help offset the costs of your improved treatment system. Organizations such as schools and churches sometime raise funds through the issuance of bonds or similar instruments. It is important to check with legal and financial advisors before you go far in pursuing this option.

Issuing Equity

Another option that may be available to certain types of water supply organizations may be the issuing of shares in the organization. This approach might apply in the case of a private water system, owned by a limited number of informed individuals. In this case the water supply organization does not assume a debt; instead it creates an opportunity for its customers to purchase a share of the ownership of the system. For example, in certain areas of Europe the large water suppliers have been privatized for many years, and their shares are attractive to investors.

Raising project funds partly through a share issue may also appeal to lenders who may be approached to fund another portion of the project. In this case you may be able to demonstrate favourable debt to equity ratio, and improve your chances of negotiating a loan. In offering shares you should be aware of the legislation surrounding the issuing of securities. It is important to check with legal and financial advisors before you go too far in pursuing this option.

A4.3 Obtaining grants through government

There are some government assistance programs which may be of interest to your organization. In certain circumstances they may help you to pay for part of the planning phases of your project, or make a contribution to the capital cost of system purchase and installation.

Only certain types of water supply organizations are generally eligible for government contributions. For example improvement districts in BC may apply for an infrastructure planning grant, administered by the ministry of community services. If you are an improvement district, this application should normally be submitted through your regional district administration. Clearly you require the cooperation of the regional district for this to occur. The planning grant may assist you to employ a specialist to undertake a large part of the project planning.

A4.4 Leasing POE / POU Systems

There are two main options open to community water systems when considering the procurement of Point of Entry / Point of Use systems: purchasing and leasing. The process of equipment purchase is commonly understood, and methods of financing the purchase of a treatment system are outlined in the subsections above. On the other hand, leasing equipment for the treatment of water is an innovative approach which may gain ground in the future. Information about the leasing of treatment equipment is provided in the following sections.

Why Organizations Choose to Lease

Organizations may choose to lease equipment for a variety of reasons. Equipment does not normally increase in value over time. It usually loses value. Cash tied up in fixed assets is no longer available for other uses. Some organization have difficulty in obtaining the funds for capital purchases even though they may have steady and assured sources of revenue. For these reason, many organizations seek to lease much of their equipment. They realize that owning a depreciating asset is not always the logical answer. Even organizations with ample cash resources should evaluate all available financing options when acquiring new equipment.

In Canada, the federal and provincial governments are major lessees of a wide range of equipment. There is a greater awareness of the advantages of leasing equipment, and the approach is more commonly used today than in the past.

Benefits of Leasing

Conservation of Capital: leasing frees up cash flow and keeps existing lines of credit open.

Tax Considerations: Organizations may be able to expense monthly payments rather than depreciating the equipment cost, allowing them to order new equipment, as needed.

Obsolescence: By leasing an organization can acquire the equipment it needs today and use it cost effectively until it no longer meets their needs. They can then upgrade and avoid dealing with outdated and obsolete equipment.

Flexibility: Leasing can accommodate varying cash flow patterns and tax situations, as well as equipment upgrades and add-ons.

Source of Capital: In certain circumstances the use of a lease buy back arrangement on existing equipment can be used as a source of capital to expand a business.

Types of Lease Agreements

A lease is an agreement under which the owner of the equipment conveys to the user the right to use the equipment in return for a number of specified payments over an agreed period of time. The owner of the equipment is referred to as the "*lessor*". The user of the equipment is known as the "*lessee*". In entering into a lease, the lessee replaces the cost of depreciation, interest expenses and other charges otherwise associated with ownership of the asset, with the agreed lease payments for the duration of the lease agreement. A lease may also allow for mitigating financial and other risks

Generally speaking, there are two kinds of leases. A *capital lease* is usually used to finance equipment for the major part of its useful life, and there is a reasonable assurance that the lessee will obtain ownership of the equipment by the end of the lease term. An *operating lease* usually finances equipment for less than its useful life and at the end of the lease term, the lessee can return the equipment to the lessor without further obligation. Equipment for treatment of water generally be leased using a capital lease contract.

Appendix 4.1: Advantages and Disadvantages of Design-Build

Advantages

The design-build approach to water treatment projects has several benefits when an experienced supplier is involved:

- The supplier may specialize in a range of treatment technologies and proprietary products and is able to quickly identify the equipment that will best meet your needs once he/she is aware of details such as source water quality.
- The supplier has considerable experience in use of treatment equipment and can efficiently produce a design that is functional and cost effective.
- The supplier is likely to have encountered and solved difficulties in the past; he can appraise your system and anticipate problems before they occur.
- The supplier has close ties with manufacturers, and can seek the advice of specialists with the manufacturing organizations.
- The supplier may be able to provide a warranty that is directly supported by the manufacturer.

Disadvantages

- Unlike a consultant, the supplier is not employed exclusively to act in the interests of the owner; business considerations may influence the supplier's approach.
- The supplier may only represent a limited range of manufacturers and may not be familiar with certain treatment technologies.
- The supplier is unlikely to have the same broad view of the scope and constraints of the overall project as would a consultant. The supplier may be less effective in integrating wider aspects of the project such as regulatory approval, financial considerations and public involvement activities.
- The supplier may have limited experience in adapting a design for unusual or demanding site conditions, particularly those that require extensive civil works, or incorporate complex systems other than the treatment equipment.

Appendix 4.2: Framework for a Design-Build Request for Proposals

The following outline provides a suggested framework for the contents of a Request for Proposals (RFP) for a typical project. This outline should be expanded/reduced, modified, or detailed as required for each project situation.

1. General Information (business terms)

a. Introduction
b. RFP Schedule
c. Selection Procedure
d. Selection Criteria (and weighting)
e. Budget (or Cost Limitations)
f. Project Schedule

2. Site Information (qualitative data relating to existing site conditions)

a. Site Description
b. Topographical and Boundary Survey
c. Soil Investigation Data
d. Utility Information
e. Covenants and Restrictions on Property

3. Project Requirements (design criteria)

a. Program Summary
b. Functional Requirements (goals and objectives)
c. General Physical Characteristics Requirements
d. Performance Specifications, Including Warranties
e. Codes and Standards,
f. Functional Relationship Diagrams or Conceptual Layout

4. Design-Build Contract Requirements (may be a summary of contract terms or a copy of actual contract)

a. Design Responsibilities
b. Construction Responsibilities
c. Responsibilities of the Owner
d. General Conditions

5. Requirements for Proposal (the material to be provided by proponents; the “deliverables”)

a. Drawings
b. Specifications
c. Design-Build Organization
d. Project Personnel

e. Quality Control Program
f. Schedule
g. Price Proposal

Appendix 4.3: Selection/Evaluation Process

The purpose of the selection and evaluation process should be to determine which proposal provides the greatest value to the owner. A variety of selection/evaluation processes are available to private and public sector owners.

Of these processes the Weighted Criteria approach is typically suitable for POE / POU projects. In this process, proponents are notified that they have been placed on the short list and are given final requirements for the submittal of a qualitative proposal (e.g. management plan, experience, design solution and other qualitative issues) and firm price. The owner establishes a point rating for qualitative factors and for price. (For example, qualitative and design factors may weigh 60 points, and price 40 points.) The qualitative proposals are received by the owner. Price is simultaneously submitted in a separately sealed envelope. The owner reviews each proposal. The owner may then hear oral presentations from each proponent. The owner assigns points on a scoring matrix for each proponents response to each of the evaluation factors.

After the design and qualitative criteria are evaluated, the price envelopes are opened. Maximum price points are assigned to the lowest dollar bid, and all others are scaled inversely proportional to that amount. High total points then determine the award. The following example illustrates this process:

Proposer	Qualitative Score (60 maximum)	Price Proposal	Price Score (40 maximum)	Total Score (100 maximum)
Firm "A"	51	$1,629,000	37	88
Firm "B"	63	$1,546,000	39	92*
Firm "C"	44	$1,510,000	40	84

*Award to proposer withhighest total score.

Appendix 5.1: Using Services of a Consulting Engineer

Use of a consulting engineer for technical design of the water treatment project has several benefits:

- The consultant is employed directly by the owner and acts in the interests of the owner when dealing with the supplier.
- The consultant typically has significant experience in the design of water treatment systems and may be considered as a qualified professional within the meaning of applicable regulations.
- The consultant typically has experience not only in the technical design but also in the other aspects of the project such as the identification of options for meeting the needs, and in working with regulators.
- The consultant may be experienced in dealing with complex engineering projects and is very capable of assembling a multidisciplinary team.
- The consultant may be able to compare the life-cycle costs of various solutions. He/she will help the owner avoid a decision based on capital cost alone, and instead to consider operating and maintenance cost over the life of the project.

Some further considerations in the employment of a consultant for technical design include:

The consultant may not be fully aware of all suitable treatment approaches. Innovations in technology may occur of which the consultant may be unaware.

- The consultant is responsible for effective design. In some cases this may lead to project specifications which add costs without also providing clear benefits.
- Tailor-made design solutions may be proposed, when less expensive off-the shelf solutions may be more cost-effective..
- Experienced consultants are expensive. Smaller projects do not achieve the economies of scale that are found in larger projects. Small water supply organization may not have the financial resources to pay for extensive consulting services.

Appendix A6.1: The Design, Tender, Build Approach

1 Contract Documents

Tendering is a formal process whereby the owner invites suppliers to make an offer to supply required products or services. For complex infrastructure projects with high value (e.g., the construction of a bridge or a hospital), the tender process involves considerable documentation, and a series of formal procedures. Smaller projects, such as the supply and installation of a POE / POU treatment system, do not normally involve a lengthy or complicated tender process.

Prior to tendering, a comprehensive package of documents should be prepared to communicate your requirements. This package may be prepared by your consultant, or you may prepare it with in-house resources. The tender package with which you will invite suppliers to respond may include the components outlined below. The components can include:

- The contract drawings
- The specifications
- The general conditions of contract
- The form of tender.

Contract Drawings

The contract drawings express the detailed design of the system, and were prepared in Step 5 of the process. Most contract drawings are now created using computer technology. The designers preparing the drawings will require a range of information. For example, you may have old "as-built" drawings in paper form, which show parts of your system that were built many years ago, and to which the designer will refer when creating the new drawings. The designers will also refer to other sources of information such as legal plans which show details of property boundaries.

Specifications

The specifications refer to the various components that make up the system, and specify the form and function of those components. In some cases the specification for a particular component will specify requirements for the component in great detail. For example it may specify the composition of the material from which it is to be made, the colour, hardness, and strength. In other cases the specification may refer to a broadly recognized standard, such as one developed by the Canadian Standards Association (CSA), or the American Society for Testing of materials (ASTM). In other cases specifications may specify only the function that is to be performed by the component, and leave details of materials and manufacturing to the supplier.

Conditions of Contract

The conditions of contract govern the relationship between the owner and the supplier. They cover a wide range of topics such as: the way payments will be approved and made; how disputes will be addressed; and, how extra work is to be priced. Conditions of a contract also cover the responsibilities of the contractor such as: maintaining the safety of the work sites; providing notice of service interruptions; the need to seek approval for departures from the drawings and specifications; and, required warranties.

Form of Tender

The form of tender is a document which the supplier/contractor is required to complete, and constitutes their actual offer to undertake the work in compliance with the other contract documents. It is produced by the owner or the owner's consultant. In this way the owner has greater assurance that the offer is made in a manner which meets the requirements of the owner. This is less likely to be the case if the owner accepts a tender drafted entirely by the supplier/contractor. When the form of tender is not drafted by the owner, the supplier/contractor may simply provide a letter offering to undertake the work and quoting the price to be charged, with no reference to drawings, specification or any conditions governing the contract.

The contract documents are a very important part of your project. When properly prepared they help ensure that the project will run smoothly without confusion, delay and/or extra cost.

2 Tendering Process

Once the contract documents are prepared your project is ready to go to tender. Tendering is the process whereby a number of contractors/suppliers are invited to provide an offer to undertake the work proposed.

You may advertise that you are interested in tendering a project, through an "Invitation to Tender". Alternatively, you may ask two or three selected contractors to each provide you with a tender. You should confirm that contractors you invite to tender are reliable and trustworthy. A good contractor should be easy to contact and should provide technical assistance in the event a problem occurs. If you asked several suppliers to provide you with budget quotations in Step 2, you may include them on your list of selected contractors for the formal tender process.

There are several suppliers of POE / POU systems in British Columbia. For a list of suppliers go to www.SustianIS.Org and look under the "POE/ POU" category.

The tender package will include instructions which will advise all potential tenderers of the closing date and time for receipt of tenders, the address the tender should be delivered to, and the documents which must be included in the tender package. After the closing date and time the tenders can be opened and checked to ensure that they are all “formal”. A formal tender is a tender that complies with all stated requirements. An informal tender is one that has some significant deficiency. For example, you may have specified that a “Bid Bond” should be included with the tender. If this is missing from a tender package submitted by a tenderer, you may declare that tender is informal, and decide not to consider it further.

Tenders should be reviewed by those experienced in the process and the work to be undertaken. If you are working with an external consultant, you may ask the consultant to undertake this review and to recommend which tender if any should be accepted. It is normal to make it clear in your contract documents that you, as the owner, reserve the right to not accept any of the tenders submitted, and also to accept a tender other than the one with the lowest price if you consider that to be in your best interests.

For small projects you may choose to invite tenders from three contractors you know to be interested in the work. Inviting tenders for small projects from a large number of contractors should generally be avoided. This is because the odds for any one contractor of being awarded the work are lowered as the number of Tenderers increases. In this situation a comparatively large number of organizations are making significant effort with little chance of reward.

The preparation of a tender, even for a small job, may require a fair amount of work for a contractor bidding on the project. Be sure to recognize this effort through the provision of clear and concise tender documents and ensure that you adhere to procedures that are clear, fair and reasonable.

3. Contract Award

After the closing date you can begin to review the submissions. Once the informal tenders have been discarded (see Tendering Process), those tenders that comply can then be analyzed and compared. This process will help you identify which of the tenders, if any, you wish to accept. You may at this point follow up the references provided by your preferred tenderer. If all things are in order you may be in a position to accept the preferred tender and award the contract.

In some instances you may want to negotiate over certain details with the preferred tenderer before awarding the contract. You may also need to discuss and clarify certain aspects of the work with the preferred tenderer. For example, there may be some ambiguities in the tender you received or you may have a reason to change some aspect of the work due to new information. After discussions, if both parties have a full understanding of the requirements, deliverables, timing, responsibilities and costs associated with the project, and are in agreement over the changes, you are in a position to accept the revised tender by issuing and signing the "Contract Agreement". You now have contract in place with the successful tenderer.

You should also let the other tenderers know as soon as possible the result of your review of the tenders. Those tenderers who have been unsuccessful will want to know this so they can reallocate resources they had assigned to your project in anticipation of being awarded the contract, to other projects.

Appendix A7.1: Maintenance for Selected POU and POE Technologies

Treatment Technology	Operation and Maintenance
Adsorptive Media: **Activated Alumina (AA)[10] and Specialty Media[11]**	POU: Replacement[12] of spent cartridges and particulate pre-filters (if used). POE: Typically periodic backwashing. Replacement of spent media and particulate pre-filters (if used). Maintenance and cleaning of storage tank (if used).
Aeration: **Diffused Bubble or Shallow Tray**	<u>Only appropriate for POE</u> Replacement of particulate pre-filters. Replacement of air filters for fan intake and for exhaust. Maintenance of fan, motors, and re-pressurization pumps. Replacement of post-treatment GAC polishing filters. Maintenance and cleaning of storage tank. If UV is used for post-treatment disinfection, replacement of UV bulb and cleaning bulb housing. If ozonation is used for post-treatment disinfection, maintenance of ozonation unit.
Granular Activated Carbon (GAC)	POU: Replacement of spent cartridges and particulate pre-filters (if used). POE: Periodic backwashing. Replacement of spent media and particulate pre-filters (if used). Maintenance and cleaning of storage tank (if used). If UV is used for post-treatment disinfection, replacement of bulb and cleaning bulb housing. If ozonation is used for post-treatment disinfection, maintenance of ozonation element.
Ion Exchange (IX): **Anion Exchange (AX) and Cation Exchange (CX)**	POU: Replacement of spent resin cartridges and particulate pre-filters (if used). POE: Regular regeneration and periodic backwashing. Replacement of salt used for resin regeneration. Replacement of lost or spent resin and replacement of particulate pre-filters. Maintenance and cleaning of storage tank (if used).
Reverse Osmosis (RO)	POU and POE: Replacement of exhausted membranes, particulate pre-filters, and pre- and post- treatment GAC filters. Maintenance and cleaning of storage tank. Maintenance of (re) pressurization pumps (if used).
Ultraviolet Light (UV)	POU and POE: Replacement of UV bulbs and sensors. Cleaning quartz sleeve separating bulb and water. Replacement of sleeve but not as often as bulb. Replacement of spent resin cartridges and particulate pre-filters (if used).

[10] The regeneration process for AA is complex and requires the use of strong caustics and acids. Therefore, to avoid potential health risks associated with the storage of these chemicals in residences, POE AA should only be considered for use on a throwaway basis unless systems can provide offsite regeneration and/or vessel exchange facilities.
[11] Regeneration of specialty media is generally not effective due to the high affinity of the media for the contaminant(s) of concern and is typically a complex operation. Therefore, specialty media installed at the POU or POE should only be considered for use on a throwaway basis.
[12] Currently spent filter cartridges for most adsorptive media used in POU systems are classified as household waste and can be discarded in the trash as such.

Appendix A7.2: Access and Maintenance Agreement

Following is an element of an access and maintenance agreement prepared for use in the US. Water supply systems (WSS) in BC should create their own agreement to meet their particular needs, and in conjunction with legal assistance.

This is an Agreement between _____(*insert name of WSS*) ___ (known as WSS in this agreement), and

(*insert name of property owner*) __________ (known as the Owner in this agreement)

who is the legal owner of ______________________(*insert full legal description of property)*

Whereas:

WSS will install *INSERT TYPE OF POU OR POE TREATMENT DEVICE* to treat for *INSERT CONTAMINANT(S) BEING REMOVED*. WSS has chosen to use this treatment technology as an effective means of removing this type of contamination from our drinking water in a cost-efficient manner. Installation of this technology will help to ensure the delivery of safe water to customers. It is important to note that failure to properly operate and maintain these units may produce water with new or higher levels of contamination.

____.[1]

The undersigned agree:

1. The Owners are the current legal owners of, and can provide access to, the property described above.

1. The Owner agrees to allow WSS, its employees, authorized representatives, and others under agreement with the WSS to enter the aforementioned property to:
   a. Install, replace, maintain, or remove the treatment unit and any ancillary equipment.
   b. Maintain the treatment unit and any ancillary equipment. Maintenance may include periodic testing of the unit as well as the collection of samples. Any maintenance, testing, or sample collection will occur during normal business hours or as arranged between the WSS and the Owner.

[1] Insert a description of the property here. This description should include the full address and the legal description. Ensure that the undersigned owns the structure (e.g., house, business, office, other building) and not just the land that the structure is on.

2. The Owner agrees to not adjust, modify, tamper with, bypass, or remove the treatment unit or any ancillary equipment.

3. The Owner agrees to within a reasonable period of time, notify the WSS
   a. Any problems, concerns, or questions concerning the treatment unit or any ancillary equipment.
   b. The rental, lease, sale, or other transfer of the aforementioned property.

4. The Owner agrees to indemnify and hold harmless the WSS for any injury or damage which may occur as a result of the installation, maintenance, operation, monitoring, or removal of the treatment unit or any ancillary equipment.

5. All equipment shall remain the property of the WSS. The Owner agrees to reimburse the WSS for any costs incurred because the Owner adjusted, modified, bypassed, tampered with, or removed the treatment unit or any ancillary equipment.

6. While in effect, this agreement shall run with the land and shall be binding on all parties having or acquiring any right, title, or interest in the property described herein.

7. This written permission is given by the Owners voluntarily with knowledge of legal rights and without threat or promise of any kind.

8. This agreement remains in effect until:

Owners:

________________________________ ________________________________
Name Date Name Date

________________________________ ________________________________

For the WSS:

________________________________ ________________________________
Name Date Name Date