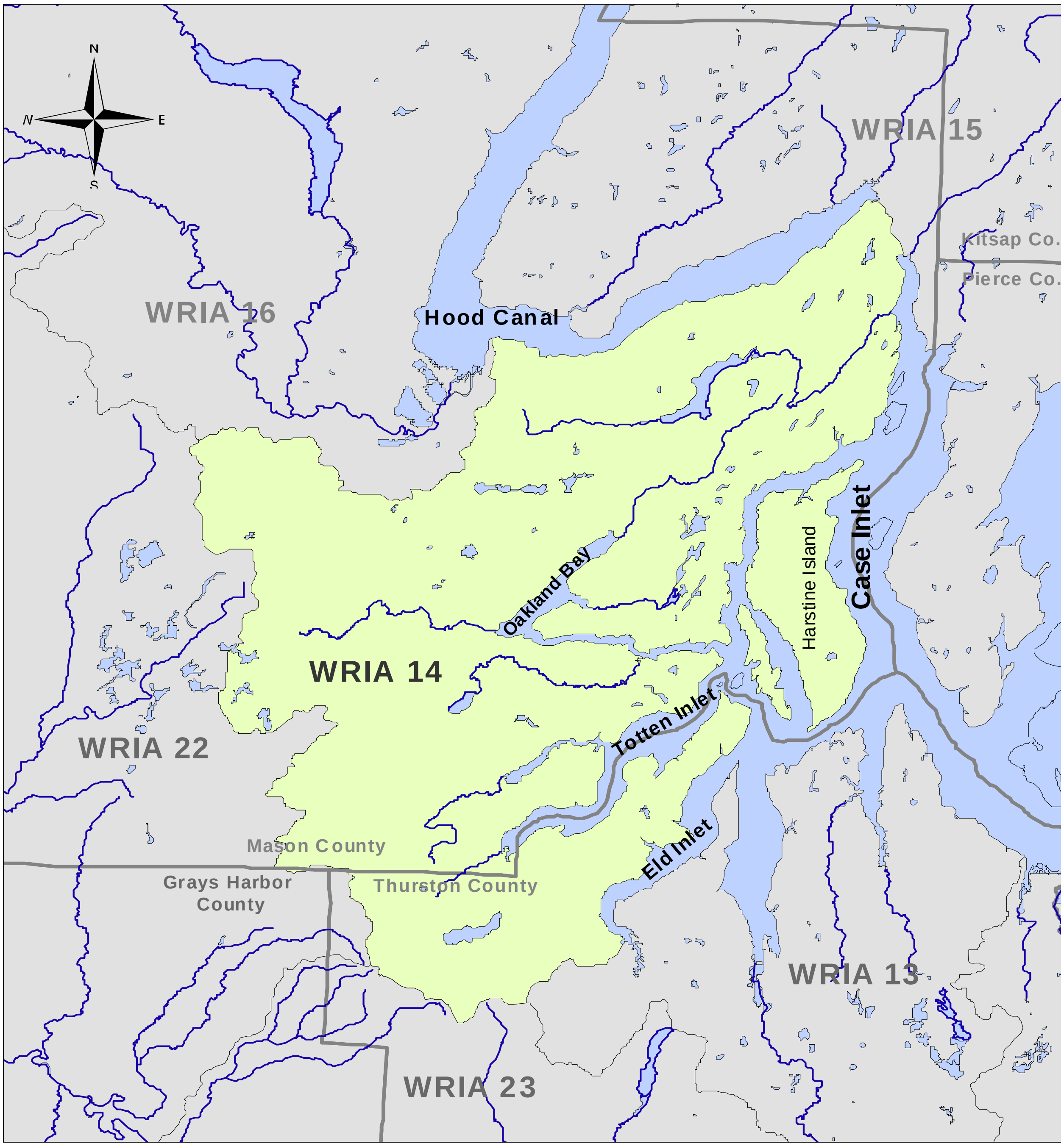
WRIA 14
SURFACE WATER QUALITY MONITORING STRATEGY



PRODUCED FOR THE WRIA 14 PLANNING UNIT THROUGH A WATERSHED PLANNING WATER QUALITY GRANT FROM THE DEPARTMENT OF ECOLOGY (#G0300147)

PRODUCED BY: ENVIROVISION CORPORATION **AUGUST 2003**

WRIA 14
SURFACE WATER QUALITY MONITORING STRATEGY

PURPOSE AND NEED

Stakeholders within Water Resource Inventory Area (WRIA) 14 are developing a watershed plan under the rules of the Watershed Management Act of 1998 (RCW 90.82). Ultimately the watershed plan will be a guide to the long-term management of water resources in the WRIA. One of the requirements for understanding the long-term condition of water resources is a method for assessing that condition. The purpose of this monitoring plan as described in the Watershed Management Act (RCW 90.82.090) is to provide a "…means of monitoring by appropriate government agencies whether actions taken to implement the approach to bring about improvements in water quality are sufficient to achieve compliance with water quality standards." Some goals of the monitoring plan as set by the planning unit members were to; formulate a process for collecting available data, provide quality assurance and consistency in reporting, and improve and establish coordination of water quality monitoring data among the stakeholders.

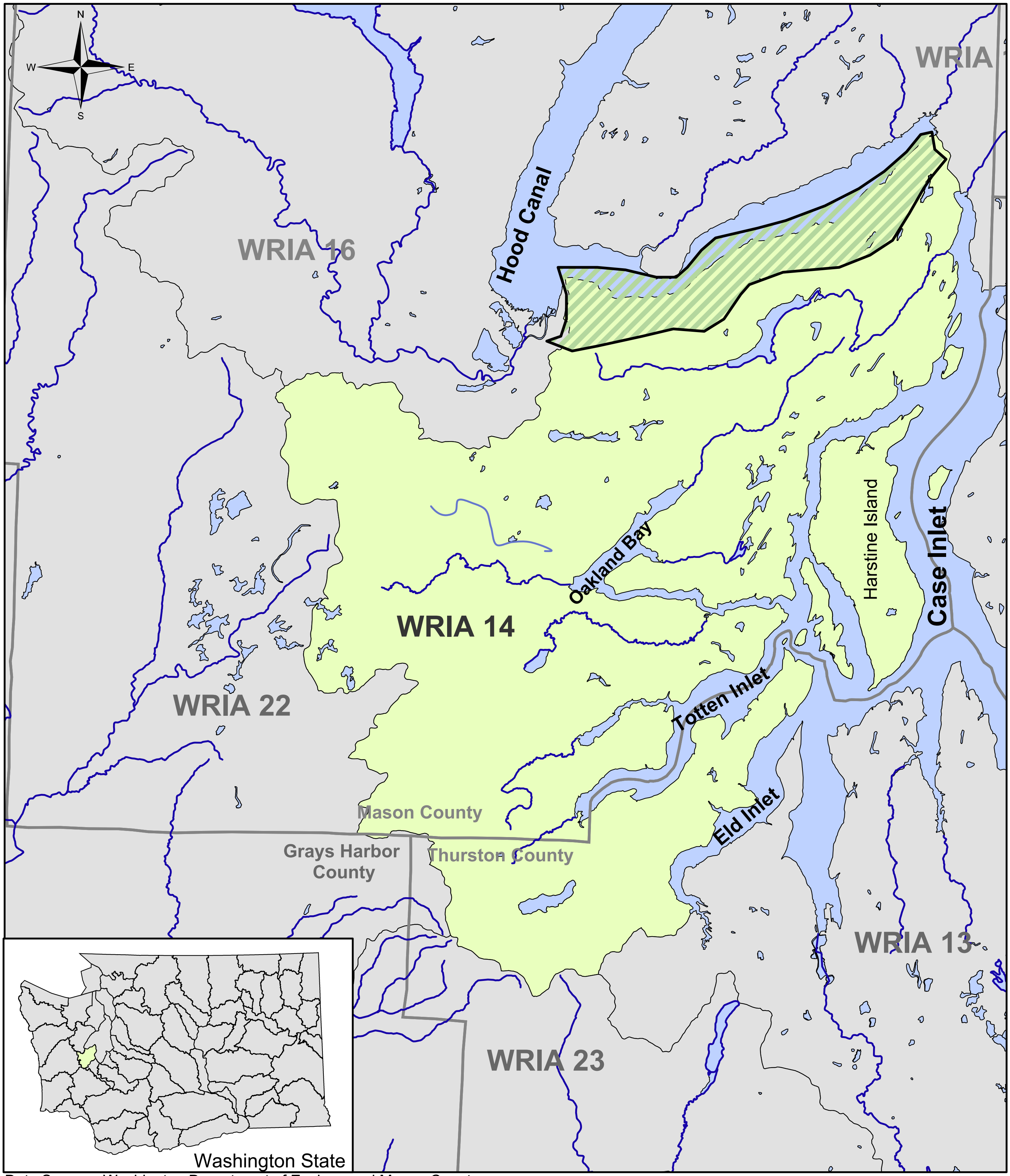
This surface water quality monitoring strategy represents one part of the overall assessment approach that will be required to meet the Watershed Plan goals. The primary objectives of this strategy are to identify long-term trends in stream water quality and impacts of land use. Eventually, the data collected will be useful for supporting future policies and encouraging local agency responsibility toward area water resource management.

WATERSHED OVERVIEW

Water Resource Inventory Area (WRIA) 14 also known as the Kennedy-Goldsborough Watershed covers an area of 307 square miles including seven islands and marine areas. The WRIA is bounded on the north by the lower arm of Hood Canal. (Note: The northern portion of the watershed that is directly adjacent to Hood Canal, known as the South Shore, is formally contained within WRIA 14, but for watershed planning purposes, it has been included with WRIA 16.) On the east, WRIA 14 is bordered by Case Inlet. The southern boundary of the WRIA is defined by the Kennedy Creek watershed and Eld Inlet, while the western boundary reaches up toward the Olympic Mountains and the Lower Chehalis Watershed (WRIA 22) (Figure 1). WRIA 14 also contains seven islands: Stretch, Treasure, McMicken, Harstene, Hope, Squaxin and one freshwater island located in Island Lake.

WRIA 14 represents a network of numerous smaller rivers that discharge directly into the marine waters of Puget Sound. There are numerous streams and creeks that drain WRIA 14, including Kennedy, Skookum, Mill, Goldsborough, Shelton, Cranberry, Deer, Shumocher, Sherwood, Uncle Johns, and Johns Creeks (Figure 2,). Many of these streams have headwaters originating from natural springs, wetlands or small lakes. WRIA 14 also has many lakes (Figure 2,). A more complete listing of lakes and streams is included as Appendix B.

Figure 1. WRIA 14 Boundary and General Location



Data Source: Washington Department of Ecology and Mason County

0 1.25 2.5 5 7.5 10
Miles

Legend

Water Bodies — Rivers/Streams — Other WRIAs — WRIA 14

Portion of WRIA 14 addressed in WRIA 16 planning

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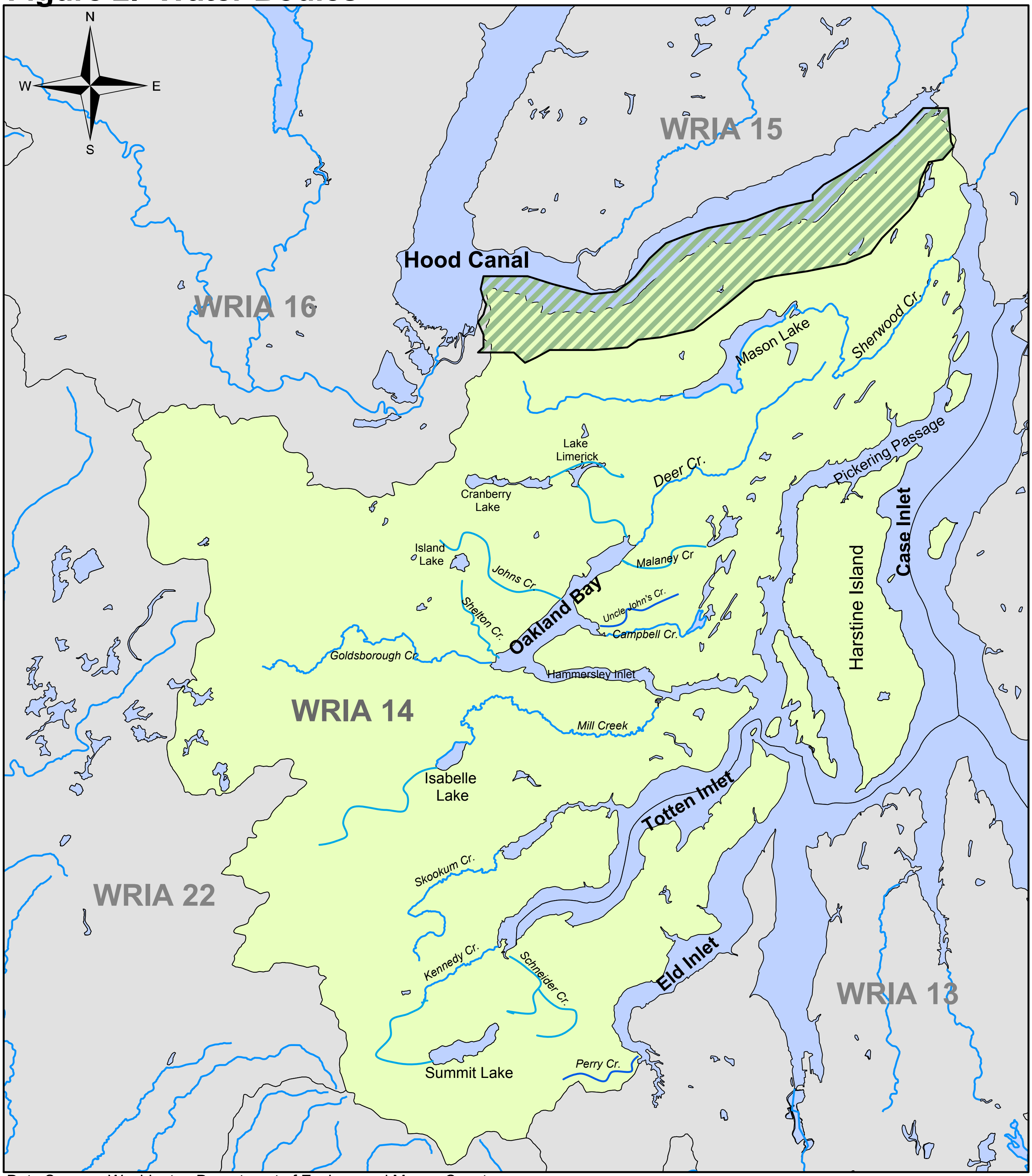
Figure 2. Water Bodies



Data Source: Washington Department of Ecology and Mason County

Legend

Water Bodies | Other WRIAs | WRIA 14

Rivers/Streams

Portion of WRIA 14 addressed in WRIA 16 planning

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The geological characteristics of WRIA 14 are fairly consistent throughout. In the southwest corner of WRIA 14, volcanic activity produced areas of exposed basalt rock formations that make up much of the Black Hills. Glacial and interglacial deposits comprise the rest of the area. These deposits produced unconsolidated sediments ranging in thickness of up to 3000 feet. In some areas, exposed clay and silt deposits can be identified. The geological characteristics lend themselves to less developed water resource potential (Golder, 2003). WRIA 14 consists primarily of low-lying hills ranging in elevation of 100 to 400 feet. Some areas in the northwest corner near the Olympic Mountains reach elevations of 2400 feet. There is no measurable amount of high elevation snow or ice packs; therefore rainfall is the only significant source of water for the area (WDOE, 1983).

The Kennedy-Goldsborough watershed is typical of a marine temperate environment and characterized by cool, dry summers and mild, wet winters. Summer and winter average temperatures only fluctuate by 30 degrees throughout the year with winter temperatures averaging 38° F and summer temperatures around 65° F. Because temperatures rarely reach freezing, significant accumulations of snow over any prolonged period of time is minimal. Average annual precipitation ranges from 55 inches near the eastern marine shorelines to nearly 90 inches along the Olympic Mountain Range. Stream discharge peaks during the winter months and progressively decreases throughout the summer.

The Level 1 Assessment separated WRIA 14 into four sub-basins based on surface water and topographical characteristics (Case Inlet, Goldsborough, Kennedy and Skookum) (Golder, 2003). Case Inlet, the second largest subbasin in total area, consists mostly of marine waters and includes Harstine and Squaxin Island. The Goldsborough subbasin, which includes the City of Shelton and surrounding area, has the highest population density. Skookum Creek and the north shore of Totten Inlet are located within the Skookum subbasin. Also, all development for the Squaxin Island Tribe occurs within this subbasin. The Kennedy Creek subbasin contains the Black Hills portion of WRIA 14 and has lower summer instream flows due to the basalt rock formations in that area. Table 1 below identifies the drainage characteristics and population densities for the four WRIA 14 sub-basins.

Table 1. Subbasin characteristics of WRIA 14. (Population densities based on 2000 U.S. Census Data.)

Sub-basin	**Total Miles Squared**	**Average Annual Precipitation** (inches)	**Population Density** (Persons/mile^2)
Case Inlet	65.1	56.7	79
Goldsborough	155.3	67.6	159
Kennedy	53.4	62.7	118
Skookum	33.2	67.9	99

Source: Golder (2003)

WRIA 14 is primarily located in Mason County (84%) but includes small portions of Thurston (15%) and Grays Harbor Counties (< 1%). There are few incorporated towns and cities within the WRIA, the largest municipality being the City of Shelton. The Squaxin Island Tribe also has reservation properties in the WRIA including Squaxin Island, and areas near Totten Inlet, Hammersley Inlet, Skookum Creek, and Oakland Bay.

The majority of the watershed (71%) is forested land dominated by western hemlock, Douglas fir, and red alder (http://www.ecy.wa.gov/programs/wq/wria_summaries/wria14.pdf). The remaining land base in the watershed is spread among rangeland (3%), lakes, streams and marine areas (14%) and other uses (12%) such as urban and rural residential, commercial, industrial, agricultural and other minor categories. The economic makeup of WRIA 14 consists of forestry/agricultural practices (4%), retail trade (17%), manufacturing (17%), government (29%), services (18%) and various others (15%) (http://www.ecy.wa.gov/programs/wq/wria_summaries/wria14.pdf). The streams within the WRIA are used for municipal water sources as well as for irrigation and private and commercial water supplies. For example, Shelton Springs, the headwaters of Shelton Creek, provides the municipal water supply for the City of Shelton, and Goldsborough Creek provides an industrial water supply for Simpson Timber Company (WDOE, 1983).

MONITORING STRATEGY DEVELOPMENT

An effective monitoring strategy must account for the known condition of surface waters and past and existing monitoring efforts, and balance these against established monitoring objectives. The following is a summary of this background information as it pertains to WRIA 14.

Water Quality Assessment

The first step in development of the monitoring strategy is to assess the existing water quality. The Level 1 Assessment for WRIA 14 (Golder, 2003) was reviewed as a means of summarizing the known water quality condition. The Level 1 Assessment only addressed known areas of non-compliance. These are areas where State water quality standards are not met and therefore they have been included in EPA's "303(d) list" of impaired waters. Table 2 lists current 303 (d) listings in WRIA 14 as well as those streams or segments where stream flow does not meet Instream Flow requirements as defined in WAC 173-514-040. The table indicates that high concentrations of fecal coliform bacteria occur throughout the WRIA streams and that this is the key area of concern in terms of water quality. However, to a large extent this may be a function of past monitoring efforts. That is, there may be other water quality problems (e.g., high summer temperatures) but there is no data available for making the determination. The fact that many of the streams also exhibit summer period flow problems suggests there may be coincident problems with temperature and dissolved oxygen concentrations that warrant investigating.

The Level 1 Assessment (Golder 2003) presented a number of data gaps or recommendations for further assessment. Most were associated with water quantity issues related to water rights and use. The following is a summary of those that were water quality based or may be significant to development of a surface water quality monitoring strategy:

- ✓ Evaluation of streamflow during water withdrawals for habitat needs of fish. (Note: In terms of water quality; temperature and dissolved oxygen as well as streamflow can define fish habitat limitations.)
- ✓ Re-establish past gaging stations and establish new sites.
- ✓ Coordinate monitoring efforts and develop a centralized database.
- ✓ Focus additional assessment efforts in areas of concentrated population areas of pending water rights.

Table 2: Segments identified as having either water quality problems or water quantity problems as evidenced by a stream closure period.

Water body Name	303(d) Listing	Flow Limited Closures	Township, Range, Section
Burns Creek	Fecal Coliform, pH	No	19N 03W 27
Campbell Creek	Fecal Coliform	Yes (1)	20N 03W 13
Campbell Creek	Fecal Coliform	Yes (1)	20N 03W 14
Cranberry Creek	NA	Yes (2)	21N 3W 36
Deer Creek	NA	Yes (2)	21N 3W 20
Elson Creek	NA	Yes (1)	
Fawn Lake Outlet	NA	Yes (1)	
Goldsborough Creek	Fecal Coliform	Yes (1)	20N 03W 20
Jarrell Creek	NA	Yes (1)	
Johns Creek	NA	Yes (2)	20N 3W 03
Jones Creek	NA	Yes (1)	
Kennedy Creek	pH	Yes (3)	19N 03W 32
Little Creek	NA	Yes (1)	
Melaney Creek	NA	Yes (1)	
Perry Creek	pH	Yes (1)	18N 03W 13
Pierre Creek	Fecal Coliform, pH	No	19N 03W 27
Schneider Creek	pH	Yes (1)	19N 03W 33
Shelton Creek	Fecal Coliform	Yes (1)	20N 03W 20
Sherwood Creek	NA	Yes (2)	22N 01W 20
Skookum Creek	Fecal Coliform	Yes (1)	19N 03W 19
Uncle John Creek	Fecal Coliform	Yes (1)	20N 03W 14

Source: Final 1998 Section 303(d) List – WRIA 14 and WAC 173-514-040

(1) Closures are for the period from May 1 through October 31.
(2) Closures for the period from May 1 through November 15.
(3) Closure for the period of May 1 to November 15.

NA Not Applicable for 303(d) listing but is a known problem segment for stream closure.

Existing/Past Monitoring Efforts and Data

To be most cost-effective, the WRIA-wide monitoring should compliment existing monitoring efforts. Local and State agencies and tribes were contacted to develop a summary of monitoring efforts and available data. The Washington State Departments of Ecology and Health, Mason County, Thurston County, the USGS, and the Squaxin Island Tribe all have been involved in monitoring in the area. The following is a summary of their monitoring efforts.

The Washington State Department of Ecology (Ecology) is not currently conducting watershed based monitoring in the WRIA as part of their ambient monitoring program. (TMDL related monitoring and monitoring in marine waters has occurred and is described below.) However, there are past records of monthly monitoring at two stations; both located on Goldsborough Creek. The first station was located at the 1st Street Bridge in Shelton and was monitored more than three decades ago from 1965 - 1970 (Station 14A070). A second station (Station 14A060) located at a bridge crossing on Dayton-Matlock Road was monitored during the period from 1994-1999 (Figure 3). Data collected at Station 14A070 may be valuable for making historical comparisons. It included measurement of temperature, pH, conductance, and nitrate+nitrite. The data collected from Station 14A060 was more comprehensive consisting of the parameters mentioned above as well as several other parameters including phosphorus, dissolved oxygen, flow, and fecal coliform.

As part of the Puget Sound Ambient Monitoring Program, Ecology conducts marine water quality monitoring at about 40 stations in Puget Sound, Grays Harbor and Willapa Bay. Some of these stations are identified as "Core" stations and are monitored each year on a monthly basis. Others are identified as "Rotational" and are monitored on a rotating schedule. Parameters monitored include profiles of temperature, salinity, density, dissolved oxygen, light transmission, pH, as well as discrete samples at various depths for fecal coliform bacteria, chlorophyll a, phaeopigment, nitrate, nitrite, ammonium, orthophosphate, silicate and Secchi disk depth. Generally samples are taken at 0, 10, and 30 meters depth. In WRIA 14 there is one core station (in Oakland Bay) and 2 rotating stations, one each in Case and Totten Inlets.

Ecology (Michaud, 1988) also carried out a two-year investigative study of fecal coliform bacteria (FC bacteria) sources in Shelton and Goldsborough Creeks. This involved monitoring 4 stations in lower Goldsborough Creek and 10 stations in Shelton Creek, as well as monitoring of the inner harbor area.

Ecology and other involved agencies have recently been monitoring for at least two fecal coliform based TMDL plans within WRIA 14. The monitoring included marine waters and tributaries of Oakland Bay, Hammersley Inlet, Eld Inlet, Totten Inlet and Little Skookum Inlet (Hempleman, C., personal communication). The development of the related TMDL plan for Oakland Bay and Hammersley Inlet marine waters and tributaries will begin in 2003. Development of implementation plans for the other areas monitored are not yet scheduled.

During the time period between 1989 and 1999, Ecology maintained a volunteer based lake monitoring program. In WRIA 14, nine lakes were monitored during this program, including Mason, Limerick, Island, Spencer, Isabelle, Summit, Lost, Phillips and Trails End Lakes. Although specific monitoring years varied between each lake, the general parameters measured were the same. In each lake, data on temperature, pH, total phosphorus, total nitrogen and chlorophyll were collected. Additionally, secchi depth measurements were taken. In some of the lakes (Mason, Limerick and Island), parameters of hardness, turbidity, calcium and aquatic vegetation were also assessed during select years. Some of these lakes (e.g., Limerick, Island, and Mason) continue to be monitored through local programs.

The Washington State Department of Health (WDOH) performs routine bacterial (FC bacteria) monitoring in the marine waters and nearshore areas associated with commercial and recreational shellfish beds. This monitoring includes monthly sampling at stations in Conditionally Approved Areas (e.g., Oakland Bay and North Bay) and monitoring six times per year in Approved Areas (e.g., Skookum Inlet). .

Mason County through their Threatened Area Response Strategy has recently begun two investigative monitoring efforts. One, in Oakland Bay, has a primary focus of on-site wastewater systems in the area around Chapman Cove, since this is the area most in danger of a shellfish harvesting downgrade. The second study is occurring in the North Bay area and is also focused on areas near the marine shoreline and potential wastewater problems. These are short-term investigative efforts that are grant-funded and therefore not considered to be long-term in nature. Essentially they include monthly collection of FC bacteria samples from numerous sites in these areas.

Thurston County has a County wide routine monitoring program that includes two stations in WRIA 14: one on Kennedy Creek and one on Schneider Creek (Figure 3). The County monitors for nutrients (total phosphorus and nitrates/nitrates), dissolved oxygen, fecal coliform bacteria, temperature, and conductivity. The monitoring program includes six monitoring events each year; four during the high flow season and two during the low flow season. The County has also done summer period monitoring in Summit Lake.

The Squaxin Island Tribe has recently begun conducting fairly comprehensive monitoring of the WRIA. They have established over 40 stations in the WRIA that are monitored on a monthly, quarterly, or "as warranted" basis. Bacteria (Fecal and E. coli) are the only parameters measured on a frequent (monthly) basis, however physical measurements (e.g., temperature, pH, specific conductance, dissolved oxygen, turbidity) and two chemical parameters (i.e., total phosphorus and nitrates) are monitored quarterly at 23 stations. Also, there will be annual measurements of aquatic macroinvertebrates and periodic measurements of streamflow. The Squaxin monitoring strategy has also included the establishment of six stream gaging stations on Mill, Goldsborough, Cranberry, Shumocher, Skookum, and Johns Creeks.

There is no active stream gaging by the USGS in WRIA 14. There is old data from a ten-year period mostly during the 1940s for Deer, Cranberry, Johns, Goldsborough (at Shelton), Mill, and Skookum Creeks. There is more recent data for Goldsborough (near Shelton), Kennedy Creek, and Schneider Creek; however recent in this case is early 1970s.

In summary,

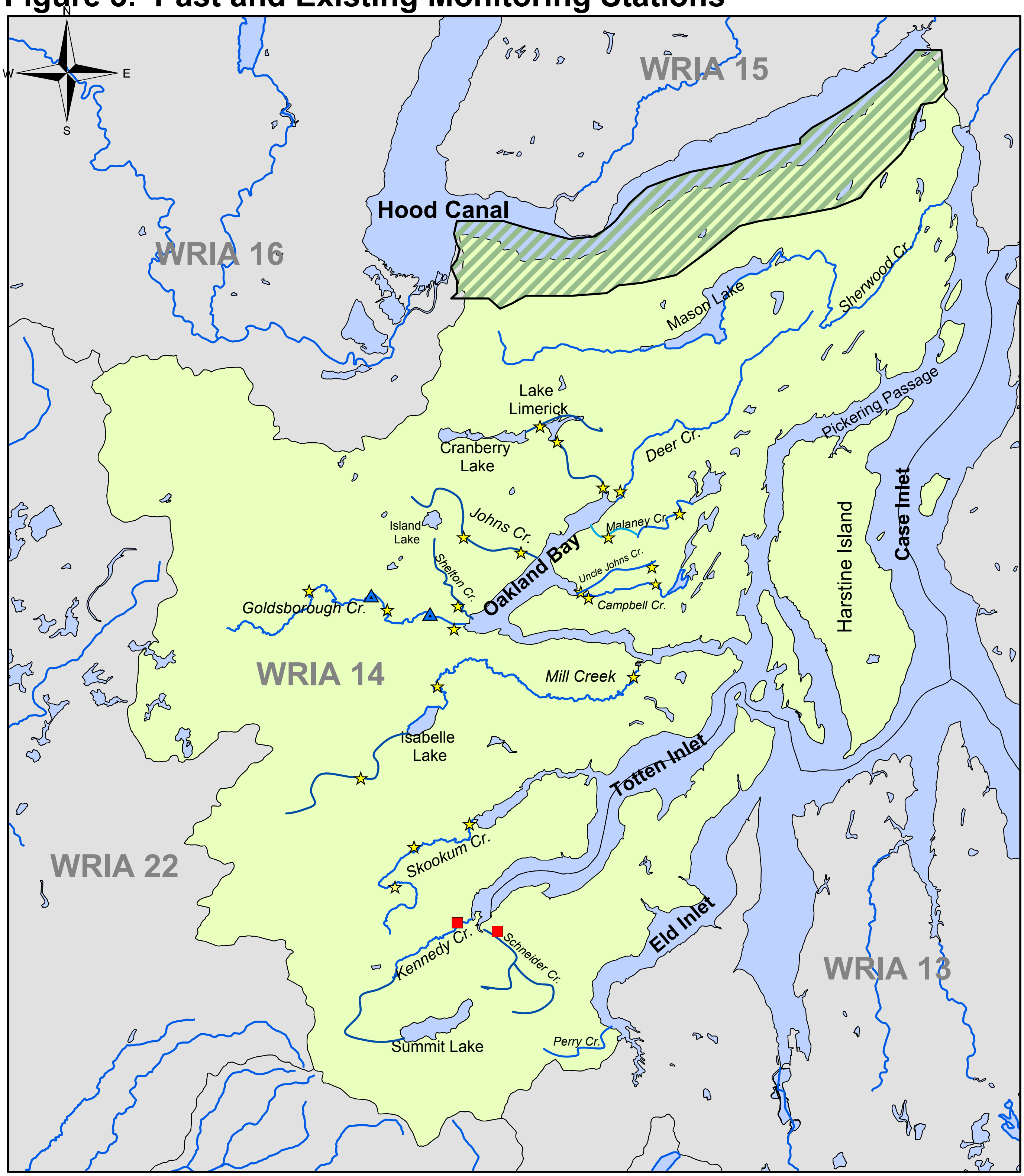
- With the exception of a sporadic data record for two stations on Goldsborough Creek there is no historic or long-term data record for the freshwater resources in the WRIA.
- There is also no current streamflow record; even historic records cover less than a 10year period and therefore are not long enough to display climatic oscillations.
- The most significant water quality concern in WRIA 14 is associated with fecal coliform bacteria problems and the threat to the shellfish industry. As a consequence, most of the water quality monitoring done in WRIA 14 has focused on measurements of fecal coliform bacteria concentrations and marine areas.
- The monitoring program recently begun by the Squaxin Island Tribe represents a good base where from which to expand for the most cost-effective WRIA-wide monitoring program.

MONITORING OBJECTIVES

The following list of monitoring objectives was approved by the WRIA 14 planning unit members.

- Develop a database that can be used to monitor long-term trends in conventional surface water quality conditions.
- Determine whether there are water quality conditions or trends that can be attributed to land use and development.
- Develop a dataset that can be used to guide public policy and build local agency initiative and responsibility toward area water resources.

Figure 3. Past and Existing Monitoring Stations



Data Source: Washington Department of Ecology and Mason County

Legend

- Water Bodies
- Other WRIAs
- WRIA 14
- Rivers/Streams
- DOE Water Quality Sites
- Squaxin Sites (existing)
- Thurston County Sites
- Portion of WRIA 14 addressed in WRIA 16 planning

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Although the need to assess compliance with State water quality standards was also deemed important, it was believed that for most parameters this could be achieved by meeting the top priority objectives. Evaluation of the effectiveness of TMDL's or water clean-up plans was also considered as an objective, but it was believed that this need would be met through the TMDL implementation plans.

In addition to identifying objectives for this monitoring strategy the committee discussed the limitations to this monitoring strategy. It was agreed that the strategy should concentrate on freshwater and streams since this fits best with the goals of watershed based planning and the requirements of RCW 90.82. Therefore, groundwater, marine waters, wetlands, and stormwater were not primary considerations for this strategy. (This should not be construed to suggest that these water resources are not also of interest in the area. It is expected that they will be addressed through other monitoring strategies or investigative efforts.) Similarly, this strategy is to be water quality based and not address water quantity issues except in terms of collecting stream flow measurements for assessment of pollutant loads and yields. The committee also agreed that a "tiered" approach to monitoring that would allow for increasing the cost and complexity through time, or allow for picking and choosing amongst tiers would best suit area needs.

MONITORING STRATEGY

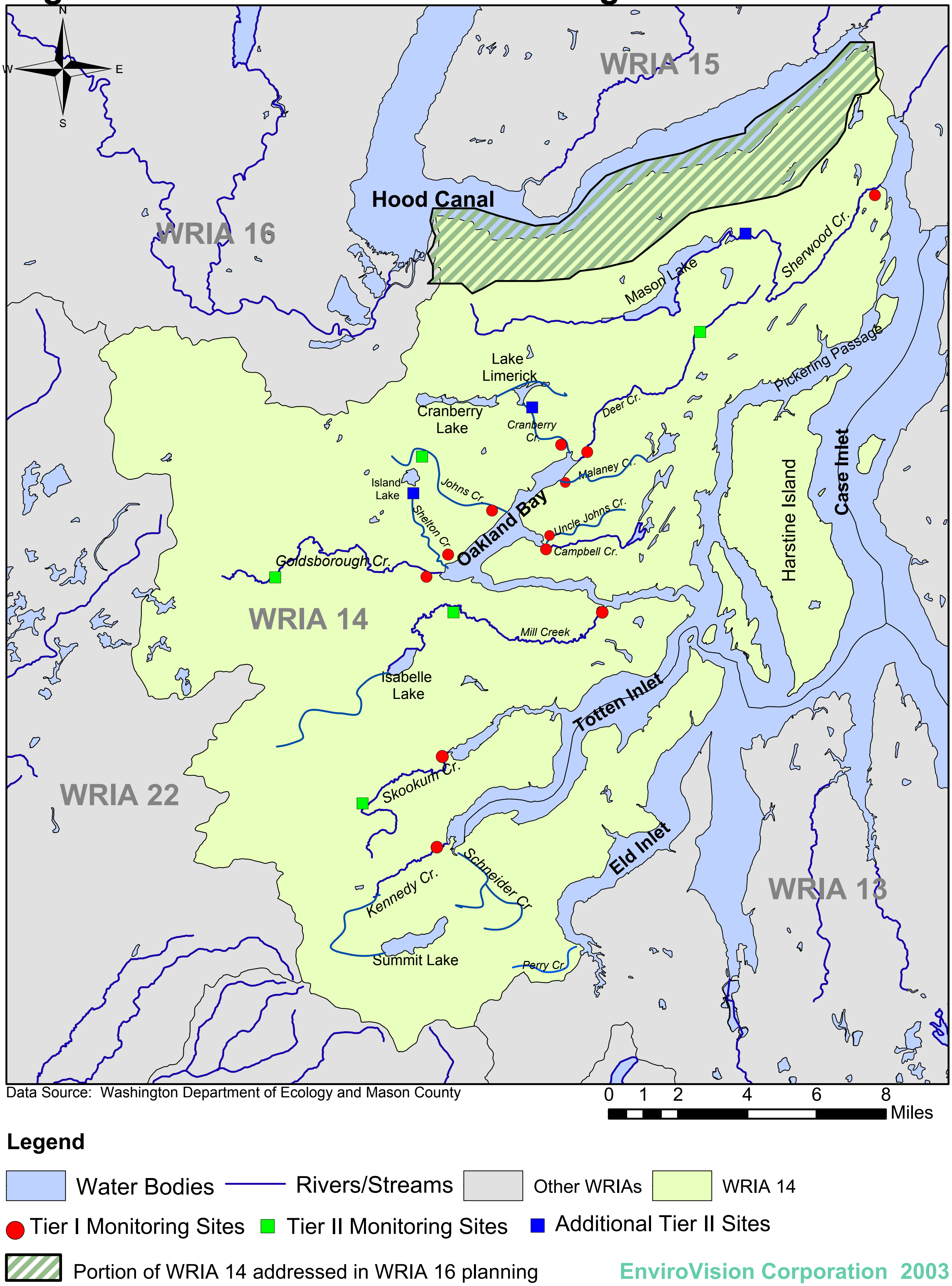
The Tier I or Baseline Strategy described below represents an optimized approach for meeting the highest priority monitoring objective; long term trend assessment. The Baseline Strategy is followed by four tiers each of which would result in a more comprehensive monitoring program. These additional Tiers can be added to the Baseline Strategy in pieces or as a whole to meet available resources. It is not necessary for the Tiers to be initiated in any sequence. In other words, the Baseline Strategy could be implemented along with Tier V without any requirement to implement Tiers II through IV.

Tier I (Baseline Strategy)

The baseline strategy covers long term trend monitoring for twelve key streams within WRIA 14. These twelve streams were selected based on known or suspected problems and land use or development pressure. The twelve streams are Kennedy, Skookum, Goldsborough, Shelton, Johns, Cranberry, Deer, Uncle John), Mill, Maloney, Campbell and Sherwood Creeks (Figure 4). Monitoring would be slated to occur near the mouths of all of these streams. (Note: This strategy requires either establishing stations upstream of the area of tidal influence or timing all monitoring for low tides.)

The water quality parameters should include; both fecal coliform and E. coli bacteria, nitrate+nitrite, total phosphorus, total suspended solids, biochemical oxygen demand (BOD), turbidity, dissolved oxygen, temperature, pH, specific conductance and flow. These parameters were selected because they are either a known concern or because they lend themselves to trend analysis. Collection and analysis protocols for all of these parameters are described in the QAPP (Appendix A). Because pollutant load and yield information is often the best way of assessing long term trends, adequate flow monitoring and gaging is critical to the monitoring programs effectiveness. Flow gages are recommended for each of the twelve streams at the mouth.

Figure 4. Tier I and Tier II Monitoring Sites



Monitoring programs traditionally have required bi-weekly or monthly sampling regimes. This provides a broad picture of the range in water quality conditions over the year. However, there are generally two periods in the year that can be used to represent worst-case conditions. The first, and easiest to capture is the late summer low flow period when the combination of low stream flows and high solar input can create the most critical temperature and dissolved oxygen conditions. In WRIA 14 where there is no snow melt or glacial runoff to cool streams into the summer, the critical high temperature period could begin as early as July and last through September. The second period occurs during the wet weather months (November through March) when high rainfall produces high runoff and the most variable period for pollutant loads and yields. Targeting these worse case conditions would involve monitoring four times during the wet weather season (bi-weekly or monthly intervals) and four times during the low flow season (focusing on late July through mid-September) at bi-weekly intervals. By targeting these time periods it is possible to more quickly develop a database that may reflect long-term variation rather than annual variation. This approach can also be used to decrease the total number of monitoring events each year, which decreases overall monitoring costs.

Tier II (General Land Use Impacts)

Meeting the second priority monitoring objective, would require establishing additional monitoring stations at upstream sites in selected stream systems. These sites would be located upstream of the area of influence from urban development and agriculture impacts. (The stations may still be affected by upstream forestry activities, which would need to be taken into account during assessment of the data.) At a minimum, upstream stations should be established at Skookum, Mill, Johns, Goldsborough and Deer Creeks (Figure 4). These five stations should provide enough "background" data to use for establishing typical upstream water quality characteristics that can be used for comparative evaluation for all of the streams in the WRIA. Since this would be expected to eventually be included in the long term monitoring strategy, the number of stations has been kept to a minimum. However, future needs and land use patterns may necessitate inclusion of additional permanent upstream stations (i.e. Shelton, Cranberry or Sherwood Creeks). (Note: If Tier II stations are established on streams that contain lakes (e.g., Sherwood Creek), stations should generally be located downstream of the lake. This is because the lake will have a large affect on water quality and in determining the baseline condition against which to compare affects.)

Parameters measured and monitoring frequency would be the same as defined for the Baseline program.

Tier III (Priority Pollutants and Aquatic Macroinvertebrates)

Tier I and II focus on conventional water quality parameters and concerns associated with such things as increased sediment and nutrient loads. To create a more comprehensive assessment of the health of stream systems, priority pollutant contaminants and aquatic macroinvertebrate monitoring should be considered.

The priority pollutants selected for measurement include the heavy metals and the group of organic priority pollutants that is captured through analysis of the chlorinated acid herbicides and organochlorine pesticides. (Note: The analytical method used determines which of the heavy metals and organic pollutants are specifically measured. The analytical method is noted in Table 2 of the QAPP (Appendix A).) Total organic carbon will also need to be measured to enhance interpretation of the information. Heavy metals were selected for analysis because they are related to urban impacts and road runoff. The pesticides can be an indicator of agricultural or urban impacts.

Priority pollutants such as heavy metals and pesticides are rarely seen at measurable concentrations in water samples, consequently, sediment sampling is recommended. Samples are collected from depositional areas near the mouths of streams but well above the area of salt-water influence. All twelve Tier I streams should be tested.

Aquatic macroinvertebrates abundance and diversity estimates provide an indirect measure of overall stream health and therefore can be good long-term indicators. Samples should be collected from riffle areas above the area of impact from tides, as described in the accompanying QAPP (Appendix A).

Both priority pollutant and aquatic macroinvertebrate sampling could be scheduled to occur only once every two years. Monitoring in late summer (August or September) would be appropriate for aquatic macroinvertebrates since they should be larger later in the season. Sediment samples are probably best collected in late spring or early summer when stream flows will be low with good depositional areas for sediment sampling.

Tier IV (Subbasin Investigations)

The next step toward increasing efforts and complexity is the addition of a system of rotating through subbasins to complete a more in depth assessment of each. For example, if the Goldsborough Subbasin were selected for the first investigative monitoring effort, 5 or 10 additional sampling sites would be identified within the river and its tributaries. These sites would be monitored for a two-year period at the same relative frequency as for the baseline strategy (i.e., four winter and four summer events). After the two-year study on Goldsborough, the next Subbasin would be selected for more intense monitoring. In this way, each of the four subbasins (Case, Goldsborough, Kennedy, Skookum) would be monitored more intensely two years out of every eight. The parameters measured could be the same as those measured in Tier I and II or a subset that includes field measurements (pH, DO, conductivity, and temperature) and a few lab measurements (e.g., TSS and bacteria) could be selected to decrease analytical costs. Additional macroinvertebrate and sediment contaminant sites might also be considered for inclusion during the Tier IV monitoring efforts.

Tier V (Lakes)

Lakes are an important water resource that should also be included in a comprehensive area-wide monitoring strategy. Because lakes are highly variable in terms of depth, water sources, configuration, and concerns, any effective monitoring strategy would need to be lake specific. A minimal sampling approach for a lake might include monitoring at least one station near the middle of the lake and monitoring any inflowing streams. Monitoring should be done twice monthly during the June to September period. Lake station monitoring should include depth profiles of temperature, dissolved oxygen, pH, and specific conductance. The nutrients, total and soluble phosphorus, and nitrate+nitrite should be measured near the surface and bottom of the lake, along with chlorophyll*a* measurements. Secchi disk depth and total water depth should also be measured. Measurements in the inflowing stream should include; total and soluble phosphorus, nitrate+nitrite, temperature, specific conductance, dissolved oxygen, and flow. Although not strictly a water quality concern, annual surveys of the aquatic plant populations are also recommended. At the least these surveys should be used to determine the presence of noxious (invasive) aquatic plant species such as Eurasian watermilfoil, Brazilian waterweed, and Purple Loosestrife.

Lakes often have a strong base of support from local residents and therefore lend themselves to monitoring by volunteers. There are many volunteer based lake monitoring programs. Some are very simple and include just Secchi disk depth and total water depth measurements. Some include the collection of nutrient and chlorophyll samples from the near surface waters since this can be done without the use of special equipment, and others include the entire gamut of measurements and locations with all of the requisite training in equipment calibration and care. More discussion of volunteer monitoring considerations is included later in this report.

ROLES AND RESPONSIBILITIES

Monitoring

The identification of a lead agency that is responsible for implementing this monitoring plan and coordinating with other entities is critical to its success. In many areas this responsibility lies with the County government, however a separate agency/entity could also be created to carry out these efforts. This does not imply that one agency or entity must perform all of the monitoring and evaluation, but it must at least coordinate and oversee the effort for the WRIA. In addition to overseeing the implementation of this plan, the lead agency could also be responsible to overseeing implementation of TMDL 's or other efforts, and generally tracking monitoring efforts and the condition of the water resource. The final Watershed Plan for WRIA 14 should clearly identify the responsible agency.

Using the Squaxin Island Tribes monitoring efforts as a starting point, and assuming that it would continue and the data would be accessible to all stakeholders, the following outlines the additions/changes that would need to be made to implement this plan.

- ✓ At this time, the Tribe has established stations at the mouth of seven of the twelve streams identified for Tier I monitoring, and four of the five stations identified for Tier II. However, monitoring at a number of the stations include only collection of bacteria samples, and at stations where a wider array of water quality parameters are measured, it only happens on a quarterly basis. Consequently, implementation would require expanding the number of stations slightly and increasing the number of parameters measured. However, the largest change would be in sampling frequency since neither the quarterly sampling or monthly sampling fits closely with the targeted seasonal approach recommended.

- ✓ The Tribe has begun flow monitoring at Johns, Mill, Goldsborough, Cranberry, Deer, Skookum and Little Skookum Creeks. To meet the Tier I implementation needs, flow monitoring and establishment of gaging stations would also need to occur near the mouth of each of the remaining four streams (Shelton, Uncle John, Kennedy and Sherwood Creeks).

- ✓ The Tribe monitoring plan includes collection of aquatic macroinvertebrate samples from four sites in the Little Skookum watershed and on Kennedy Creek. Thus, ten additional stations would be required to capture all twelve of the Tier I stations.

- ✓ No sediment monitoring for priority pollutants is currently being done in the WRIA. All of this effort would represent an expansion of existing efforts.

Data Management and Accessibility

Data entry and QA of field and lab results should be done by whoever collects the data following the procedures outlined in the QAPP (Appendix A). However, the process of making the data accessible to the rest of the WRIA stakeholders could be performed by another entity. Initially this could be in the form of distribution of data CDs on an "as requested" basis. However, over the long-term a web based approach such as used by Ecology and Thurston County is preferable. (While there continues to be discussions on a State level of a web site that contains all State water quality data there has yet to be a process in place at Ecology for handling this. The data CD approach may be the appropriate level of effort until this process develops. By following Ecology's data management and entry methods outlined in the QAPP (Appendix A) the eventual transfer of the data to an Ecology maintained website will be smoother.

Data Evaluations

At a minimum, the collected data should be used to create a bi-annual report on the condition of WRIA 14 surface water resources. The report should provide range and mean values for the different seasons of interest, and a discussion for each water body on whether there are indicators of possible water quality problems or water quality standards violations. Pollutant load and yield calculations should be used to compare between streams and between stations in streams. As the data set increases the report should also include some assessment of possible trends in concentrations or pollutant yields.

RESOURCE NEEDS AND AVAILABILITY

No financial or human resources have been assigned to implementation of this monitoring strategy. Typically, monitoring strategies are developed to meet resource constraints, thus it is likely that the specifics of this strategy will be modified as the financial and human resources become available. The following is provided as a general summary of the resources that might be required for implementing this monitoring strategy.

Equipment: Implementation of this monitoring strategy would require; field meters (oxygen, pH, conductivity, turbidity, flow, temperature), personal gear (waders, field vests, field notebooks), other miscellaneous equipment, and access to an automobile. There is a wide range of costs associated with each of these items. Lake sampling would require different types of field meters, a mechanism for collecting water from below the surface, a boat, Secchi disk, and other miscellaneous equipment.

Analytical: Bacteria, nutrients, total suspended solids, biochemical oxygen demand (BOD), all require laboratory support. A per station cost of $140 should be appropriate for planning level estimates of analytical costs. This would be slightly higher for lake sampling to account for the additional nutrient and chlorophyll measurements. To monitor all 12 Tier I stations eight times per year would require approximately $15,000 per year including QA costs. Priority pollutant analysis of sediments (approximately $500/station) and aquatic macroinvertebrate sorting and identification (approximately $100/station) also require laboratory support

Personnel: Each field monitoring event requires one field day (typically a 10 hour day) plus time for preparation, data QA, and data entry. This equates to approximately 16 hours per event. If a two-person crew were required for the fieldwork, those hours would increase to 26. This is in addition to time spent establishing gaging stations and doing other support tasks. Personnel time will also be required for eventual reporting. The reporting element could range from a simple description of methods and table of results to a lengthy description of results by station, season, and year. Clearly, the cost for this effort is widely variable. Personnel time required for supporting volunteer programs is described in the next section. There are also long term costs associated with managing the database.

VOLUNTEER PROGRAMS

Development of a volunteer monitoring program may eventually be considered as a means of supplementing monitoring efforts. Volunteer programs can range from fairly simple efforts to complex monitoring schemes with rigorous training on protocols, QA, and even data evaluation. The advantages of a volunteer program also vary according to the program design. There are always at least two great advantages. The first is that there are more “eyes and ears” in the watershed and the second is that the people involved become strong advocates for water resource protection. However, it is commonly believed that these programs are free or low cost. Costs are incurred in training, recruitment, data management, and staff support for the program.

Volunteer programs like all monitoring programs must be designed to meet stated objectives. The following should be considered:

- The quality of data obtained is directly related to the training provided to volunteers. If professional quality data is desired, then training and data QA protocols must reflect that need. And, since volunteer turnover can be high, training sessions need to be scheduled at regular intervals.

- Recruitment of new volunteers also must be considered to keep the program going. (Recruitment often occurs through advertising of training events.)

- Volunteer programs require support staff to manage the program and to respond to volunteer’s concerns. From an agency perspective, volunteer programs can fail if there is not adequate support from the agency to answer all of the questions and concerns that are generated by having more people in the field.

There are many resources for volunteer programs. The Streamkeeper’s of Clallam County (2002) has an excellent volunteer monitoring program that could be used as a template. The program places much of the responsibility of monitoring into the hands of citizens, especially those areas related to volunteer recruitment and safety. The volunteer handbook details the specifics of each monitoring protocol, the safety issues surrounding stream monitoring, and recruitment opportunities for volunteers. The program includes annual reviews for changes in monitoring frequency, stream needs, and volunteer recruitment.

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APPENDIX A

WRIA 14 MONITORING STRATEGY

QUALITY ASSURANCE PROJECT PLAN

WRIA 14 LONG TERM MONITORING STRATEGY QUALITY ASSURANCE PROJECT PLAN

The following plan describes specific procedures and methods that should be followed when implementing this monitoring strategy. These protocols were developed to help insure consistency in data collection and reporting and to enable the eventual development of a coordinated water quality database. It has been assumed in developing this QAPP that it will be implemented by a professional who has experience with standard protocols and methods for water quality monitoring. References for more detailed protocols are provided.

1.0 OVERVIEW OF PROJECT QUALITY OBJECTIVES

The following elements define the data quality objectives for the surface water quality monitoring and specify the methods used to evaluate them. Further detail on the use of these methods to evaluate precision and bias is provided in Section 4.0, Quality Control Procedures.

- **Precision** is a measurement of the scatter in data due to random error and is stated in terms of percent relative standard deviation (RSD). Major sources of random error are the sampling and analytical procedures. The total precision of results can be estimated from the results of replicate samples. For laboratory analysis, precision will be assessed using laboratory duplicates. To assess precision in the field, water quality field replicates will be collected for at least 10 percent of the samples submitted for analysis.

- **Bias** is a measure of the difference between the result for a parameter and the true value due to systematic errors. Potential sources of bias include; (1) sample collection, (2) physical or chemical instability of samples, (3) interference effects, (4) inability to measure all forms of a determinant, (5) calibration of the measurement system, and (6) contamination.

  Previous studies pertaining to the sources of bias due to sampling have led to the recommended procedures currently in use. Thus, careful adherence to standard procedures for collection, preservation, transportation, and storage of samples will reduce or eliminate most sources of bias. Bias affecting laboratory measurement procedures will be assessed by the use of matrix spike recovery, method blanks, and check samples in accordance with the laboratory Quality Assurance (QA) Plan. Analysis of split samples will provide an estimate of overall sampling bias including variation in concentration due to sample heterogeneity. Matrix spikes are used to detect interference effects due to the sample matrix. An estimate of bias due to calibration is calculated from the difference between the check standard results and the true concentration.

- **Detection Limits** for the parameters to be analyzed for this project represent the measurement quality objectives.

- **Representativeness** is achieved by selecting sampling locations, methods, and times so that the data describe the site conditions that the project seeks to evaluate. The sampling design was developed to ensure the data are representative. Samples will be taken at the same location and at nearly the same time during the monitoring period. Samples will be collected systematically through entire monitoring period. Additionally, representativeness of the data is assured through definition of stream locations and qualifying conditions.

- **Comparability** will be maintained by ensuring usage of standard operating procedures when collecting and handling samples. Various reporting methods such as unit measures will be consistent between samplings and all sampling methods will be consistent with the standard procedures outlined in this report. Careful planning of fieldwork and methods will maximize the amount of accurate and comparable data. Designing each monitoring "tier" so that it can be accomplished in one field day or that up and down stream stations are monitored somewhat simultaneously also enhances comparability.

2.0 SCHEDULE

The monitoring schedule will be as follows:

- Tier I and Tier II monitoring will occur four times between November and March. This can be done on either a bi-weekly or monthly schedule. The late summer monitoring should occur over a more compressed schedule to reflect the shorter period of critical conditions. Monitoring should be scheduled to occur four times beginning at the end of July and extending to the early part of September.

- Stream gage data should be collected for each sampling event. However, actual in-stream flow measurements to support the gage data should be scheduled separately because of the extra time it takes to accurately measure flow and the limited time available in a typical field day. The goal should be to measure stream flow at each flow site at least 3 times during the summer and fall low flow period and 3 times during the late winter and early spring. A rating curve for low flow and channel forming flow can be established using this schedule.

- Priority pollutants and macroinvertebrates will be monitored during mid-spring on a bi-annual (once every two years) basis.

- Lake monitoring will occur during the summer months between June and September.

- The schedule for investigative monitoring will need to be developed to meet the objectives of the investigation.

Table 1 below describes the types of parameters each Tier in the Monitoring Strategy covers and the frequency of monitoring.

Table 1. Breakdown of Monitoring Strategy Tiers and frequency of parameters.

	Tier I	**Tier II**	**Tier III**	**Tier IV** [(1)]	**Tier V**
Field Measurements					
DO	√	√		√	√
Temperature	√	√		√	√
pH	√	√		√	√
Conductivity	√	√		√	√
Flow	√	√		√	√
Analytical					
Nitrate+Nitrite	√	√		√	√
Total Phosphorus (TP)	√	√		√	√
Soluble Phosphorus (SP)	√	√		√	√
Total Suspended Solids (TSS)	√	√		√	
Biochemical Oxygen Demand (BOD_5)	√	√		√	
Total Organic Carbon (TOC)	√	√		√	
Bacteria	√	√		√	
Priority Metals			√	√	
Chlorinated Herbicides			√	√	
Organochlorine Pesticides			√	√	
Chlorophyll<u>a</u>					√
Aquatic Macroinvertebrates			√	√	
Frequency	8/year	8/year	1/year	8/year	1/year

[(1)] Parameters and frequency for investigative monitoring will be determined by the objective of the investigation.

3.0 DATA MEASUREMENT AND ACQUISITION

3.1 FIELD PREPARATION

The following field preparation practices provide the setting to develop quality data collection:

- Calibrate all field meters as per manufacturers specifications. (Note: The DO meter should be calibrated against the Winkler method.)
- Bottles should be collected, organized and labeled for sample collection including labeling of blind and replicate sample bottles.
- Equipment should be checked for damage and wear and tear. Additionally, an equipment checklist should be developed that lists all equipment needed and provides a place to mark damage and date checked.
- A random quality assurance (QA) site should be selected prior to field collection. The same should be labeled as a blind sample.

3.2 FIELD PROCEDURES

During a field day the major priority is to make sure that everything is well documented through field notes. The following are some sample collection ground rules that should be adhered to.

- Prior to sampling at each stream site the field staff should record the weather, time, and date as well as provide a summary of weather conditions in the previous days. In addition, observations with respect to adjacent land use and flow conditions within the stream should be recorded.
- All sampling should be consistent. The field staff should maintain the same sampling method, collection location and equipment for each station. If a change is necessary, then appropriate documentation is required.
- Documentation of equipment used, problems incurred, batch sizes, calibration results, etc. should be recorded so that a permanent record is maintained.

Water Chemistry

Field Meter Measurements: (temperature, pH, DO, specific conductance, turbidity)
A water quality probe will be held upstream from the entry point in stream for at least two minutes or until measurements stabilize. Parameter measurements will be recorded on data sheets or in data logger, as will be site location, date and time. If temperature, DO, or pH results indicate that water quality standards are not met, additional measurements will be

taken along the stream cross-section to evaluate the consistency and reliability of the result and determine its extent.

Grab Samples: (Nutrients, TSS, fecal coliform, E. coli, and BOD)
The analytical laboratory will provide sterile bottles and testing facilities. Samples should be collected by entering the water downstream of the sample site. Each sample bottle, except bacteria and those that may contain preservative, will be rinsed three times prior to sample collection and contamination minimized. Samples are collected by facing upstream, turning the bottle upside down and plunging it vertically through the water surface and then facing the bottle into the flow and slowly moving the bottle up and out of the water. Sample bottles should be labeled with sample number, date, time, sample type (i.e. nutrients, bacteria, etc) and location and logged onto a data sheet. Samples should be stored in an iced cooler until delivered to the laboratory for analysis.

Samples that Require Special Care: (Bacteria and DO)
Bacteria samples must be collected to minimize potential for contamination. Care must be taken to not touch the inside, edge or cap of the sterilized bottle when collecting the sample. Also, because bacteria collect on the surface film of the water, the method of sampling described above, which requires the bottle to be plunged quickly through the surface film, is very important.

Dissolved oxygen also requires special care. The probe and membrane are vulnerable to deterioration and contamination and results may "float" up or down over the course of a field day. Therefore the probe should be calibrated by collecting two samples each field day for verification by the Winkler method. Winkler samples must be collected into a special glass BOD bottle. Precautions must be taken to ensure the Winkler sample isn't aerated during collection and that no bubbles are trapped in the container.

Sediment Chemistry

Sediment samples will be collected for analysis of pesticides including organochlorine pesticides, chlorinated acid herbicides, priority pollutant metals and total organic carbon. The methods below will be used when collecting sediment samples at monitoring locations:

- Three discrete sediment grab samples will be obtained from each station using a Ponar-type sampling system. Each grab sample will be placed into a stainless steel bowl and observed for color, odor, and general soil characteristics. Once these observations have been made and recorded the contents of the bowl should be mixed with a stainless steel spoon until uniform in texture and appearance. The contents of this bowl will be transferred into an appropriately cleaned glass or Teflon jar and labeled. When a field replicate is required it should be collected as a subsample from the same bowl of homogenized sediment sample.

- After each stream is sampled, the Ponar, stainless steel bowl, and stainless steel spoon will be thoroughly washed with a non-phosphate detergent and rinsed with DI water.

All sediment samples will be placed into individual four-ounce jars and labeled. Samples collected should be placed into a cooler on ice until they are delivered to the laboratory or can be put under more permanent refrigeration.

Aquatic Macroinvertebrates

The Department of Ecology procedures for benthic macroinvertebrate monitoring (*Benthic Macroinvertebrate Biological Monitoring Protocols for Rivers and Streams* (Plotnikoff and Wiseman, 2001) will be followed for all sampling. Below is a summary of the collection protocols described in Plotnikoff and Wiseman (2001). Only riffle habitat samples will be collected from each stream monitored.

- Macroinvertebrates will be collected from riffle habitats using a D-Frame kicknet (500 μm net mesh) sampling a streambed area of 0.19 m^2.

- Large substrate material will be removed and scrubbed and streambed agitated to stir aquatic macroinvertebrates into the water column for collection.

- All collected samples will be stored in ethanol filled containers. Replicate samples will be collected and stored in separate containers.

- All samples will be stored in 85% ethanol and labeled with stream name, location, habitat type (i.e., riffle), date, sample number and collector's name.

Flow Monitoring

Stream flow/discharge measurements are critical for assessing water quality trends. Flow should be measured at a suitable location within the designated reach. The most suitable locations are those within a fairly straight section of channel that is free of major obstructions and undercut banks. Flow monitoring sites should be selected to avoid areas of flow diversions, side channels, undercut banks, or other obstructions. A glide area with a "U" shaped channel that is free of obstructions typically provides the best conditions.

The most common procedure for measuring discharge is based on "velocity-area" calculations. Because velocity and depth can vary greatly across a stream, accuracy in flow measurement is achieved by measuring the mean velocity at many incremental distances over the cross-section of the stream (Figure 1). The standard is to measure flow at 20-25 places in the cross section with each location containing no more than 5% of the total flow. (Done by dividing the total stream width by 20-25 and using the result as the measurement interval).

Velocity varies vertically at each point in the stream. Stream hydrologists have determined that in a stream segment that is less than 2.5 feet deep, the best estimate of average velocity occurs at 60 percent of the total depth. If a segment is greater than 2.5 feet deep, a velocity measurement should be taken at 20 and 80 percent depths and the average of these two values used to represent average velocity at that location.

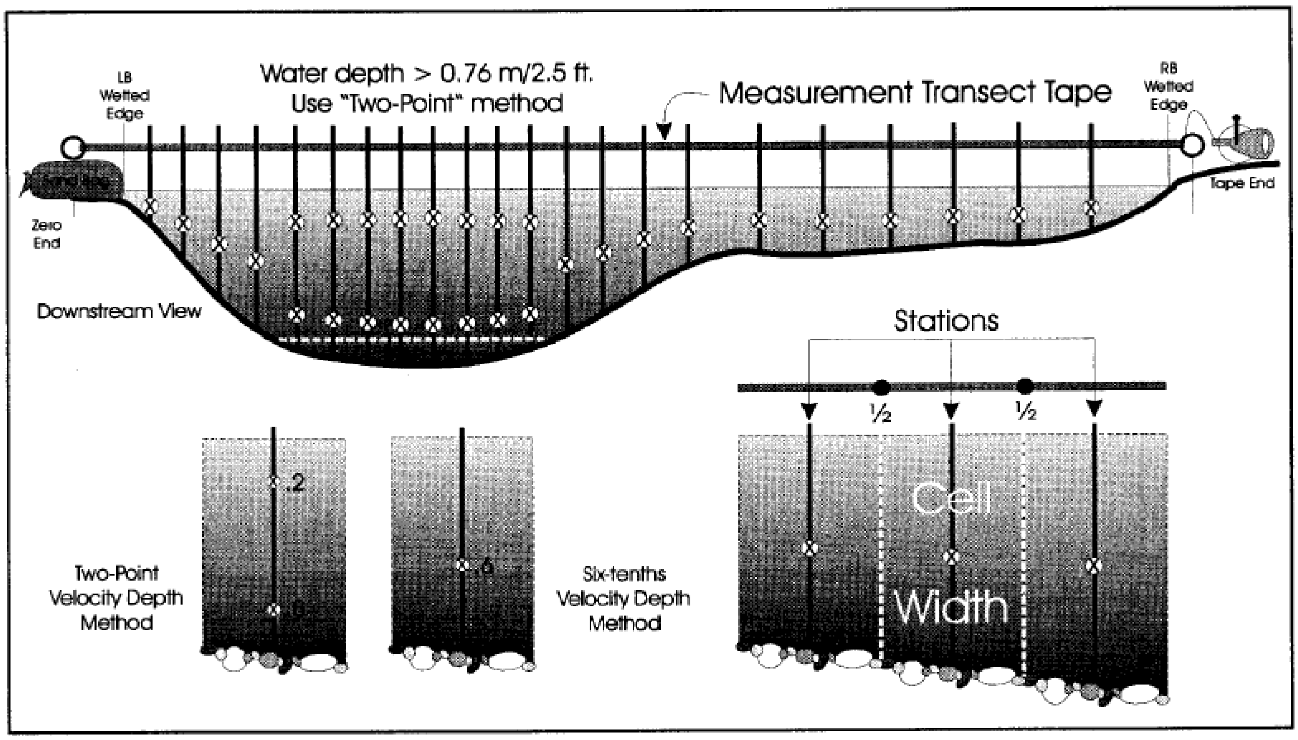
Station number, stream name, and total stream width should be recorded for each flow monitoring station. Total water depth and depth of velocity measurement should be recorded as well as the velocity measured at each depth.

More detailed references for stream flow monitoring can be found in

Environmental Monitoring and Assessment Program-Surface Waters; Western Pilot Study: Field Operations Manual for Wadeable Streams. EPA (2001)

- Department of Ecology, Guidance for Conducting Water Quality Assessments (1989)
- Michaud, Joy P. A Citizen's Guide to Understanding and Monitoring Lakes and Streams (1991)

Figure 1: Cross section of stream showing tape position, depth and velocity measurement stations, and cell width boundaries. (TFW, 1999)



Lake Sampling

No specific lake monitoring program has been developed for WRIA 14 and therefore specific sampling methods and protocols cannot be provided. The analytical methods and detection limits provided in Table 2 are also appropriate for lake sampling as are the requirements for data QA and reporting. References for lake sampling protocols include:

- Michaud, Joy P. A Citizen's Guide to Understanding and Monitoring Lakes and Streams (1991).
- EPA, Volunteer Monitoring: A Methods Manual, Publication EPA440-4-91-002

3.3 LABORATORY PROCEDURES

Analytical parameters and methods, detection limits and units, preservation methods, and holding times for samples collected during monitoring are summarized in Table 2. The analytical laboratory is responsible for internal QA checks.

Table 2. Parameters and analytical methods.

Parameter	Method[1]	Matrix/Type	Detection Limit[2]	Holding Time
Total Suspended Solids	160.2	Water/Grab	1 mg/L	7 days
Phosphorous (total)	365.2	Water/Grab	0.01mg/L	28 days
Nitrate-Nitrite	300.0	Water/Grab	0.05 mg/L	28 days
Fecal Coliform	APHA – 9222 D.	Water/Grab	0/100 mL	30 hours
E. coli	APHA - 9225	Water/Grab	0/100 mL	30 hours
Biochemical Oxygen Demand (5-day)	405.1	Water/Grab	2 mg/L	48 hours
Organochlorine Pesticides	8081A	Sediment/Composite	Varies	14 days
Chlorinated Acid Herbicides	8151A	Sediment/Composite	Varies	14 days
Priority Pollutant Metals	6010B/7471A	Sediment/Composite	Varies	6 months
Total Organic Carbon	SW 9060	Sediment/Composite	1 mg/L	28 days

(1) U.S. Environmental Protection Agency (EPA) Publications EPA/600/4-79-020, EPA/600/R-94-111, EPA/600/R-93-100, and SW-846. APHA Standard Methods, 1992.

(2) mg/L = milligrams/liter
μg/L = micrograms/liter

Aquatic macroinvertebrate samples will be analyzed by the following protocol summary from Plotnikoff and Wiseman (2001).

- Riffle habitat samples will be sub-sampled to a 500-organism count using a gridded tray.
- All major macroinvertebrates will be identified to genus level using suggested taxonomic keys located in Plotnikoff and Wiseman (2001).

4.0 QUALITY CONTROL PROCEDURES

Quality control samples will be collected for both and field and laboratory activities. Field quality control samples will include the collection of field replicate samples. Field replicates will be collected at a minimum frequency of 10 percent of samples. Laboratory quality control samples will include laboratory blanks, laboratory duplicates, matrix spikes, and laboratory control samples. These will be analyzed with a minimum frequency of 5 percent for each analytical parameter batch. The following field and laboratory quality control procedures apply to the entire data set for a given parameter measured during a specific laboratory "batch" are summarized as follows:

- **Field Replicates:** Field replicates are collected to represent field variation. These results are not used to make decisions to "accept" or "reject" data, however the data should be examined to assess variation and look for possible problems. Replicates should not be identified when submitted to the laboratory. Replicate results should be reported separately in the database, but the average of the two results will be used for data evaluation.

- **Laboratory Blanks:** The quality control objective for the laboratory blank is for a concentration less than the specified detection limit. If the blank concentration is greater than the field samples, the values will be rejected or re-analysis will be requested, unless the field samples are below the non-detectable limit. The laboratory QA Officer will review laboratory procedures and decide if samples should be re-analyzed if blank contamination is noted.

- **Laboratory Duplicates:** Laboratory duplicates are one sample that has been split into two containers. If both sample results are below laboratory detection limits, no evaluation of duplicates is required. If duplicates are within 20 percent relative percent difference (RPD) of their twin they are acceptable. For duplicate RPD values that are greater than 20 percent:

  - Since RPD criteria may be misleading at low concentrations, all data that exceed the 20 percent RPD value should be assessed to determine whether the concentration measured was within 5 times the Detection Limit. If this is the case, the data should be accepted without reservation.

  - RPD values that do not meet the above criteria but are less than 35% RPD should be considered for inclusion as an "estimated" value if all other lab QA for that parameter (i.e., blanks, detection limits, and matrix spikes) are acceptable.

  - Parameters with RPDs of greater than 35% should be considered for rejection.

- **Matrix Spikes:** The quality control (QC) objective for matrix spike percent recovery varies with the analytical method. For samples that show matrix spike recoveries outside the QC criteria, the sample results may be assigned data qualifiers or the sample may be re-analyzed. The laboratory QA Officer will be responsible for making initial determinations, but will include the information with the submitted data.

- **Quality Control Requirements**:

  Field QC Checks - Data quality will be addressed with consistent performance of valid procedures documented in this plan. Sampling locations will be clearly established and proper calibration and maintenance of instruments, handling of samples and accurate recording of data will be applied. Data quality can be further checked with replicate sampling and adherence to standard procedures.

  Laboratory QC Checks - The laboratory should maintain their own standard procedures and will follow according to laboratory certification regulation.

  Data Analysis QC Checks – All QA checks for data will be completed before the data is entered into the database.

- **Field Meter Calibration:**

  - Field personnel will routinely inspect equipment for damage and perform routine preventative maintenance and cleaning of field equipment based on manufacturers recommendations.

  - Conductivity Probes: These should be calibrated against a known standard at the beginning and end of the field day. The measured conductivity should be within 10% of the theoretical value.

  - Oxygen and Temperature Probe: At the beginning of the field day the probe should be calibrated according to the manufacturers instructions in water saturated air. (Some probes may require 15 minutes to equilibrate before calibrating.) The calibration should be performed as close to stream temperature as possible by using stream water to fill the calibration chamber prior to equilibration. Field results should be verified against wet chemistry analysis based on the Winkler method. Winkler results should be within 0.5 mg/L of the probe reading.

  - pH Probe: These probes should be calibrated following the manufacturers recommendations, preferably using two different calibration standards. Calibration should occur at the beginning and end of each field day and after the probe is turned off.

  - Turbidity: The probe should be calibrated by following manufacturers recommendations. Calibration should occur at the beginning and end of each field day. A 10% drift tolerance is acceptable.

5.0 DATA MANAGEMENT PROCEDURES

Field staff will fill out chain of custody forms with date, time, sample and location. Copies will be retained for the project files following submittal of samples. The laboratory will send water quality data directly to the designated Task Manager with a narrative of QA/QC results and discussions of any discrepancies. Established databases of water quality data will be spot-checked (recommend 10% cross-checking by a different person) for erroneous data entry. Laboratory water quality reports and case narratives will be included as an appendix in the reports.

A good information management system will allow easy access, sharing, and manipulation of data by all potential users. Rather than creating a specific database for the WRIA, it is recommended that Ecology's Environmental Information Management (EIM) system be followed. Using the EIM protocol and format has at least two advantages: First, utilizing an existing well-established database saves resources and second, if Ecology does begin to accept and manage all water quality data the data entry and format will already be consistent. A third advantage is that Ecology staff are typically available for technical support.

The EIM essentially consists of three data submittal forms that describe the study, location, and result data. Ecology maintains a website that contains information on methods and rationale for inputting data into EIM, (http://www.ecy.wa.gov/services/as/iip/eim/index.html). This website also contains a data submittal page with downloadable Excel® based templates and help documents. It is strongly recommended that the help section be reviewed before using the templates, especially since there are some limitations based on which version of Excel is being used.

Consistent implementation of the data management system is critical when it comes to data sharing and eventual analysis. For this reason appointment of a data steward is recommended. The steward should work for an entity that is part of the data gathering process, and have a vested interest in the maintenance of good data. The steward's job would be to maintain the main data set; including checking data formatting and general QA/QC, as well as act as the liaison with Ecology's EIM manager.

6.0 REFERENCES

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APPENDIX B

Lakes and Creeks in WRIA 14

Source: Washington State Atlas and Gazetteer

Lakes (more than 20 acres)

- Anderson Lake
- Benson Lake
- Clear Lake
- Coon Lake
- Cranberry Lake
- Deveraux Lake
- Fawn Lake
- Forbes Lake
- Hanks Lake
- Isabella Lake
- Island Lake
- Johns Lake
- Kent Lake
- Lake Limerick
- Little Timber Lake
- Lost Lake
- Mason Lake
- Munson Lake
- Panhandle Lake
- Phillips Lake
- Prickett Lake (AKA Trails End Lake)
- Rex Lake
- Spencer Lake
- Summit Lake
- Timber Lake
- Trask Lake
- Turtle Lake

Major Creeks (marine water or lake output)

- Campbell Creek
- Coffee Creek
- Cranberry Creek
- Deer Creek
- Goldsborough Creek
- Gosnell Creek
- Johns Creek
- Kennedy Creek
- Maloney Creek
- Mill Creek
- Perry Creek
- Rock Creek
- Schneider Creek
- Shelton Creek
- Sherwood Creek
- Shumocher Creek
- Skookum Creek
- Snodgrass Creek
- Uncle John Creek