Rev 5 (12/17/99)

PROJECT PROPOSAL COVERSHEET

WRD REGION: Western

PROPOSAL NUMBER: WA06E

SCIENCE CENTER/PROJECT OFFICE: WA

DATE (Initial): April 13, 2006

PROJECT TITLE: Characterization and Numerical Simulation of the Water Resources in the Chambers-Clover Creek Watershed, Pierce County, Washington

DATE (Revised):

PROJECT NUMBER:

BEGIN DATE (mo/yr): April 2006

SHORT TITLE: Chambers-Clover Model

END DATE (mo/yr): December 2009

PROJECT CHIEF: Mark Savoca

RESEARCH **RESOURCE APPRAISAL** X

DISCIPLINE: ground-water quantity 80 %, surface-water quantity 20 %, ground-water quality __%, surface-water quality __ %; or exclusively) administration __ %. (See instructions for Coversheets: A project is either technical or administration; it cannot be a mix of both. Technical percentages, if used, must total 100%. Administration, if used, must be 0 or 100%.)

ESTIMATED PROJECT FUNDING

Firm: Probable: X Questionable:

CUSTOMER NAME(S)/NUMBER(S): Pierce Conservation District /

FISCAL YEAR:	**2006**	**2007**	**2008**	**2009**	**2010**
OFA/FEDERAL:					
COOP REPAY:	$50,755	$119,455	$137,350	$86,470	$15,685
COOP DIRECT:					
COOP UNMATCHED:					
COOP TOTAL:					
FMFs:	$50,755	$119,455	$137,350	$86,470	$15,685
TOTAL FOR FISCAL YEAR:	$101,510	$238,910	$274,700	$172,940	$31,370

REMARKS:

AUTHOR: _____ April 13, 2006
Mark Savoca, Supervisory Hydrologist

CENTER ENDORSEMENT: _____ April 13, 2006
Cynthia Barton, Center Director

REGIONAL ENDORSEMENT: _____

APPROVED BY: _____

SUMMARY

Characterization and Numerical Simulation of the Water Resources in the Chambers-Clover Creek Watershed, Pierce County, Washington

A proposal prepared by the U.S. Geological Survey for the Pierce Conservation District
March 30, 2006

Problem — In 1998, the Washington State Legislature established the Washington State Watershed Management Act (codified under RCW 90.82) to address diminishing water availability and quality and the loss of critical habitat for fish and wildlife. Watershed planning under this Act was started in 1998 in the Chambers-Clover Creek Watershed (CCCW) Water Resources Inventory Area (WRIA 12) by a group of Initiating Governments, including Pierce County, the City of Tacoma, the Puyallup Tribe, and the Lakewood Water District. Upon completion of the Technical Assessment, and during preparation of the Watershed Management Plan, some members of the Initiating Governments and other project partners concluded that data gaps in the Technical Assessment would limit the usefulness of the plan. Planning Unit members and stakeholders have asked the USGS Washington Water Science Center to help design and conduct a study, including the construction of a numerical ground-water flow model, to address remaining data gaps and assist in the development of a long-term watershed management plan for the CCCW.

Objectives —The major objectives of the study are to characterize the ground-water flow system in the CCCW and its interaction with associated surface-water features, and to integrate this information into a numerical ground-water flow model to assist water resource managers in the development of a long-term watershed management plan. This study also will create project management tools to facilitate communication between project partners and stakeholders, and to establish consistent methods and practices among project participants for project data collection, QA/QC, and archiving.

Relevance and Benefits —This study is consistent with the national USGS mission and goals and to water-resource issues identified in the Center's Science Plan. The study addresses ground-water availability and sustainability, and surface-water and ground-water interactions as related to water-resource management, which are priority issues for both the Strategic Directions of the Water Resources Division 1999-2008 and the USGS Washington Water Science Center's Science Plan. This study also will provide resources managers in the CCCW with a numerical flow model to assist in the development of a long-term watershed management plan to meet the needs of current and future water demands within the watershed, while also working to protect and improve its natural resources. This study is appropriate for inclusion in the USGS Cooperative Program because it will provide information that advances understanding of hydrologic processes.

Approach — A project website and a quality-assurance/quality-control plan will be developed to facilitate communication and methods between project partners and stakeholders. Existing and new ground-water and surface-water data will be compiled and evaluated to characterize the flow system, and entered into the National Water Information System data base. A numerical ground-water flow model will be constructed to simulate potential anthropogenic and climatic impacts on ground-water and surface-water resources, and the model will be transferred to the Planning Unit for assisting development of a long-term watershed management plan.

Characterization and Numerical Simulation of the Water Resources in the Chambers-Clover Creek Watershed, Pierce County, Washington

A proposal prepared by the U.S. Geological Survey for the Pierce Conservation District
March 30, 2006

Background — In 1998, the Washington State Legislature established the Washington State Watershed Management Act (codified under RCW 90.82) to address diminishing water availability and quality and the loss of critical habitat for fish and wildlife. Watershed planning under this Act was started in 1998 in the Chambers-Clover Creek Watershed (CCCW) Water Resources Inventory Area (WRIA 12) by a group of Initiating Governments, including Pierce County, the City of Tacoma, the Puyallup Tribe, and the Lakewood Water District. The Initiating Governments formed a Planning Unit composed of governmental and non-governmental representatives that voluntarily led the watershed planning effort.

The CCCW is a 180-square-mile area located in the southern Puget Sound Lowland, Pierce County, western Washington (fig. 1). The watershed is bounded by the Puget Sound to the northwest, the Puyallup River Basin to the northeast, and the Nisqually River Basin to the south, and is underlain by a thick sequence of unconsolidated glacial and interglacial deposits. Clover Creek originates from springs and ground-water discharge in the eastern uplands of the watershed and enters Steilacoom Lake, which in turn is the source of Chambers Creek which discharges directly to Puget Sound.

The CCCW is home to Coho salmon, a Species of Concern under the Endangered Species Act, and the watershed includes the western half of the City of Tacoma, all of the Cities of Lakewood and University Place, and the Towns of Steilacoom, Dupont, Fircrest, and significant portions of

unincorporated Pierce County, including the communities of Parkland, Spanaway, Elk Plain, Frederickson, and Midland. McChord Air Force Base and part of Fort Lewis occupy a large portion of the central and southern part of the watershed.

The mission of the CCCW Planning Unit was to develop a comprehensive Watershed Management Plan, under the guidance of the Watershed Management Act (WMA), for the CCCW. The plan would address and, if possible, provide the necessary framework and guidance to resolve water-quantity, water-quality, and fish-habitat issues in the watershed. To accomplish the mission, the Planning Unit prepared a Technical Assessment which would form the scientific basis for the Watershed Management Plan. The Planning Unit also considered other pertinent resource planning documents and the collective knowledge of its members to develop the Watershed Management Plan.

The WMA identifies four planning elements that may be addressed through each Watershed Management Plan: water quantity, water quality, habitat, and setting instream flows. The Planning Unit decided early in the process that the focus of the Technical Assessment and Watershed Management Plan would be on water-quantity issues, a required element of watershed planning under the WMA, and the optional elements of water quality and habitat.

Problem — Upon completion of the Technical Assessment and during preparation of the Watershed Management Plan, some members of the Initiating Governments and other project partners concluded that data gaps in the Technical Assessment would limit the usefulness of the Plan. As a result, the Planning Unit was unable to reach consensus, and in 2004, the Watershed

Management Plan was not approved by the Planning Unit and the planning process under the WMA was terminated.

In 2005, the Initiating Governments identified several key data gaps not addressed by the Technical Assessment, including: 1) the sustainability of ground-water and surface-water resources and the potential impacts of future appropriation; 2) the prioritization of water resources and geographic areas based on need of water and benefit of water use; 3) a complete compilation of existing water rights; and 4) a detailed characterization of ground-water and surface-water interactions. The Planning Unit noted that several of these data gaps could be addressed through the development and use of a numerical ground-water flow model.

Recent efforts to address these data gaps led to an initial CCCW project planning meeting (9/20/05) attended by members of the Planning Unit, stakeholders, and the USGS. Meeting attendees generated questions relevant to water resources issues in the watershed (listed below) and agreed that additional data collection and analysis and the construction and use of a numerical flow model of the CCCW were needed to help address many of these questions and assist water resource managers in the development of a long-term watershed management plan. As a result of this and subsequent meetings, Planning Unit members and stakeholders asked the USGS Washington Water Science Center (WWSC) to help design and conduct a study, including the construction of a numerical flow model, to assist in the development of a long-term watershed management plan for the CCCW.

Questions from the 9/20/05 meeting are listed below; an asterisk indicates questions that can be addressed in large part with the data and model from this study. Water-quality data collection and

analysis and water-quality modeling will be required to fully address questions 1 and 17a. Surface-water drainage networks and surface-water modeling will be required to fully address questions 8 and 14. These additional data sets and modeling efforts are not part of this proposal. The proposed project will perform approximately six numerical-model simulations, representing a range of potential management decisions and hydrologic conditions that reflect many of the issues expressed in the questions.

1. How can we get clean and cool water back into the surface water system?
2. *How defensible does the model (the conclusions) need to be? Our conclusions need to be scientifically defensible.
3. *What were the historical stream flows?
4. *What are the present day stream flows?
5. Is there sufficient water in WRIA 12 to meet growth demands? What are the population demands? Will we need to import more water?
6. *How are the waters connected (surface with the various aquifers)?
7. What has caused the lowering of lake levels?
8. *Where are storm water drains capturing base flows?
9. *What is the actual water rights picture? Some water rights are nowhere near being fully utilized. We need quantification of all inchoate water rights.
10. Is it possible to both improve stream flows and provide more water for people?
11. *Is it possible to restore flows in Clover Creek below 138th Street?
12. *What would be the impacts to streams and lakes of further pumping and use of ground water in the various aquifers?
13. How do the urban growth requirements interact with the water?
14. *What is the impact of storm water and Low Impact Development (LID) on flooding?

15. *What is the impact on recharge of sanitary sewers versus on-site sewage systems?
16. *How may climatic changes impact water resources in the watershed?
17. Can we utilize the aquifers at times that have (a) maximum water-quality benefit, and (b)*minimal impact on stream flows?

Objectives — The major objectives of the study are to characterize the ground-water flow system in the CCCW and its interaction with associated surface water features, and to integrate this information into a numerical ground-water flow model to assist water resource managers in the development of a long-term watershed management plan. This study also will create project management tools to facilitate communication between project partners and stakeholders, and to establish consistent methods and practices among project participants for project data collection, QA/QC, and archiving.

Relevance and Benefits —This study is consistent with the national USGS mission and goals and to water-resource issues identified in the Center's Science Plan. The study addresses ground-water availability and sustainability, and surface-water and ground-water interactions as related to water-resource management, which are priority issues for both the Strategic Directions of the Water Resources Division 1999-2008 and the Washington Water Science Center's Science Plan. This study also will provide resources managers in the CCCW with a numerical flow model to assist in the development of a long-term watershed management plan to meet the needs of current and future water demands within the watershed, while also working to protect and improve its natural resources. This study is appropriate for inclusion in the USGS Cooperative Program because it will provide information that advances understanding of hydrologic processes.

Approach — A project website and a quality-assurance/quality-control plan will be developed to facilitate communication and methods between project partners and stakeholders. Existing and new ground-water and surface-water data will be compiled and evaluated to characterize the flow system, and entered into the National Water Information System data base. A numerical ground-water flow model will be constructed to simulate potential anthropogenic and climatic impacts on ground-water and surface-water resources, and the model will be transferred to the Planning Unit for assisting development of a long-term watershed management plan. Two USGS Water-Resources Investigations Reports will be published to describe: 1) the conceptual model of the watershed; and 2) numerical model construction, limitations, and results from approximately six simulations representing a range of potential anthropogenic activities and hydrologic conditions. An overview of the specific tasks needed to complete the study is presented below. A project timeline and budget are given at the end of this document. The project duration is expected to be approximately 3.75 years, with 2 years of ground-water level and streamflow data collection at established monitoring network sites.

I. Create project management tools to facilitate communication between project partners and stakeholders, and to establish consistent methods and practices among project participants for project data collection, QA/QC, and archiving

Task 1.1 Establish Project Website (FY06) - Create a project website, accessible by Project Team members and the public, to provide descriptions of CCCW project objectives and study methods, periodic project progress updates, project reports, and other products. The website also may contain links to project data and results. Links to preliminary project data and results will be password protected to prevent the premature dissemination of

information outside the Project Team. The website will hosted by the USGS, and maintained for the duration of the project.

Task 1.2 Establish Project QA/QC Plan (FY06) - Develop a project quality-assurance/quality-control plan to establish accurate and consistent methods and procedures for data collection, analysis, and storage. This plan will be based on the WWSC QA/QC Plan for ground-water activities (Drost, 2005).

II. Characterize the ground-water flow system in the CCCW and its interaction with associated surface-water features

Task 2.1 Compile and Evaluate Currently Available Data and Populate Database (FY06) - Compile currently available data, evaluate its accuracy, and populate the project database (GWSI) and website. The area is within the Puget Sound Regional Aquifer System, which was described at a regional scale by Vaccaro and others (1998). Once all available data have been compiled and reviewed, the extent of the area to be represented in the numerical flow model will be determined. Once established, the area to be modeled will guide decisions about additional data needs. Data to be compiled will include: a) information describing the areal extent, thickness, and lithologic composition of aquifers and aquitards, ground-water levels, aquifer boundary conditions, and the spatial distribution of aquifer hydraulic properties; b) soils and land use coverages; c) aquifer recharge data (precipitation, leakage from surface-water features, anthropogenic return flows, and inflows from tributary basins and adjacent uplands); d) aquifer discharge data (withdrawals from wells and permitted water rights, baseflow to surface-water features,

evapotranspiration estimates, and underflow to adjacent units); and e) streamflow and lake-level records for the study area to identify possible trends and delineate gaining/losing reaches.

A spatially oriented project database(s) for storage, evaluation, and analysis of currently available information for the study area will be established using a combination of GIS and data management and analysis software (ArcGISVersion 9.1, GWSI, Rockworks, etc.). The database will integrate information from multiple sources, and will be continually populated with new data as they become available. All data will be checked for accuracy in accordance with the project QA/QC plan. The database will contain information about geology, hydrology, water use, and land use in the study area, and will be accessible to all project members.

Task 2.2 Identify Additional Data Needs (FY06) - Identify additional data necessary to meet study objectives, based on an evaluation of currently available data. Additional data collection will be guided by information needed to construct a numerical flow model of the CCCW and will help address data gaps identified by the Chambers-Clover Watershed Management Plan Initiating Governments (February 2005), and technical questions from Management Team and Stakeholder Group members of the current study. Additional data collection may be necessary in parts of the study area to adequately define the hydrogeologic framework of the ground-water system for the numerical flow model.

Task 2.3 Additional Data Collection - Additional data may include the collection of ground-water levels, streamflows, and lake levels. These data will be used to supplement

existing monitoring networks in areas of interest that are not currently being monitored. Baseflow measurements also may be made to delineate gaining/losing stream reaches, and drillers' logs and other geologic information may be used to refine aquifer/aquitard extent and thickness maps. The construction and/or addition of monitoring wells and stream-gaging sites may be considered where required. Exploratory drilling and geophysical investigations also may be necessary to fully define the hydrogeologic framework. Specific data collection tasks include:

Task 2.3.1 Augment TPCHD Ground-Water Monitoring Network (FY06-07) and Data Collection and Processing (FY07-08) - The Tacoma-Pierce County Health Department (TPCHD) maintains a long-term ground-water monitoring network (monthly water levels) for about 100 large public supply wells in Pierce County. The number of ground-water monitoring wells will be increased by about 60 wells) to: 1) provide more complete areal and vertical coverage of the major aquifers in the study area, 2) to better evaluate ground- and surface-water interactions, and 3) to document ground-water levels away from major withdrawal areas. Selected monitoring wells (6 wells) will be instrumented with continuous recorders. Activities in FY06 will include a well-records inventory and a field inventory (well location and access permission). In FY07-08, transducers will be installed, and data collected and processed (monthly water-level measurements, transducers down-loaded, and data entered into GWSI).

Task 2.3.2 Conduct Stream Baseflow Measurements (FY07-08) - Stream baseflow measurements will be made to delineate gaining/losing stream reaches. Baseflow measurement sites (16 sites) will augment the 10 USGS surface-water gaging stations

currently operating in the study area. Measurements will be made eight times throughout the year to document seasonal changes in GW/SW exchange.

Task 2.3.3 Survey Locations of Additional Monitoring Well Sites (FY07) - Use Digital Global Position System (DGPS) methods to determine locations of additional monitoring wells, process data and enter into GWSI database

Task 2.3.4 Construct Water-Level Maps (FY07) - Construction of water-level maps for major aquifers in the CCCW based on data collected during this study. The maps will provide information about ground-water flow directions, horizontal and vertical gradients, and the delineation of gaining/losing stream reaches.

Task 2.3.5 Exploratory Drilling and Geophysical Surveys - If Needed (FY07) - Additional data collection may be necessary in parts of the study area to adequately define the hydrogeologic framework of the ground-water system to be represented in the numerical flow model. If needed, this work would occur in FY07; however, the potential funds required for this work are uncertain and not included in the proposal budget. The possible need for additional funding to conduct task 2.3.5 has been acknowledged by the cooperator. The need for exploratory drilling and geophysical surveys will be evaluated in task 2.2. This work would: 1) be limited to those areas where existing data are insufficient to adequately determine the depth to bedrock and to characterize (depth, thickness, and extent) major aquifers and aquitards; 2) be contracted to a private vendor with local experience; and 3) conducted as early as

possible in FY07 to ensure availability of results for inclusion in the Conceptual Model Report (task 2.4) and construction of the numerical model (task 3.1).

Cost estimates for exploratory drilling and geophysical surveys will largely depend on the: 1) methods used, 2) number of data collection sites, and 3) the depths to be investigated. Seismic-reflection profiling currently costs about $30,000 per mile for collection and processing. Exploratory well drilling costs about $100 per foot for a completed well (steel casing and screen). Down-hole geophysical logging of steel cased exploratory wells would include natural gamma (grain size and mineralogy), and gamma-gamma/neutron porosity (density and porosity). Down-hole geophysical logging (collection and processing) currently costs about $12,000 per week - one well per day; deeper wells (> 1,000 ft) may require 1.5 days to log. For budgeting purposes, assume the CCCW project requires three 600 ft deep exploratory wells (600 ft x 3 x $100/ft), down-hole logging ($12,000/week x 1 week), and three 1/2-mile seismic profiles ($30,000/mile x 1.5 miles), the total estimated gross cost would be about $237,000. Cost estimates for exploratory drilling and geophysical surveys are not included in the proposal budget.

Task 2.4 Conceptual Model and Report (FY07-08) - The conceptual model will be based on the interpretations of previously available and newly collected information, and will provide the conceptual understanding necessary to accurately represent the hydrogeologic framework and hydrologic processes of the CCCW in the numerical ground-water flow model. Using previous investigations, additional data, geologic maps, and the lithologic information from drillers' logs, hydrogeologic cross sections for the study area will be

constructed using Rockworks software. After the sections are constructed and the major hydrogeologic units have been identified, maps of the tops and extents of the major units will be constructed. Hydraulic parameters will be estimated for hydrogeologic units using available data from aquifer tests, drillers' reports (specific capacity tests), and published values. Ground-water recharge estimates will be based on previously published values (Vaccaro and others, 1998), and refined with updated and more detailed land cover mapping. Water-right and current/historic water-use information will be provided by municipalities and water purveyors located within the study area.

A report summarizing the conceptual model of the CCCW will be prepared and published by March 31, 2008. The Publication Service Center (PSC) will provide illustration, editorial, and publishing services. The conceptual model report will include descriptions of: a) information describing the tops and extents, and lithologic composition of major aquifers and aquitards, aquifer boundary conditions, and the spatial distribution of aquifer hydraulic properties; b) ground-water movement as it relates to aquifers, aquitards and surface-water features; c) soils and land use coverages; d) aquifer recharge data (precipitation, leakage from surface-water features, anthropogenic return flows, and inflows from tributary basins and adjacent uplands); e) aquifer discharge data (withdrawals from wells, baseflow to surface-water features, evapotranspiration estimates, and underflow to adjacent units and the Puget Sound); and f) streamflow and lake-level records for the CCCW to identify possible trends and delineate gaining/losing reaches.

III. Integrate project information into a numerical flow model to assist water resource managers in the development of a long-range watershed management plan

Task 3.1 Construct and Calibrate a Steady-State Numerical Ground-Water Flow Model (FY08) -

A numerical ground-water flow model (MODFLOW) will be constructed to represent hydrologic processes in the CCCW, and simulate potential anthropogenic and climatic impacts on ground-water and surface-water resources. MODFLOW is a widely used three-dimensional, finite-difference ground-water flow model written by the USGS (Harbaugh, 2005; and McDonald and Harbaugh, 1988), that includes the Observation, Sensitivity, and Parameter Estimation software process (Hill and others, 2000). Steady-state and transient (task 3.2) condition models will be constructed and calibrated. Model calibration and sensitivity analysis will be conducted using parameter estimation methods. Time-averaged and synoptic ground-water-level and streamflow data will be evaluated (see task 2.4) for use in steady-state model calibration. A commercial graphical user interface will be used to construct the model, manage the data, and conduct post-processing of modeling results. A report documenting model development, limitations, and the results from approximately six simulations representing a range of potential anthropogenic activities and hydrologic conditions will be prepared and published.

Model boundary locations and conditions that match natural boundary features as closely as possible will be selected. Ground-water boundaries in the deeper parts of the aquifer system may not coincide with the CCCW boundary, as defined by surface-water drainage patterns. If it can be determined, through the analysis of ground-water levels and other information, that ground-water movement in the deeper parts of the aquifer system are

governed by regional boundary conditions located beyond the watershed boundary, then those more distant and representative features may be used to bound the model. The location of model boundaries that closely correlate to deeper aquifer conditions will allow water resource managers to achieve more plausible simulations of the potential effects of deeper aquifer withdrawals on the ground-water and surface-water system. Previous hydrologic investigations in the Puget Sound Lowland (Drost and others, 1999; Jones and others, 1999) have documented conditions (ground-water-level and streamflow measurements) that suggest the Puyallup and Nisqually Rivers produce no-flow boundary conditions for all but the deepest aquifers in the region. The eastern boundary of the model will likely coincide with the western margin of the Cascade foothills, where permeable unconsolidated deposits thin above a rising lower-permeability bedrock surface. The model will be bounded to the west by the Puget Sound.

Task 3.2 Convert Steady-State Numerical Flow Model to Transient and Calibrate (FY09) - The steady-state model will be converted to transient once the collection of temporal water-level and streamflow data is completed and available for model calibration. Data collection is scheduled to begin October 2006 and end October 2008 (task 2.3). The transient model will have a monthly or shorter time step, depending on how quickly the actual flow system responds to stresses.

Task 3.3 Model Performance Simulations (FY09) - Model performance will be demonstrated by approximately six simulations representing a range of conditions. Simulations will demonstrate modeled responses (changes in streamflow and ground-water level) to variations in ground-water withdrawal rates, depths, and locations, and recharge

rates (precipitation and anthropogenic infrastructure such as pavement and storm water drains). Simulation conditions will be determined by the USGS and Pierce Conservation District by September 30, 2008, in consultation with project partners, stakeholders, and others.

Task 3.4 Prepare Report Summarizing Model Construction and Results (FY09) -
A report summarizing numerical model construction, performance, limitations, and results from approximately six simulations will be prepared.

Task 3.5 Report Publication and Transfer of Model to Cooperator (FY10) - The model report will be published and the model, including input files, will be transferred to the cooperator or a designee(s) of the cooperator by December 31, 2009. The Publication Service Center (PSC) will provide illustration, editorial, and publishing services. The cooperator or their designee(s) will be required to have a working knowledge of appropriate modeling software. The USGS will not provide instruction on ground-water flow modeling or the use of modeling software. It is noted that the model and input files are within the public domain and will be provided to any entity requesting them.

Budget.— The project will cost $819,430 over five fiscal years (FY 2006-2010). Project costs will be shared equally by the USGS and Pierce Conservation District.

Funding Sources —

Agency	**FY2006**	**FY2007**	**FY2008**	**FY2009**	**FY2010**
USGS	$ 50,755	$119,455	$137,350	$ 86,470	$15,685
Pierce Conservation District	50,755	119,455	137,350	86,470	15,685
Total	$101,510	$238,910	$274,700	$172,940	$31,370

Personnel —

	FY 2006 Hours	**FY 2007 Hours**	**FY 2008 Hours**	**FY 2009 Hours**	**FY 2010 Hours**
Hydrologist GS 13	376	744	970	1020	24
Geographer GS 11	112	96	176	64	
Hydrologist GS 11	76				
Hydro Tech GS 9	220	1,004	768	80	
IT Specialist 9	24				
STEP 4	60	120			

Timelines and Report Products — The USGS will prepare and publish two USGS Science Investigations Reports. The Conceptual Model Report will be published by March 31, 2008. The Numerical Model Report will be published and the model, including input files, will be transferred to a designee of the cooperator by December 31, 2009. A project website will be established and maintained for the duration of the study. A detailed timeline for the project is provided in the table below.

FY	2006		2007				2008				2009				10
Quarter starting	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct
Tasks															
1.1 Establish project website	X														
1.2 Establish project QA/QC plan	X														
2.1 Compile and evaluate currently available data and populate database	X	X													
2.2 Identify additional data needs		X													
2.3 Additional data collection															
2.3.1 Augment TPCHD gw network; data collection and processing		X	X	X	X	X	X	X	X	X					
2.3.2 Conduct stream baseflow measurements			X	X	X	X	X	X	X	X					
2.3.3 Survey locations of additional monitoring well sites (DGPS)			X												
2.3.4 Construct water-level maps				X											
2.3.5 Exploratory drilling and geophysical surveys - if needed				X	X										
2.4 Conceptual model and report					X	X	X	X							
3.1 Construct and calibrate steady-state numerical flow model									X	X					
3.2 Convert steady-state numerical flow model to transient and calibrate											X	X			
3.3 Model Performance Simulations												X			
3.4 Prepare numerical model report													X	X	
3.5 Publish numerical model report and transfer model														X	X

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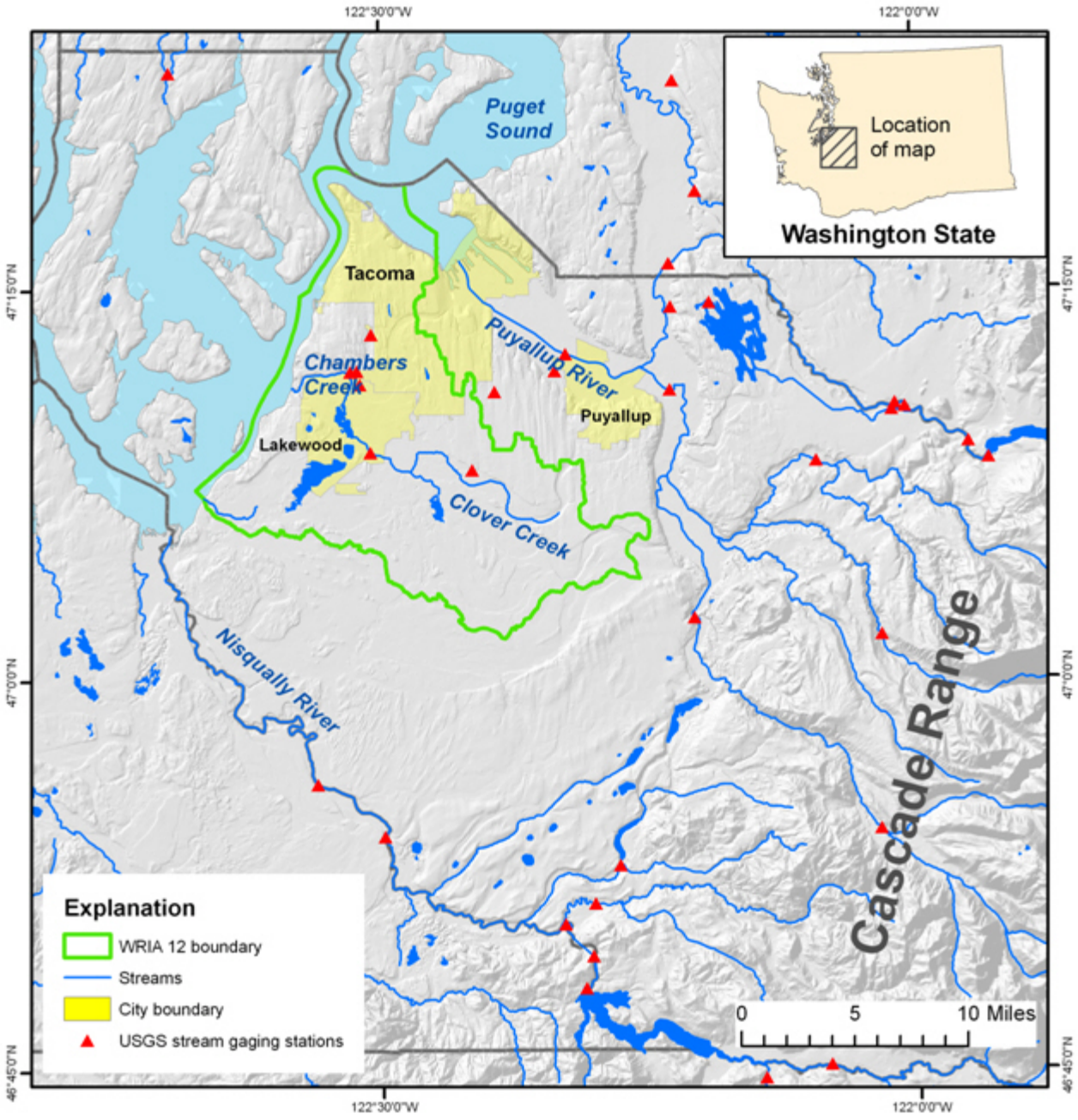

Figure 1. WRIA12 and surrounding areas.