United States
Environmental Protection
Agency

Office Of Water
(4602)

EPA 813-R-95-001
July 1995

EPA

Tribal Wellhead Protection Demonstration Projects

FACT SHEET: TRIBAL WELLHEAD PROTECTION DEMONSTRATION PROJECTS

GROUND WATER PROTECTION DIVISION
OFFICE OF GROUND WATER AND DRINKING WATER
U.S. ENVIRONMENTAL PROTECTION AGENCY

)neida Tribe, Wisconsin

ietting: The Oneida Tribe consists of pproximately 10,000 Tribal members, nearly alf of whom live on or near the reservation. 'he reservation is geographically located vithin two counties, Brown and Outagamie, ear Green Bay. The Tribe owns about one-hird of the area surrounding its public wells.

Vater Supply: The Tribe operates 8 ommunity water supply wells which range in epth from 235 to 505 feet.

lydrogeology: The main water-bearing interval ; a confined sandstone aquifer. The aquifer echarge area is about 10 miles west of the eservation. Vertical hydraulic conductivities ı the confining unit are estimated at .00007 eet per day which suggests that recharge ccurs at outcrop areas only.

essons Learned: Delineate wellhead rotection areas in conjunction with local land wners and municipalities.

'ontact: Steve Loritz
Environmental Department
Oneida Tribe of Wisconsin
P.O. Box 3065
Oneida, WI 54155
(414) 497-5812

Zuni Pueblo, New Mexico

Setting: The Zuni Pueblo consists of approximately 7500 Tribal members. Most live on or near the reservation. The reservation is located on 620 sq. mi. in w. New Mexico.

Water Supply: The Pueblo operates 8 public water supply wells which range in depth from 600 to 865 feet.

Hydrogeology: The wells tap two separate aquifers; one semi-confined and one confined, both sandstones interbedded with less permeable intervals. The confined aquifer recharge area in the Zuni Mountains is about 25 miles away from the main population center. Recharge to the semi-confined aquifer may occur through vertical leakage through the alluvium of the Zuni river. Vertical hydraulic conductivities in the semi-confining unit are estimated at .08 feet per day.

Lessons Learned: Ground water protection should be complemented with surface water protection activities because of the possibility that Zuni river water may recharge the semi-confined aquifer.

Contact: Steve Davis
Bureau of Indian Affairs
Zuni Agency
P.O. Box 368
Zuni, New Mexico 87327
(505) 782-5592

Hoopa Valley Tribe, California

Setting: The Hoopa Valley Indian Reservation is located in the rural northeastern portion of Humboldt County, California. The reservation consists of approximately 144 square miles with a population of 2200 people.

Water Supply: Water is provided to the reservation from a variety of sources. Three municipal wells representing three well fields supply an unknown volume of water.

Hydrogeology: Ground water is available primarily from alluvial aquifers.

Lessons Learned: The source inventory resulted in the discovery of possible inadequate sanitary setback distances that may be related to Tribal cases of Hepatitis A.

Contact: Collen Goff
Planning Department
Hoopa Valley Reservation
Loop Road
P.O. Box 1348
Hoopa, CA 95546
(916) 625-4276

Tulalip Tribe, Washington

Setting: The Tulalip Tribe Reservation is located near Marysville, WA.

Water Supply: The Tribe relies solely on groundwater except in the southeastern corner of the reservation. Public water supply is provided by four wells located in the Tulalip Creek basin. Well pumping rates range from 170 to 225 gallons per minute.

Hydrogeology: The aquifer is located at a depth of about 100 feet. The aquifer saturated thickness is about 67 feet with regional ground water flow to the southeast. The aquifer is overlain by a 30 foot thick leaky confining layer. Vertical hydraulic conductivity in the confining unit is estimated at .1 feet per day.

Lessons Learned: Capture zones larger than the 25 year time-of-travel capture zone will extend beyond the reservation boundary. However, a 25 year capture zone is more than adequate to protect the water supply. Gravel mining is a potential source of ground water contamination.

Contact: Gillian Middlested
Environmental Program
Tulalip Tribes
7615 Totem Beach Road
Marysville, WA 98271
(206) 653-0220

Gila River Indian Community, California

Setting: The Gila River Indian Community is located near Sacaton, Arizona. The community includes four contiguous groundwater basins (A, B, C and D) southwest of Phoenix, AZ.

Water Supply: The Community uses 27 wells each pumping at their rated capacity for 2 to 12 hours per day, year round, totalling approximately 11,000 acre-feet per year. Thirteen wells in Basin A are considered Public Water Supply wells.

Hydrogeology: Ground water is supplied from a 1000 foot thick, heterogeneous, arid alluvial aquifer in the Basin and Range geologic province. Agricultural pumpage total 138,000 acre feet from 44 wells.

Lessons Learned: Because of the complex hydrogeology, it was necessary to construct a regional ground water flow model. Individual wellhead protection areas were delineated based on the basin wide model results.

Contact: Glenn Stark
Water Quality Planning
Gila River Indian Community
PO Box 370
Sacaton, AZ 85247
(602) 562-3203

INTRODUCTION

Preventing contamination is the key to keeping ground water supplies safe. Once a drinking water supply becomes contaminated, a tribe is faced with the difficult and costly task of installing treatment facilities or locating an alternative source. Wellhead Protection provides the tribes with an opportunity to protect their drinking water supplies through local community planning. The planning program should include the delineation of wellhead protection areas and the identification and location of potential sources of contamination. Other protection activities should include the management of the wellhead protection area to minimize the potential for contamination and development of a contingency plan to ensure alternate public water supplies if contamination occurs.

The case studies described herein illustrate Tribal Wellhead Protection activities and highlight several concerns Tribes may have in implementing Wellhead Protection. These concerns include:

1) Ground water recharge or wellhead protection areas that are located outside the boundaries of Tribal reservations.

2) Intimate relationship between ground and surface water within the reservation.

3) Difficulties in implementing or enforcing a program in the absence of a Tribal judicial body.

The case study details should be useful in assisting Tribes to develop a Wellhead Protection Program under the Safe Drinking Water Act that is tailored to their unique set of circumstances. Case studies of successful Tribal Wellhead Programs may include elements that are adaptable to other Tribal Programs.

Oneida Indians of Wisconsin

Wellhead Protection Project
Summary

The Reservation Setting

The Oneida Tribe of Indians of Wisconsin is a federally-recognized Indian Tribe consisting of approximately 10,000 Tribal members, nearly half of whom live on or near the reservation. The Oneida Reservation is located near the City of Green Bay in northeastern Wisconsin (see Figure 1 for location map). The reservation is geographically located within two counties, Brown and Outagamie. The Tribe currently owns and controls approximately 5,000 of the 65,000 acres within the reservation. (See Figure 2 for a Tribal ownership map). The remaining acreage is held by non-tribal members, which makes land use planning and natural resources management difficult.

The Tribe is organized under a Constitution which delegates decision-making power to the General Tribal Council (GTC). The GTC consists of all the adult members of the Tribe, which every three years elects a nine-member Oneida Business Committee to handle day-to-day decisions of the Tribe.

The Oneida Tribal water systems are operated, maintained, and managed by the Oneida Utilities Department. Organizationally, the Utilities Department is within the Public Works Department which is within the Community Development Division. The Oneida Utilities Department currently operates eight (8) community water supply wells which range in depth from 235-505 feet. These wells are located near major centers of Tribal activity.

The aquifer system in the vicinity of the Oneida Reservation is complex and is comprised of three aquifers and two confining beds. Most of the high capacity wells tap one or both of the deep sandstone aquifers which are highly confined throughout the Green Bay and Reservation areas.

Wellhead Protection Project Goals and Objectives

In 1992, the Oneida Tribe became the first Tribe in USEPA-Region 5 to receive funds to support a wellhead protection demonstration project. The Wellhead Protection Demonstration Project was undertaken to study the community water resources for the Oneida Nation and to develop a wellhead protection program for the Tribe that could prevent ground water contamination of its public water supply system.

The objectives of the project were to delineate a wellhead protection area for the 8 wells, identify sources of contamination within the wellhead protection areas, develop a wellhead protection management plan and possible ordinance, and to implement a public education program.

Project Approach and Accomplishments

A Wellhead Protection Coordinator was hired to manage the project for the Tribe within the Tribe's Environmental, Health, and Safety Department.

The eight wells that serve the long term needs to the community were studied to determine the locations where water entered into the appropriate aquifer systems. The Tribe initially contracted with the U.S. Geological Survey to model the ground water flow and to delineate a wellhead protection area for the Tribe's wells. Since the early 1950's, the USGS had undertaken a considerable amount of research to define the ground water system in the Green Bay Metropolitan area which is adjacent to the Oneida reservation. Through this research, the hydraulic properties and geometry of the aquifers and confining units underlying the Oneida reservation were defined and mapped. As a result, the USGS utilized a three-dimensional ground water flow model to simulate the aquifer system. A particle tracking routine was used to delineate the geographic areas contributing to the pumping areas. The result of the USGS delineation identified a recharge area of some 30 square miles which included land outside the reservation boundaries. The model also demonstrated that travel times are on the order of 1 mile per 500 years and that the contributing areas are large and located to the west of pumping area wells and the reservation. The ground water used by the Oneida Tribe for drinking water may be over 2000 years old.

Recognizing the difficulty in protecting the land area outside the reservation boundaries, as well as large parcels of land owned by non-tribal entities, another approach was taken by the Tribe to delineate a wellhead protection area. Overall, the Tribe utilized three factors in its revised delineation. These included:

- Portions of the USGS model for the recharge zones for two of the well sites.
- A minimum 2500 foot radius around all of the wells
- Portions of the main stem of Duck Creek where losing reaches were possible.

In addition, it seemed appropriate to use whole sections of the Tribal area to eliminate the difficulty to legally describe. The resulting wellhead protection area consists of 30 sections of land which encompass the heart of the tribal activity. The final wellhead protection area is illustrated in Figure 2.

Man-made features which could contaminate ground water are abundant in the wellhead protection area. Potential sources of contamination were identified from data drawn from USGS topographic maps, the State's Department of Natural Resources and Department of Transportation files, along with data and reports in the Tribal Environmental Department. Internally, data was verified and reviewed by the Tribe's Conservation, Public Works, and Utilities sections. Numerous windshield surveys were also taken to confirm locations of sources within the WHPA.

The sources of contamination identified range from a sewage disposal pond to auto repair facilities. The table below lists the sources found and the number of sites identified. In addition, the Tribe developed a map of all the sources identified within the wellhead protection area utilizing the Tribe's geographic information system. (Figure 3 illustrates these potential sources of contamination.)

Potential Source of Contamination	Number of Sites
Underground Storage Tanks	40 (approx.)
Quarries/Sand, Gravel Pits	17
Manure Storage	11
Abandoned Wells	7
Leaking Underground Storage Tanks (LUSTs)	6
Junkyards	4
Cemeteries	4
Sludge Spreading	2

It was also found that the most widespread potential sources of ground water contamination are not readily mappable. Agricultural operations are vast throughout the wellhead protection area. Numerous septic disposal systems are also present. A conservative estimate would show more than 200 septic systems present with perhaps 1/3 of these in need of repair or replacement. Currently only four sections of the WHPA are served by the Green Bay Metropolitan Sewage District. About four miles of railroad right-of-way cross the northern portion of the wellhead protection area. Above and beyond the risks associated with accidental spills or releases, during the summer months, the edges of the railroad property are sprayed with a chemical which turns the vegetation from a lush green to a dead orange-brown.

Under the project, these potential sources of contamination were evaluated and a summary of measures that could be taken to promote ground water protection was developed. Figure 4 illustrates the management strategies the Tribe could pursue to better protect its public water supplies. Both Tribal and civil law approaches are identified in the management strategies table.

Given the highly confined nature of the wells, the Tribe was particularly concerned with abandoned wells. In May, 1994 a Memorandum of Understanding was formed between the Tribe and the Wisconsin Department of Natural Resources to implement a means to accomplish sealing of abandoned wells on non-tribal lands within the reservation. Also, the Tribe passed a law in September, 1994 which covers proper abandonment procedures for Tribal lands within the reservation. (Copies of the Memorandum of Understanding and Well Abandonment Law are attached.)

General ground water education efforts were undertaken in support of the wellhead protection program. Informational booklets aimed at school age tribal member were sent to teachers. Tribal members in key roles in the Tribal Departments (Public Works, Conservation, Tribal School) were targeted for education and outreach on general ground water protection and the wellhead protection program. An article on the wellhead protection project was published in the Tribe's Environmental Services Program newsletter. In addition, the Tribe distributed hundreds of rain gauges with the inscription "Rain Today - Well Water Tomorrow - Protect Your Groundwater!" as a means of promoting the message of ground water and wellhead protection. This promotional campaign was well received.

Lessons Learned

The Tribe was surprised to learn that the USGS modelling of its recharge area resulted in a 30 square mile wellhead protection area which was 10 miles west of the reservation and that the ground water movement was very slow (10-15 feet per year). The use of travel time of water to wells as a criteria became a moot point. As a result of the extensive delineation outside the reservation boundaries they found the USGS delineation to be unimplementable. Therefore, the Tribe refined the delineation to cover an area within the reservation boundaries.

They were also pleased to learn, however, the extent to which their water supply is protected since their aquifer systems are so highly confined. It gave them a level of comfort that they hadn't had before. Due to the highly confined nature of their system, though, the sources of greatest concern are the abandoned wells and they recognized the need to aggressively address those. As a result, the Tribe adopted a well abandonment code.

The Tribe found that a good majority of the potential sources of contamination found within the wellhead protection area could be regulated by ordinances already in place which contain water protection measures. However, the Tribal judicial systems have never been created to enforce these ordinances. In addition, the State siting restrictions are utilized by the Tribe. Those areas, however, 1200 feet or less around the wells were fairly small areas and were serving as a norm for what was needed to protect the wells when further protection might be more appropriate.

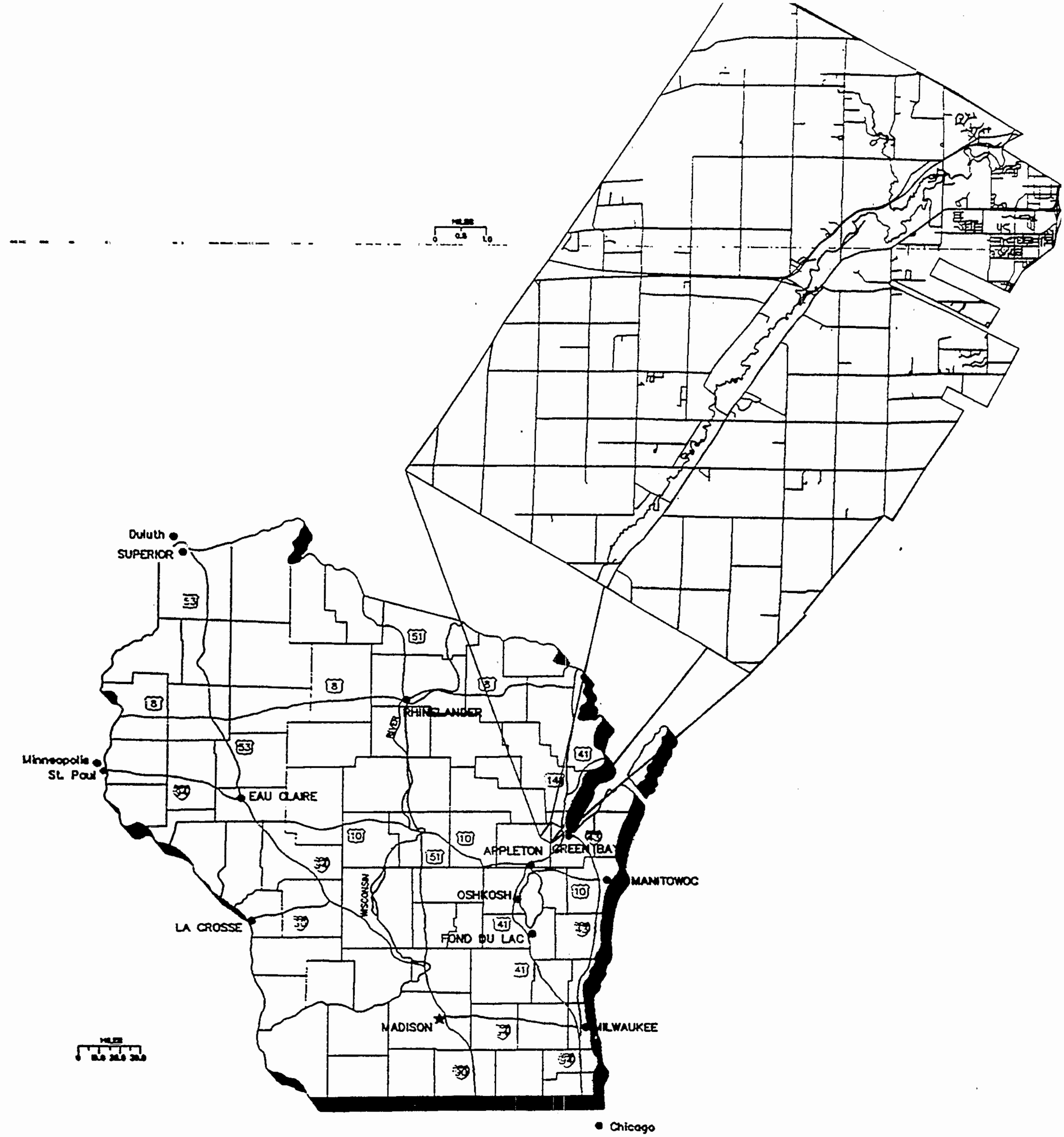
The Tribe owns only about 1/3 of the land within the wellhead protection area. This creates a lot of difficulty for the Tribe to implement management on land where Oneida Tribal law may not have jurisdiction. As a result, the Tribe has learned that they need to involve the Towns of Hobart and Oneida, within the reservation, to properly implement the program and to protect the Tribe's wells.

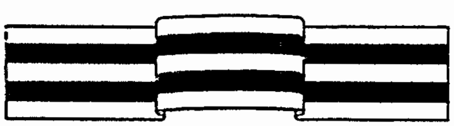
Another surprise to the Project Coordinator was the limited knowledge and understanding by the Tribe overall about water resource issues. This resulted in a lack of interest and coordination on water issues. Significant plans were underway for Green Bay Metro water supply planning. While local governments would usually send high level leaders to the planning meetings, Oneida would usually send a consultant for the planning department. As a result of the Metro area planning, a site is being considered for future wells to support Green Bay metro needs which would be located within the Tribes reservation. Efforts are underway to stimulate interest in water issues by providing Tribal legal staff with water rights information. All ground water to the major metro wells must pass under reservation land.

Bureaucratic structure and rivalry between departments is not unusual in any governmental system. Such is the case in the Tribal structure. The Superintendent of Wells and Septic Systems is placed within the Department of Buildings and Grounds. This department exists separately from the Tribal Utilities Section which operates the public water supply wells. The Environmental, Health, and Safety Department exists as a regulatory vehicle under the government and business divisions. As a result, they have found that water quality issues need to close alignment and cooperation of all the Departments and Sections.

Under their effort to educate the public on the wellhead protection program or ground water protection in general, the Tribe found that there were a number of resources out there that could be used. Nearly every public interest group (i.e. League of Women Voters) and State system (i.e. University of Wisconsin Extension Service) has produced pamphlets, booklets, or videos on water quality issues. Oneida also felt that the promotional tools worked well. They had distributed hundreds of rain gauges with the inscription "Rain Today - Well Water Tomorrow- Protect the Groundwater !". Other ideas they came up with to promote groundwater protection included: sponges to mimic the function of aquifers, straws to suggest wells tapping the aquifer, and cups embossed with the Tribal slogan. A good slogan might be "Keeping the water pure is one of the first laws of life. If you destroy the water, you destroy life".

Lastly, they found that regional cooperation on groundwater resource quantity and quality is a must for all people in Northeastern Wisconsin and the Oneida Tribe has a role of guardian for all concerned.

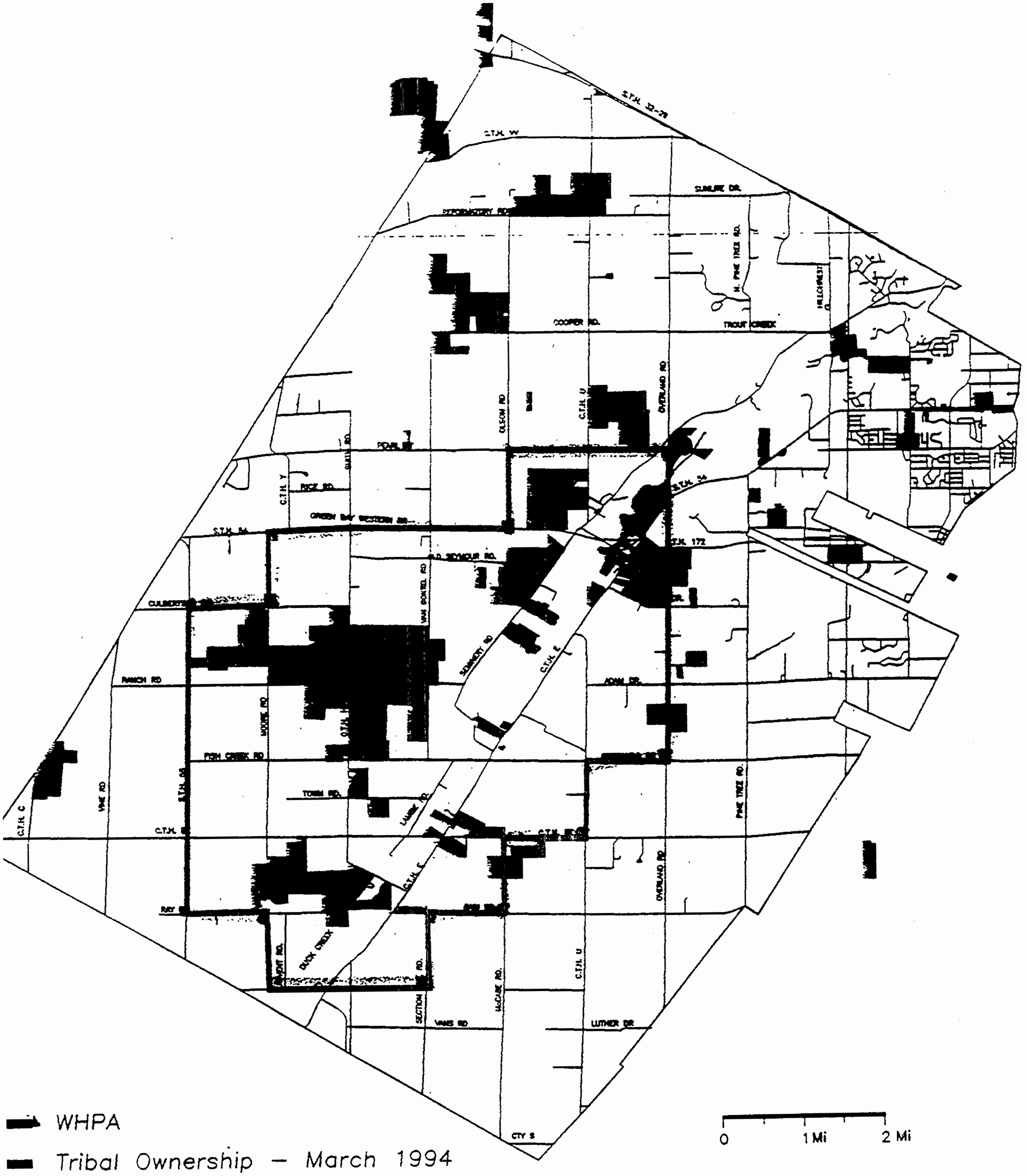




1838 TREATY BOUNDARY

SOVEREIGN NATION OF THE ONEIDA IN WISCONSIN

FIGURE



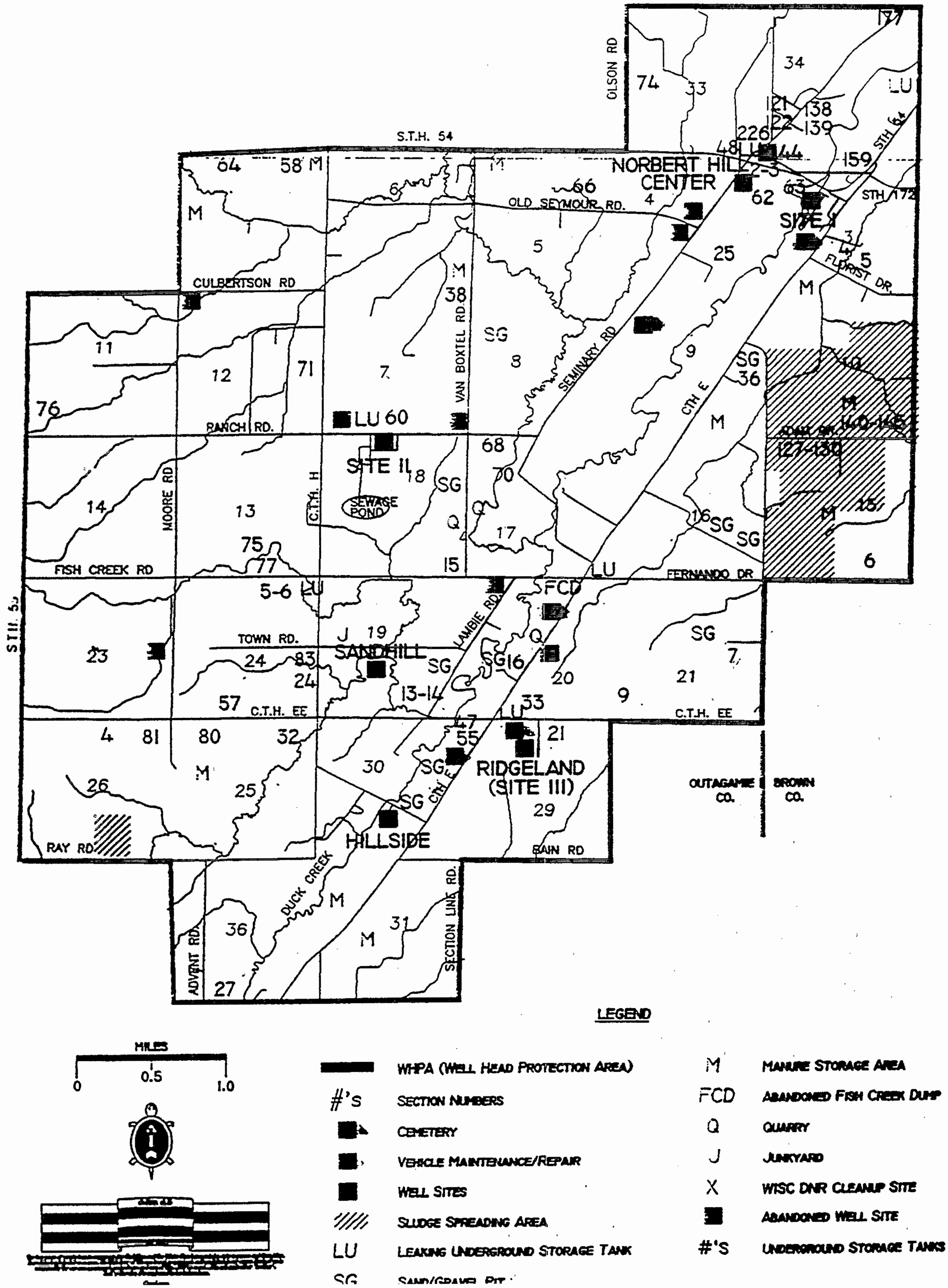
TRIBAL OWNERSHIP

SOVEREIGN NATION OF THE ONEIDA IN WISCONSI

FIGURE 2

WELL HEAD PROTECTION AREA MAP

SOVEREIGN NATION OF THE ONEIDA IN WISCONSIN



MANAGEMENT STRATEGIES

Category	Activity	Description	Responsible Department	Goal
1. Existing Programs	a. Clean Sweep	* Hazardous waste collection and disposal: currently once per year * Target residents of WHPAs to participate	* Individual Volunteers * Brown and Outagamie Counties * Oneida Tribal Utilities	* Send special mailing to advertise program annually. * Annual clean sweep program
	b. On-site waste disposal system (septic) inspections	* Inspection & maintenance currently required for system owners on record. * ERB currently assists with monitoring * Orders issued to confirmed failing system owners * Add property owners in WHPA to Notification Data base * Conduct Public Education * Consider sewer service for WHPA	* Tribal Planning Department * Environmental Resource Board (ERB) * Environmental Health Department	* Update database to include WHPA residents * Send request for inspection and maintenance * Request BC to study sewer service to WHPA
	c. Well Abandonment	* Well Abandonment Law * Require proper abandonment of unused wells * Create well inventory in WHPA	* Tribal Departments * Wisconsin DNR-MOU * Oneida Tribal Utilities and Public Works	* Create inventory of private well in WHPA * Update well inventory in conjunction with CSI update * Seal unused wells
2. Land Use Controls	a. Existing Zoning and Ordinance	* Review existing law * Discourage conditional uses or zoning changes that increase risk * Provide Business Committee with list of high risk land uses * Pass Business Committee resolution to support wellhead protection in considering future variances	* County Boards * County Boards of Adjustment * County Planning Department * Business Committee * Oneida Public Works Department	* Provide County Board with list of high risk land uses and draft resolution supporting WHPA * County Board and Tribe passes resolution
	b. Land Acquisition	* Retain existing ownership * Investigate feasibility of purchasing additional land or development rights	* Oneida Tribal Land Department	* Evaluate possible land or development right acquisition feasibility. Recommend to Utility Commission
3. Monitoring	a. Contaminant Survey	* Update the Contamination Inventory and conduct windshield survey quarterly	* Oneida Utilities * Environmental Quality Section	* Update maps of contaminants quarterly
	b. Water Quality Monitoring	* Conduct sampling of monitoring wells as needed	* Oneida Utilities	* Obtain and analyze water samples from selected monitoring wells
4. Public Education & Awareness	a. Private Well Sampling	* Coordinate with existing County program * Target residents in WHPAs	* Environmental Health Department	* Send mailing to property owners in WHPA * Notify residents in WHPA of County Program
	b. Public Informational Meetings	* Perform at beginning of program, and yearly thereafter	* Oneida Utilities * ERB Board * Oneida Planning Department	* Hold public information meeting to present Wellhead Protection Plan * Informational meetings, as appropriate
	c. Presentation to Business Committee	* Perform early in program implementation * Annual spring meeting as appropriate	* Oneida Public Utilities * ERB Board	* Meet with Business Committee * Update Business Committee during annual spring meeting
	d. News Releases	* Issue early in program implementation, and reinforce annually as necessary	* Oneida Utilities	* Initial news release * Annual news release update
	e. Informational Materials distributed to Residents of WHPAs	* Quarterly Environmental Newsletter * Materials describing proper use & application of fertilizers & pesticides * Other materials or fact sheets describing proper use and disposal of wastes, and protection of private wells	* Oneida Utilities * Wisconsin DNR * Oneida Farms	* Semi-annual newsletter prior to spring clean sweep * Other public educational brochures for general distribution
	f. WHPA Signs	* Post and maintain roadway signs at entrance to WHPAs	* Planning Department Sign Committee	* Fabricate and post signs in WHPAs
	g. Hazardous Waste Awareness	* Notify and offer guidance to owners of potential high risk land uses in WHPAs * Annually notify RCRA regulated industries of Wellhead Protection Plan issues	* Oneida Utilities * Wisconsin DNR	* Conduct mailing to selected properties identified in CSI * Notify/ educate RCRA regulated industries
	i. School Age Children Education	* Participate in school education	* Oneida Utilities * Environmental Department	* Provide water plant tours and incorporate Wellhead Protection Plan topics in education program

MEMORANDUM OF UNDERSTANDING

BETWEEN THE

Wisconsin Department of Natural Resources
and
The Oneida Tribe of Indians of Wisconsin

This Memorandum of Understanding (MOU) between ~~the Wisconsin Departme~~ of Natural Resources and Oneida Tribe of Indians of Wisconsin is an agreeme between the two parties, in hopes of effectively closing all unused wel within the Reservation boundaries. The well closure is an actual proce which is usually done by a licensed well driller or pump installer. Unus and improperly abandoned wells are a threat to groundwater quality and ca pose a danger to personal safety. For the following document; the te "Tribal Land" shall mean all lands held in fee by the Oneida Tribe of India of Wisconsin and/or it's individual members, and all lands held by the Unit States of America in trust for the Oneida Tribe of Indians of Wiscons and/or it's individual members.

I. PURPOSE

The purpose of the Memorandum of Understanding (MOU) is to formulate cooperative procedure between the two parties listed. This procedure wil outline roles and responsibilities for the proper abandonment of designate wells on non-tribal property within the Oneida reservation boundaries.

TERM OF AGREEMENT

This MOU shall remain in effect for one year from the date of execution It is understood that this MOU may be terminated by either party, upo serving a written notice to the other at their principal place of business not less than thirty (30) days prior to the termination date. Our goal is t develop a long term agreement among the parties. This document is assumed t be automatically renewed each year unless a notice of termination i submitted by either party.

III. PROTECTION OF JURISDICTION

It is understood by the parties, that this agreement in no way waive the Sovereign Immunity of the Oneida Tribe of Indians of Wisconsin or th United States. This MOU represents an arrangement between the partie intended solely to provide for the protection of natural resources on th Oneida Reservation without regard to what the jurisdiction of the partie might be in the absence of this agreement. Neither party intends that thi agreement recognize, expand or restrict the jurisdiction that either part may have in it's absence.

IV. PERFORMANCES OF THE PARTIES

THE TRIBE WILL:

Provide the DNR with location descriptions of unused wells on Non-Triba lands. If needed the Oneida Environmental Department along wit

Wisconsin DNR staff will field survey the "listed" unused wells so that exact locations are understood. If needed name, address, phone number and maps will be provided.

2. Abandon ~~all~~ unused wells on Tribal lands following procedures contained in section NR 112.26 of the Wisconsin Administrative Code. Supply to the Wisconsin DNR completed form 3300-5B "WELL/DRILLHOLE/BOREHOLE ABANDONMENT", upon the complete abandonment of unused wells located on tribal land.

3. Aid the DNR as requested to assist in coordinating this agreement.

THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES WILL:

1. Inform the Oneida Environmental Department of unused well locations within reservation borders, as they become known to the DNR.

2. Contact non-tribal landowners that are reported to possess an unused well, to determine compliance with Wisconsin Administrative Code, NR 112.26, which governs proper abandonment of private water supply wells.

3. Advise the well owners on how to achieve compliance with Wisconsin Administrative Code, NR 112.26.

4. Provide to the Oneida Environmental Department completed copies of form 3300-5B upon review by the DNR for those wells on non-tribal land.

5. Share information with the Tribe regarding any funds available for well abandonment.

6. Bring to the attention of the Tribe any related environmental or health concerns in relation to these well closures.

[signature]	George E. Meyer
DEBBIE DOXTATOR	George E. Meyer
ONEIDA TRIBAL CHAIRWOMAN	Secretary of Wisconsin Department of Natural Resources
4-13-94	5-11-94
DATE	DATE
NORBERT HILL CENTER	WISCONSIN DNR
P.O. BOX 365	P.O. BOX 7921
ONEIDA, WI 54155	MADISON, WI 53707

APPROVED

WELL ABANDONMENT LAW

Article I. Purpose and Policy

1-1. The purpose of this law is to require the abandonment or upgrading of all unused, unsafe or noncomplying wells located within the exterior Reservation boundaries of the Oneida Tribe of Indians to prevent contamination of groundwater.

1-2. The proper abandonment of wells protects public health, safety and welfare by assuring that unused, unsafe or noncomplying wells, or wells which may serve as conduits for contamination, or wells which may be illegally cross-connected to the municipal water system, are properly abandoned.

Article II. Adoption, Amendment, Repeal

2-1. This law may be adopted by the Oneida Business Committee or the Oneida General Tribal Council and effective ten (10) working days after date of adoption.

2-2. This law may be amended pursuant to the procedures set out in the Oneida Administrative Procedures Act by the Oneida Business Committee or the Oneida General Tribal Council, regardless of where the original adoption took place.

2-3. Should a provision of this law or the application thereof to any person or circumstances be held as invalid, such invalidity shall not affect other provisions of this law which are considered to have legal force without the invalid portions.

2-4. All other Oneida laws, policies, regulations, rules, resolutions, motions and all other similar actions which are inconsistent with this policy are hereby repealed unless specifically re-enacted after adoption of this policy.

2-5. This law shall apply to all Oneida Tribal entities, the Oneida Tribe, members of the Oneida Tribe of Indians of Wisconsin who own land within the exterior boundaries of the Reservation of the Oneida Tribe of Indians, residents and all entities within the Oneida Utility District and is adopted and implemented by authority of the Oneida Tribe of Indians of Wisconsin Constitution.

Article III. Definitions

3-1. All words used herein shall have their ordinary meaning unless specifically defined within this Article.

3-2. Unless otherwise stated within this law, the following specific definitions shall apply:

a. "Municipal water system" means a system for the provision to the public of piped water for human consumption when such system has at least 15 service connections or regularly serves at least 25 year-round residents owned or operated by a city, village, county, town, town sanitary district or public institution, or a privately owned water utility serving any of the above.

b. "Noncomplying" means a well or a pump installation which does not meet the provisions of NR 112, Wis. Admin. Code.

c. "Pump installation" means the pump and related equipment used for withdrawing water from a well including the discharge piping, the underground connections, pitless adapters, pressure tanks, pits, sampling faucets and well seals or caps.

d. "Unsafe" means a well or pump installation which produces water which is bacteriologically contaminated or contaminated with substances exceeding the standards of chs. NR 809 or 140, Wis. Admin. Code, or for which a Health Advisory has been issued.

e. "Unused" means a well or pump installation which has not been in use for three (3) months prior to the date of the adoption of this Law or has not had a functional pumping system for three consecutive months.

f. "Well" means an excavation or opening into the ground made by digging, boring, drilling, driving, or other methods for the purpose of obtaining groundwater for consumption or other use.

g. "Well Abandonment" means the filling and sealing of a well according to the provisions set out herein or by adoption within this code of §NR 112.26, Wis. Admin. Code.

Article IV. Abandonment Required

4-1. All wells located on premises served by a municipal water system or, regardless of location, are unused or of noncomplying construction, shall be abandoned in accordance with the terms of this law and §NR 112.26, Wis. Admin. Code, unless a well operation permit has been obtained from the Oneida Environmental Health Program within three (3) months of adoption of this law, prior to opening a well after adoption of this law, or a renewal permit was granted within three months of expiration of prior permits.

Article V. Well Operation Permit

5-1. The Oneida Environmental Health Program may grant a yearly well operation permit to a private well owner to operate a well for a period not to exceed five (5) years, providing the conditions of this section are met. An owner may request renewal of a well operation permit by submitting information verifying that the conditions of this section are met.

5-2. The following requirements must be met prior to granting a permit

a. A yearly water quality test is performed at the owner's expense.

b. The Oneida Environmental Health Program or its agent, may conduct inspections or have water quality tests conducted to obtain or verify information necessary for consideration of a permit application, on an annual basis for reverification, or upon request for permit renewal.

c. Permit applications and renewals shall be made on forms provided by the Oneida Environmental Health Program.

5-3. The following conditions must be met for issuance or renewal of a well operation permit.

a. The well and pump installation meet or are upgraded to meet the requirements of ch. NR 112, Wis. Admin. Code; and

b. The well construction and pump installation have a history of producing bacteriologically safe water as verified by sampling histories. No exception to this condition may be made for unsafe well, unless the Oneida Environmental Health Program provides the appropriate form for the continued use of the well; and

c. There are no cross-connections between the well and pump installation and the municipal water system; and

d. The proposed use of the well and pump installation will be reviewed on a case by case basis.

Article VI. Abandonment Procedures

6-1. All wells abandoned under the jurisdiction of the Oneida Tribe of Indians of Wisconsin shall be abandoned according the procedures and methods set out herein and supplemented in §NR 112.26, Wis. Admin. Code. Provided that, any notification within the state regulation shall be superseded and integrated as reasonable with the notification procedures herein.

6-2. The owner of the well, or the owner's agent, shall notify the Oneida Environmental Health Program at least 48 hours prior to the commencement of any well abandonment activities. The abandonment of the well may be observed by the Oneida Environmental Health Program, or its designated agent.

6-3. A well abandonment report will be completed and submitted by the owner's agent, to the Oneida Environmental Health Program within 10 days of the completion of the well abandonment. The well abandonment report form is available from the Oneida Environmental Health Program.

6-4. All debris, pump, piping, unsealed liners and any other obstructions which may interfere with sealing operations shall be removed prior to abandonment.

Article VII. Penalties

7-1. Any well owner or agent violating any provision of this law shall be subject to forfeiture of not less that $100 nor more than $1,000. Each day of violation is a separate forfeiture. Provided that each forfeiture be proven individually.

7-2. Failure to comply with this law within ten (10) working days after receiving written notice of this violation, the Oneida Tribe may impose a penalty and cause the well abandonment to be performed at the expense of the well owner.

7-3. The Oneida Environmental Health Program is authorized to bring all civil forfeiture hearings before the Oneida Environmental resource Board as the Original Hearing Body. Provided that notice and hearing procedures are conducted as directed by the Oneida Administrative Procedures Act.

7-4. It shall be a valid defense to any continuing forfeiture that the well owner has begun procedures to abandon the well and shall be by sworn affidavit that notice has been presented to the Oneida Environmental Health Program of approved well abandonment procedure.

7-5. Appeal from any final, written, judgment shall be made within five (5) working days of notice and may be made by either party.

7-6. No forfeitures accumulate after a civil hearing is begun by filing a request for forfeiture with the Environmental Resource Board.

7-7. Forfeiture collected under this law are to forwarded to the Accounts Receivable Office for placement in the General Tribal Funds.

Article VIII. Conflict with Federal Law

8-1. Should any part of this law be found to be in conflict with federal requirements which are required in order that the Oneida Tribe of Indians receive federal funds, the conflicting section of this law is to be considered inoperative only for the purpose of the particular funding and that particular conflict. Provided that any consideration in regards to federal funding does not undermine the purposes and policies of this law. Such conflict shall not affect the operation of the remainder of this law in its application to those agencies or department directly affected.

DELINEATION CASE STUDY FOR ZUNI PUEBLO, WESTERN NEW MEXICO

BY Jane Marshall Farris, Hydrologist
EPA Office of Ground Water and Drinking Water
Washington, D. C.

Introduction

The EPA Wellhead Protection Program allows States and Tribes to differential manage source of contamination within delineated wellhead protection areas. The delineated area may be based on the hydrogeologic properties of the aquifer or may be chosen simply by inscribing a circular area surrounding a well. The Zuni case study is an example of a delineated wellhead protection area based on the hydrogeologic properties of the aquifer.

Zuni Pueblo obtains its public water supplies (PWS) from two aquifers: sandstones in the Chinle Formation (Triassic Age) and the San Andres- Glorieta aquifer (Permian Age). PWS wells completed in the Chinle Formation include F1, F2, F3 and F4 located in the vicinity of the Zuni Village and Z4 and Z7 located northeast of the village (Straille, 1993). Two PWS wells completed in the San Andres-Glorieta Aquifer are located in the Black Rock Community:Black Rock Public Health Service Well - BR PHS well, and well B4* (Strallie, 1993). Additionally, the U.S. Geological Survey (1991) and Molzen-Corbin and Associates (1991) have completed studies in the southern part of the Pueblo and recommended a drill site near Ojo Caliente for two additional San Andres-Glorieta aquifer wells.

Delineation Approach for Chinle PWS Wells

The Chinle Formation underlies most of the Pueblo lands and is composed of an upper grayish to reddish brown mudstone and siltstone with some interbeds of lenticular sandstone (600 feet), about 100 feet of a grayish to brown sandstone, conglomerate, siltstone and mudstone shale middle unit (Sonsela Sandstone Bed), and a lower 600 feet of grayish to reddish to purple mudstone and siltstone (Orr, 1987). Lenses of sandstone in the Solsela Sandstone Bed and in the upper part of the Chinle contain water for Zuni's PWS at Zuni Village. Some of these wells penetrate several sandstone zones (see table 1). Additionally, the Chinle Formation outcrops north of well Z4 and provides some recharge to the aquifer.

- The Chinle Formation is considered to be a semi-confined porous aquifer in the vicinity of Zuni Village. The issue of whether the aquifer is confined or semi-confined is subject to professional judgement, however, overlying saturated alluvium and silty Chinle units could provide some leakage to the sandstones. Abandoned or improperly cased boreholes may provide conduits for contaminants.

- There is a small amount of fracturing in the vicinity of the village and extensive fracturing in the vicinity of wells Z4 and Z7 (Tom Crouch, Personal Communication). The fracturing increases transmissivities but may not significantly affect vertical leakage to aquifers.

- The suggested EPA delineation approach includes: 1) criteria of Time-of-Travel; 2) the thresholds for the time-of-travel criteria are 5 and 10 years, and the method is the EPA semi-analytical flow model (analytical method), WHPA 2.0. Due to the close proximity of wells Z4 and Z7 to a Chinle recharge area, hydrogeologic mapping methods are suggested also to delineate the recharge area.

- The EPA WHPA Model 2.0 was selected to determine the zone of contribution to the well for 5 year and 10 year time frames. The model uses semi-analytical equations to determine the zone of contribution to a well or group of wells over a selected time frame and can be used for confined, unconfined, and semi-confined porous flow aquifers. Aquifer mapping completed by the USGS (Brennan Orr, 1987) delineates the Chinle recharge area located close to the Z4 and Z7 wells.

- Five and 10 year time-of-travel zones were determined for wells F1 through F4, Z4 and Z7. The zones become the wellhead protection areas (WHPAs) in which the Pueblo will seek to manage use of possible sources of contamination. The WHPAs for each well have been drawn on the topographic maps.

- Table 1 (attached) lists data which was input into the model. In the absence of data, hydrogeologic texts were consulted to input an estimated value. Printouts as diagrams of some of the computer runs are attached.

- The Wellhead Protection Program is available for management of known contaminant sources for protection of ground water used for drinking water. The proposed WHPAs may be modified as additional data becomes available. Additionally, professionals cannot precisely predict that no contamination will reach a well over a given time frame in a given WHPA. Hydrogeology is a complex science and professionals rarely have data complete enough to thoroughly understand ground water flow and contaminant transport mechanisms in an area.

Delineation Approach for San Andres-Glorieta Aquifer PWS Wells

The Glorieta Sandstone formation and the San Andres Limestone are hydraulically interconnected as one aquifer (as much as 300 feet thick) due to fracturing at the Zuni Pueblo (Crouch, 1991, and Orr, 1987). Recharge areas (outcrop areas) are located in the Zuni Mountains (mostly northeast of the Pueblo) and along basalt covered subcrop areas located along the channel of the Zuni River. The aquifer may be recharged directly by infiltration of precipitation and surface flows across the outcrop and subcrop areas. Wells completed in the aquifer are under confining conditions. Two main springs which issue from the aquifer, Rainbow Spring and

Sacred Spring, have been developed for irrigation, religious, domestic and recreational use.

- The San Andres-Glorieta Aquifer is confined aquifer except where it outcrops in the Zuni Mountains and in the vicinity of Ojo Caliente. Wells drilled in and near Black Rock penetrate the aquifer at depths of about 800 or 900 feet. Recent wells drilled south of Zuni Village near Ojo Caliente penetrated the aquifer at depths of about 600 to 650 feet.

- Besides the fracturing, the San Andres Limestone contains karst features including sinkholes and caves. Transmissivities are very large (see Table 2).

- The selected EPA delineation approach for the confined aquifer includes: 1) aquifer boundaries criteria, 2) thresholds which include the well construction zone, well house, fence around the house of 100 feet radius, and determination of the existence and extent of all recharge areas on the Pueblo, and 3) use of the hydrogeologic mapping method for delineation of all recharge areas (already completed by USGS). Basalt subcrops along the Zuni River will also be delineated as recharge areas.

- The aquifer is considered to be truly confined although wells should be properly constructed, properly grouted and should have a concrete pad around the casing to eliminate contaminants running down the wellbore. Direction of ground water flow is very complex and subject to the location of karst features, faults and fractures in the aquifer.

- Recharge areas which are located in unpopulated and undeveloped areas (such as the Zuni Mountains) may need few if any management controls. Additionally, to test the aquifer as a truly confined aquifer, the Pueblo will need to verify that old or abandoned San Andres-Glorieta wells are properly plugged or sealed to prevent contaminants from entering them and traveling to a pumping well.

- Table 2 (attached) lists data which was considered before selecting this delineation approach. Additionally USGS was consulted regarding location of the new wells and possible sources of contaminants (Tom Crouch, personal Communication).

- The Wellhead Protection Program is available for management of known contaminant sources for protection of ground water used for drinking water. The proposed WHPAs may be modified as additional data becomes available. Additionally, professionals cannot precisely predict that no contamination will reach a well over a given time frame in a given WHPA. Hydrogeology is a complex science and professionals rarely have data complete enough to thoroughly understand ground water flow and contaminant transport mechanisms in an area.

TABLE 1: PARAMETERS USED IN EPA Delineation Characterizations
Triassic Chinle Aquifer, Zuni Pueblo, West-Central New Mexico

Input VALUE/ Information	Zuni PWS	Zuni PWS
AQUIFER TYPE	Triassic Chinle FM., semi-confined porous aquifer	Triassic Chinle FM., semi-confined fractured and porous aquifer near Pinon Springs Anticline
Delineation Criteria, Thresholds and Methods as described in EPA Guidance	5 - 10 year Time-of-Travel criteria/thresholds; semi-analytical method: WHPA-GPTRAC model and hydrogeologic mapping method (recharge area)	5 - 10 year Time-of-Travel criteria/thresholds; semi-analytical method: WHPA-GPTRAC model and hydrogeologic mapping method (recharge area)
NO. OF PUMPING WELLS	4 Modeled	2 Modeled
TRANSMISSIVITY FT^2 /DAY	F1 - 70, F2 - 50 F3 - 50 F4 - 50	Z4 - 680-780 Z7 - ?
HYDRAULIC GRADIENT (NO DIMENSIONS)	20ft/1mi =.004-area near F1;	66ft/2.2mi=.006-area near Z4
ANGLE OF AMBIENT GROUND-WATER FLOW	190 degrees	190
AQUIFER POROSITY	about 15% near Zuni	25% near Z4 and Z7
DEPTH TO AQUIFER AND THICKNESS IN FEET	F1 500',30'; F2 180',20'; 320',20'; 430',70; F3 244,15; 516',40; F4 610'Total depth, flowing	Z4 210', 90'; Z7 210'? and 90?
AQUIFER BOUNDARY TYPE AND LOCATION	not modeled in area, some discharge to Zuni River near Zuni; Chinle outcrops north of Z4 and Z7	not modeled in area, some discharge to Zuni River near Zuni; Chinle outcrops north of Z4 and Z7
SIMULATION TIME	5-10 Years	5-10 Years
CAPTURE ZONE TIME	5-10 Years	5-10 Years
CONFINING UNIT K	.08 ft/day estimate for overlying muddy siltstones	.08 ft/day estimate for overlying muddy siltstones

CONFINING UNIT THICKNESS	Assumption only - for conservative estimate: 20 feet	Assumption only - for conservative estimate: 20 feet
PUMPING WELL PARAMETERS-- LOCATION IN FEET FROM ORIGIN OF PLOT (GPTRAC Model)	X= 4000 Y=3800 F1 X= 3550 Y=2900 F2 X= 4300 Y=7000 F3 X= 2200 Y=6400 F4	X= 2750 Y=2500 Z4 X= 2650 Y=2000
WELL DISCHARGE RATE, FT**3/day, WELL RADIUS	1.45gpm=8662.5, r=4 2.80gpm=15,400, r=4.5 3.30gpm=5775, r=3 4.50gpm=9625, r=5	1. Z4-70gpm=13475, r=3 2. Z7-190gpm = 36,575, r= 4?
STATIC WATER LEVEL IN FEET BELOW LAND SURFACE	APPROX. F1-22.6 F2 35.4 F3 43.4 F4 flowing	Z4 35.2 Z7 ? 35

TABLE 2: PARAMETERS USED IN EPA Delineation Characterizations
Zuni Pueblo, West-Central New Mexico, Permian San Andres/Glorieta Aquifer

Input VALUE/ Information	Black Rock PWS	Ojo Caliente Area
AQUIFER TYPE	Permian San Andres/ Glorieta, Confined	Permian San Andres/Glorieta Confined
Delineation Criteria, Thresholds and Methods as described in EPA Guidance	criteria/threshold: area immediate surrounding well and recharge areas; methods are hydrogeologic mapping and protection at wellbore.	criteria/threshold: area immediate surrounding well and recharge areas; methods are hydrogeologic mapping and protection at wellbore.
NO. OF PUMPING WELLS	2 studied	2 studied
TRANSMISSIVITY FT^2 /DAY	BR PHS 30 - 140 BR3 - 300	Proposed new wells: New Well1: New Well2: (ZS1 -estimated 16,000 - 24,000 for Fractured and Karst Aquifer, ZS2, ZS10, ZS11, ZS13 are Karst, ZS12 - Fractured
HYDRAULIC GRADIENT (NO DIMENSIONS)	NA	NA
ANGLE OF AMBIENT GROUND-WATER FLOW	NA	NA
AQUIFER POROSITY	NA	NA
DEPTH TO AQUIFER AND THICKNESS IN FEET	938, 237' PHS 810,'250' BR3	About 609 - 865 (est. from ZS-1 information)
AQUIFER BOUNDARY TYPE AND LOCATION	Ojo Caliente Monocline may be a barrier to flow to the Southwest, recharge in the Zuni Mts. (Zuni Uplift)	Ojo Caliente Monocline may be a barrier to flow to the Southwest, recharge in the Zuni Mts. (Zuni Uplift)
SIMULATION TIME	NA/ delineation of recharge areas and area close to well	NA/ delineation of recharge areas and area close to well
CAPTURE ZONE TIME	well is properly constructed, grouted, proper well pad, well house and fence around well to prevent contamination flowing from the surface	well is properly constructed, grouted, proper well pad, well house and fence around well to prevent contamination flowing from the surface

CONFINING UNIT K	Chinle contains interbeds of siltstone and mudstone, K of each bed ranges, approximate K = about	
CONFINING UNIT THICKNESS	Both alluvium and Chinle (interbedded siltstones and sandstones) are overlying to an approximate depth of 800 - 900 feet below land surface	
PUMPING WELL locations	BR PHS 10.19.13.444 BR 3 10.19.24.122b	New Well 1 and New Well 2: 8.19.29
WELL DISCHARGE RATE, FT**3/day, WELL RADIUS	PHS 150gpm = 28,875 BR3 50 gpm = 9625	up to 1000gpm for each well
STATIC WATER LEVEL IN FEET BELOW LAND SURFACE	PHS 279 BR3 168.3	est. 489

REFERENCES

Crouch, Thomas M. 1991. Evaluation of the Bidahochi and San Andres - Glorieta Aquifers on Parts of the Zuni Indian Reservation, McKinley and Cibola Counties, New Mexico: U.S. Geological Survey WRIR 89-4192. 48 pages.

Crouch, Thomas M. 1993. Personal Communication. U. S. Geological Survey, New Mexico District Office, Albuquerque, New Mexico.

Edaakie, Strallie. 1993. Personal Communication. Zuni Water Utilities Administrator. Zuni Village at Zuni Pueblo, New Mexico.

Freeze, R.A., and Cherry, J.A. 1989. Groundwater: Englewood Cliffs, N.J., Prentiss-Hall. 604 pages.

Lohman, S.W. 1972, Ground-water Hydraulics: U.S. Geological Survey Professional Paper 708. 70 pages.

Molzin-Corbin & Associates. 1991. Pueblo of Zuni, New Mexico, Water System Evaluation Project, Phase I: Consultant's Report to the Pueblo of Zuni.

Orr, Brennan. 1987. Water Resources of the Zuni Tribal Lands, McKinley and Cibola Counties, New Mexico: U. S. Geological Survey WSP 2227, prepared in cooperation with the Pueblo of Zuni, 76 pages, 2 plates.

Salote, Gerald. 1993. Personal Communication. Indian Health Service, Public Health Service Hospital Environmental Unit, Black Rock at Zuni Pueblo, New Mexico.

U. S. Environmental Protection Agency, 1987, Guidelines for Delineation of Wellhead Protection Areas: U.S. EPA Office of Ground Water Protection, EPA 440/6-87-010.

U.S. Environmental Protection Agency. 1991. WHPA 2.0, A Modular Semi-Analytical Model for the Delineation of Wellhead Protection Areas: Contractor's Model/Report for EPA Office of Ground Water Protection.

THE GREAT SEAL OF THE HOOPA VALLEY TRIBE

Wellhead Protection Project Summary

Hoopa Valley Tribal Council

PLANNING DEPARTMENT

P.O. Box 1348

Hoopa, CA 95546

HOOPA VALLEY INDIAN RESERVATION

WELLHEAD PROTECTION PROJECT

SUMMARY

The Reservation Setting

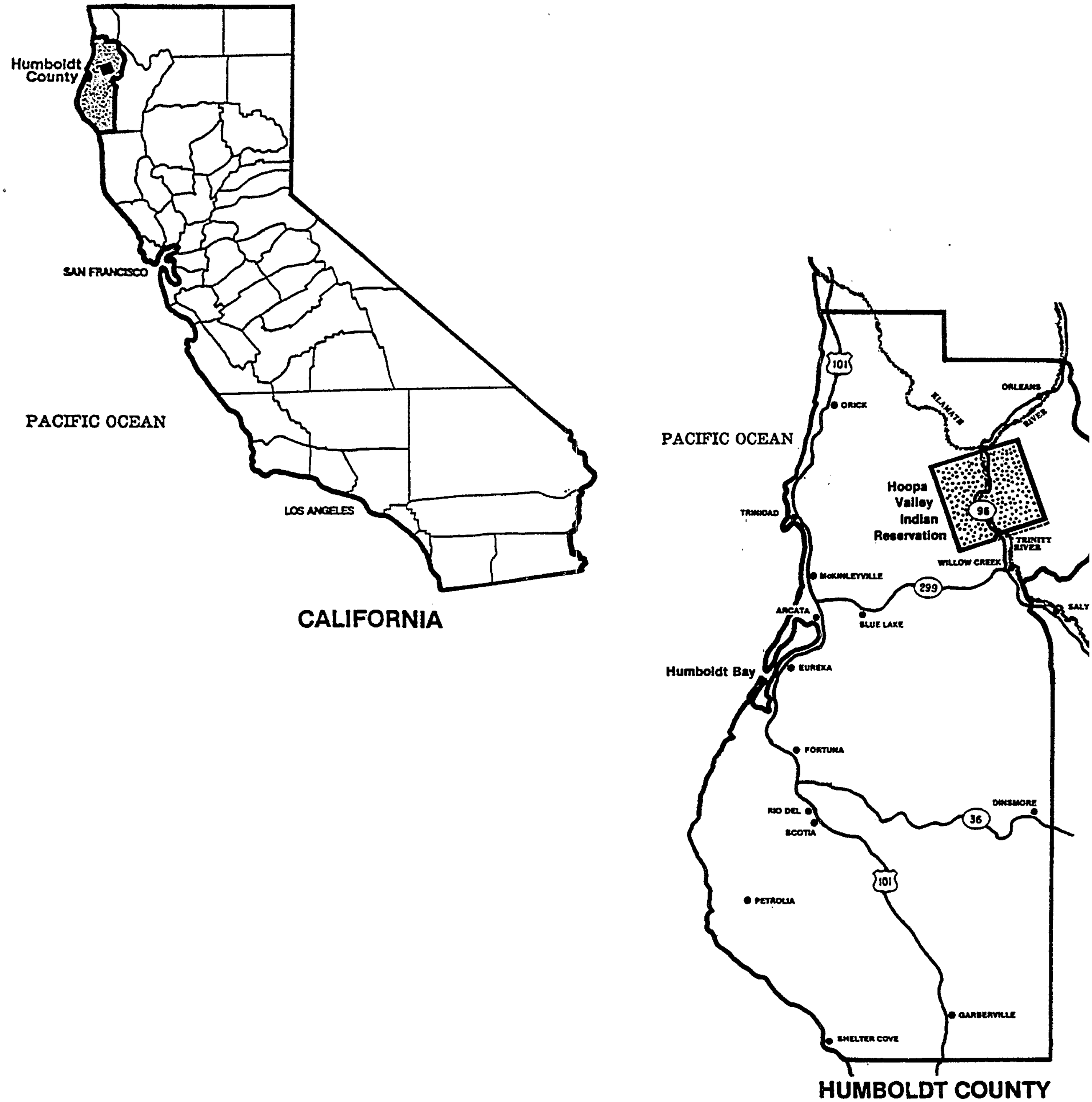
The Hoopa Valley Indian Reservation is located in the rural northeastern portion of Humboldt County, California (see Figure 1 for a location map). The Reservation is square shaped with sides measuring approximately 12 miles in length. The Hoopa Valley lies near the center of the Reservation and is bisected by the Trinity River which flows into Klamath River near the reservation's northern boundary. It is believed that the valley was virtually carved from the Klamath Mountains by the Trinity River over geologic time. Outside of the valley itself, the reservation terrain is best described as mountainous, rugged, and heavily forested. This beautiful valley and surrounding areas has been the home of the Hupa People since time immemorial.

The Hoopa Valley Tribal Council, the official governing body of the Hoopa Valley Tribe, was first formally organized under a constitution and bylaws on November 30, 1930. The Tribal Council, like any emerging government, has evolved into a state of sophistication. Expanding from a staff of one in 1967, the Hoopa Tribal Government is now the third largest government in Humboldt County. Currently tribal operations employ over 250 people in some 30 departments/entities. The Tribal Council consistently seeks ways to better serve its constituency and the community at large.

The reservation population, according to the Census 1990, is 2,199. While the Reservation encompasses over 90,000 acres, the population is concentrated within the approximately 3,500 acre valley floor. Today, as in historic times, the majority of the populated areas are situated along the Trinity River on a series of broad terrace deposits. There are six major tributary streams within the Reservation. The terrace deposits which form the valley floor are isolated by either streams flowing into the river or bedrock, resulting in nine separate fields. Based on limited geological information, the fields are believed hydraulically independent of each other.

Water is supplied to the reservation population by the Hoopa Valley Public Utilities District (PUD) distribution system, private surface water systems, and private wells. Currently, the PUD supplies water to the various fields through a single water system. This single distribution system has recently been formed by connecting two formerly separate systems on the east and west sides of the Trinity River. Primary sources of water for the PUD system are small diversions on several major tributary streams and three municipal wells in three separate fields. There are an unknown number of private surface water systems on minor streams within the Reservation and over 120 known private wells within the valley floor area.

FIGURE 1 - LOCATION MAP



Resource Management

The Hoopa Valley Tribe is one of the original ten tribes selected for participation in the Federal Self-Governance Demonstration Project. This opportunity was viewed as a vehicle for the Tribe assume greater responsibility for the management of it's natural and cultural resources. Continued participation in the project has allowed the Tribal Council to determine internal priorities, redesign certain programs previously operated by the Bureau of Indian Affairs, and reallocate resources to more effectively meet the needs of our unique community. It is felt that participation in the Self-Governance Project has served to strengthen the Tribal commitment to the full assumption and re-establishment of sovereign authority in governing all aspects of reservation resource management. Additionally, the benefit of informed and prudent judgement in matters of resource management and protection being best made at the local level has been demonstrated.

The self-governance policy of Tribal administration of resource management as a sovereign state coincides with the EPA policy of promoting self-determination in Tribal management of environmental issues on Indian lands. The Hoopa Tribe has had the pleasure establishing a positive working relationship with EPA Region IX staff and becoming actively involved in managing the reservation's water resources through receiving EPA recognition for Treatment as a State and grant funding for the purposes of Section 106 of the Clean Water Act. Initially, the Tribal Council found this funding opportunity timely and extremely appropriate. The 106 grant program has since proven very helpful in assisting the Tribe in their goal of providing wise stewardship of land and resources. It has also served to assist in understanding and working with multi-jurisdictional issues concerning the Trinity and Klamath River basins. Program funding has provided a mechanism to pursue the collection of baseline data necessary for prudent basin planning. The dual focus of the program has been the assessment and protection of reservation waters.

Responsibility for management of water resources on the Hoopa Valley Reservation is principally vested with the Hoopa Valley Tribal Council. Acting under their direction, the Tribal Planning Department is responsible for overall planning related to maintenance of clean water supply, proper disposal of hazardous wastes and sewage, and protection of the Trinity River within the Hoopa Valley. The Hoopa Valley Public Utilities District (PUD) distributes water for both domestic use and irrigation. The Tribal Fisheries Department is concerned with the quantity and quality of water in the Trinity River, its tributaries that originate within or flow through the Reservation and the suitability of that water for the fish species of cultural and commercial interest to the Tribe. The Tribal Forestry Department provides management oversight for silvicultural activities which have the potential to impact water quality.

Preliminary Wellhead Protection Activities

Initial steps to develop a Wellhead Protection (WHP) program were included in the Tribe's Section 106 program work plans in FY 91 and FY 92. An operational goal of the FY 91 Section 106 project was to establish preliminary wellhead protection areas for the entire recharge areas associated with the three public water system supply wells. The direct field approach was used to establish the areas, incorporating no-flow constant head boundaries, stream terrace bedrock boundaries, and topographic divides as ground water divides. The preliminary wellhead protection areas were clearly based on limited information which provided, at best, an overview of the geologic structure, aquifers, and ground water resources. Continued work in FY 92 provided a general sense of ground water movement in the three fields containing municipal wells, somewhat more detailed ground water modeling for one field, and very detailed information including aquifer constraints, ground water surface movement, and chemical characteristics in one field.

General activities and sources within the Reservation with the potential for contamination were listed, based on federal guidelines (General sources of ground water contamination modified from EPA Wellhead Protection Programs: Tools for Local Governments; U.S. EPA, 1989c). Within these categories, known and suspected contamination point sources potentially impacting wellhead protection areas were listed. That inventory provided an overview of past and future contamination potential, and the basic information for prioritization of sites, and design of a continuing control program.

Decreasing funding levels and increasing work loads prevented wellhead protection activities from being included in the Section 106 program FY 93 work plan. Without the aid of additional funding, WHP would have remained in the initial stage of development. Fortunately, the Hoopa Valley Tribe's application for a Wellhead Protection Project grant was selected for the award of additional FY 93 funds for groundwater activities.

Wellhead Protection Project Goals and Objectives

With the area and resource to be considered in the project, a choice had to be made on activities which could realistically be accomplished. The choice was to complete limited activities over a broad area with a concentrated focus on a small area of particular concern. The project goals and objectives were developed accordingly. The first and foremost goal of the project was to further the development of elements which contribute to a complete Wellhead Protection Program for the Hoopa Valley Indian Reservation. The project objectives are listed below.

1. Demonstrate utilization of a local resource priority system in the decision making process by affording characterization of and focused management on high priority areas currently contributing to the public drinking water supply.

2. Expand management capability by providing the mechanism for coordinating the functions of all Tribal entities which are responsible for protection of ground water resources.

3. Provide the regulatory structure for protection of ground waters that supply wells which contribute water to the local domestic distribution system through ordinance development.

4. Reduce the risk to human health by establishing the base level requirements for management of potential contamination sources.

5. Document the Tribe's undertakings, progress, and problems encountered in sufficient detail so that this project might serve as a model for other reservations or rural communities with characteristics similar to the Hoopa Valley Indian Reservation and/or the Hoopa Valley Tribe.

6. Encourage public participation and support for WHP by providing information and education on improving management practices and limiting activities which might contribute to sources of ground water contamination.

Project Approach and Activities

Initially, the project concept called for hiring a consultant to complete much of the proposed work. Upon further discussion with EPA Region IX staff, it was determined that it would be more beneficial to the Tribe to hire a full time employee for the one year project duration. A Tribal member, concurrently enrolled as a part time student in the Engineering program at Humboldt State University was hired as the project coordinator. This young man, who is actively involved in cultural and religious ceremonies, brought a culturally sensitive perspective project. Specific tasks assigned to the project coordinator included:

- classification of groundwater resources
- comprehensive mapping of contamination sources
- delineation of WHP areas for all municipal wells
- development of a WHP ordinance
- public outreach/education
- documentation

A resource team consisting of members from the Tribal PUD, Fisheries, Forestry, and Planning departments was established. The intent of the resource team approach was to fully utilize all available/applicable Tribal expertise. Responsibilities of the resource team included the following:

- provide technical guidance to the project coordinator
- identify existing studies beneficial to the project

- decide goals for classification
- decide goals for delineation
- define/clarify interaction of Tribal agencies
- provide recommendations for ordinance development
- define/develop ordinance enforcement responsibilities
- determine need for additional management techniques

Tribal Forestry's GIS Technician was also slated for membership on the resource team. All GIS data capture and mapping functions were scheduled to be completed in-house. A staff turnover within the Forestry Department near the start of the project prevented the in-house completion of much of the scheduled GIS work. A consulting firm specializing in GIS services was located in Eureka, CA; approximately 60 miles away. A contract with Geographic Resource Solutions was initiated for completion of the planned GIS data capture and mapping.

A "Watershed Approach" was adopted early on in the project. Surface water diversions contributing to the public water supply as well as the interconnection between reservation's surface and ground waters indicated the need to classify waters and delineate protection areas throughout the entire watershed.

Project Outputs and Benefits

The Hoopa Valley Tribe's Wellhead Protection Project was designed to serve as an intermediate step toward, as well as an integral part of, a comprehensive local ground water protection strategy. While we are fully aware that this project falls short of a comprehensive Wellhead Protection Program, we feel that we have been successful in achieving the intermediate step which provides the basis for future development and expansion of wellhead protection activities. Specific project outputs and associated benefits are the following:

1. Valley Wide Classification of Water Resources:

   In accordance with EPA's ground water protection strategy, a differential protection policy was adopted with the recognition that different ground waters merit different levels of protection. The classification categories were identified as: Class I - Special ground waters; Class II - Current or potential sources of drinking water; and Class III - Ground water not considered potential sources of drinking water. This classification was expected to establish a common goal for preventive and remedial ground water protection activities. Given the large number of known wells and the area's geologic characteristics, all ground waters were classified as Class II, current or potential sources of drinking water.

In line with a watershed approach, all reservation streams were classified with the assistance of the Tribe's Hydrologist. Three stream classification categories were utilized: Class I Streams - domestic water supplies, known drinking water sources; Class II Streams - known irrigation and potential drinking water supplies; and Class III Streams - seasonal runs and streams not used for domestic purposes. A GIS layer for the entire watershed was completed using this classification system. While not reduced for inclusion in this summary, a hard copy of the mapping could be made available if requested. This mapping and classification system is currently being used to identify drinking water sources located within forest management planning areas. Benefits are currently being realized in the form of identification and provisions protection of drinking water sources within the Tribe's 1995 Timber Sale Planning Area.

2. Location and Mapping of Wells and Septic Tanks:

A door-to-door survey was conducted to identify and locate existing water wells and septic tanks within the valley. The number of single family dwellings on the Reservation exceeds 840. Each housing unit was visited and the owner/occupant contacted to identify the location of septic tanks and water wells. Copies of all well drilling reports on file were obtained to aid in the mapping of comprehensive well data. Separate GIS layers for wells and septic tanks were completed. Transparencies of those layers are provided in the back cover pocket of this report.

This output has several associated benefits. Septic tanks and/or areas containing concentrations of septic tanks viewed in relation to active drinking water wells presents a fairly clear picture of contamination potential and serves as an indicator of potential health hazards. Several community residents have contacted Tribal environmental staff for information regarding individual wells. The information can and will be utilized as a planning tool for siting housing development projects, septic tank placement, or designing alternative sewage treatment/disposal facilities. In recent months, the Tribal Health Clinic has treated numerous cases of hepatitis. Current plans are to conduct an analysis of the hepatitis cases with regard to patient usage of drinking water wells located in areas also containing septic tanks.

3. Mapping of Soil Types, Hazardous Waste Sites, and the 100-Year Floodplain:

Soil types and boundaries, as identified in a soil survey conducted by U. C. Davis in 1976, were used to complete a GIS layer. This information will be utilized for land-use planning purposes. Certain soil characteristics typically indicate best or desired uses for certain parcels within the valley as well as the likelihood of septic tank failure.

Several hazardous waste sites and areas of potential contamination within the valley have been documented. The majority of these sites are the results of milling and mining operations which were conducted in years past. A detailed inventory of such sites, completed under the Tribe's Clean Water Act Section 106 program, has been used to complete a GIS layer. This coverage, when viewed in conjunction with existing wells reveals that active wells are physically located within or near known sources of contamination. This mapping will provide a current inventory and as such a valuable tool for informed WHP decision-making and future development of contingency plans.

The 100-year floodplain as delineated by the Corp of Engineers was used to complete a GIS layer. This coverage provides information beneficial to land-use planning, housing development, and installation of new septic tanks.

Transparencies of these three GIS layers are provided in the back cover pocket of this report. Although the scale and detail of the mapping provided herein is greatly reduced, they will provide a good overview of GIS capabilities and uses.

4. Delineation of WHP Areas For All Municipal Wells:

   Utilizing information gained from the field investigation, the preliminary WHP areas developed under the Section 106 program were refined and transferred to the GIS database. This mapping might be viewed separately or overlain with the contamination source mapping. This element constitutes an integral part of WHP.

5. WHP Ordinance Development:

   A Tribal Wellhead Protection Ordinance was drafted through the joint efforts of the project coordinator and the management team. The draft ordinance was presented to the Tribal Council on 10/16/94 and routed through the Tribe's Legislative Procedures Act (LPA). The LPA allows for review by all Tribal departments/entities, legal review by the Tribal Attorney, and public comment. A public hearing on the proposed Wellhead Protection Ordinance was conducted on 10/6/94. All comments/suggestions received to date have been incorporated into the draft, where appropriate. A copy of the WHP Ordinance, still in draft form, is included as Appendix A. At least one additional public hearing on the revised draft will be conducted prior to formal action by the Tribal Council.

   The Wellhead Protection Ordinance, once formally adopted by the Tribal Council, will provide the regulatory structure for long-range management and protection of wellhead protection areas. The primary purpose of the ordinance is to promote the health, safety, and general welfare of the community by ensuring an adequate quality and quantity of drinking water for the residents, institutions, and businesses of the Hoopa Valley Indian Reservation.

6. Public Outreach/Education:

   Information and education on WHP activities were provided by the project coordinator through several methods. Public Service Announcements and call-in programs were broadcast by the Tribally owned and operated Public Radio Station. Informational fliers were posted on community bulletin boards. Informational brochures were mailed to all reservation residents. A public hearing was conducted to hear community comments and concerns regarding the first draft of the WHP Ordinance.

Public support for the WHP program has been encouraged through an open flow of information. Since public opinion, particularly in our community, can have substantial impacts on the success or failure of any project, education is considered a vital element of WHP implementation.

Appendix A

DRAFT WELLHEAD PROTECTION ORDINANCE

DRAFT

WELLHEAD PROTECTION ORDINANCE

of the
HOOPA VALLEY TRIBE

HOOPA VALLEY INDIAN RESERVATION
HOOPA, CALIFORNIA

TITLE 37
HOOPA VALLEY TRIBAL CODE

ORDINANCE NO.: 3-94

DATE APPROVED:

SUBJECT: WELLHEAD PROTECTION ORDINANCE

WHEREAS: The Hoopa Valley Tribe adopted a Constitution and Bylaws (Tribal Constitution) on June 20, 1972, which was approved by the Commissioner of Indian Affairs on August 18, 1972, and ratified and confirmed by Congress on October 31, 1988 in Section 8 of Public Law 100-580, and amended on June 19, 1990 and, by tribal law, the sovereign authority of the Tribe over the matter described herein is delegated to the Hoopa Valley Tribal Council, acting by law; and

WHEREAS: The Tribal Council has concluded that it is necessary to exercise tribal authority over wellhead protection within the exterior boundaries of the Hoopa Valley Indian Reservation, and over other activities in order to protect fundamental tribal ceremonial, property interests, water quality, and the public health and safety; and

WHEREAS: Pursuant to the review process set forth in the Legislative Procedures Act Section 6.3, the Council concludes that it is now appropriate to enact said Ordinance on a permanent basis, following public hearing, and as revised in light of departmental comments and legal review developed during the review process.

THEREFORE BE IT NOW ORDAINED THAT: Pursuant to Section 6.3 of the Legislative Procedures Act, and the tribal constitutional and legal authorities recited herein, the Tribal Council hereby enacts the attached **Wellhead Protection Ordinance**, in order to protect the fundamental tribal values identified in Section 37.0 thereof and the Tribe's sovereign governmental authority.

DRAFT

BE IT FURTHER ORDAINED THAT: The Tribal Council hereby reaffirms its intent that the provisions of this Ordinance be enforceable against all persons and businesses residing or operating within the exterior boundaries of the Hoopa Valley Indian Reservation and on all land whether trust, fee, or otherwise.

BE IT FURTHER ORDAINED THAT: It shall be the policy of the Tribe and its authorized entities and departments to vigorously enforce the provisions of this Ordinance exclusive of other inconsistent laws.

37.0 SHORT TITLE, FINDINGS, AND PURPOSE

37.0.1 Short Title. This Ordinance shall be known as the **Wellhead Protection Ordinance of the Hoopa Valley Tribe.**

37.0.2 Findings. The Tribal Council hereby finds that wellhead protection is a pro-active approach to managing public groundwater supplies focusing on preventing contaminants from entering recharge areas to public water supply wells. Protecting wellheads involves: knowing the location and boundaries of the recharge area; identifying any potential sources of contamination in the recharge area; controlling those potential sources to prevent the release of contaminants; and, controlling future land use in the recharge area to prevent activities which are known to threaten groundwater quality.

37.0.3 Purpose. The purpose of this Ordinance is:

A. To promote the health, safety, and general welfare of the community by ensuring an adequate quality and quantity of drinking water for the residents, institutions, and businesses of the Hoopa Valley Indian Reservation;

B. To preserve and protect existing and potential sources of drinking water supplies;

C. To conserve the natural resources of the Hoopa Valley; and,

D. To prevent temporary and permanent contamination of the environment.

37.1 SCOPE

The provisions of this Ordinance shall apply to all wellhead protection areas within the exterior boundaries of the Reservation, to all persons and

DRAFT

businesses on the Hoopa Valley Indian Reservation, to all land,trust or fee, and to all activities in areas with the potential to affect water quality, public health and safety, and other fundamental interests of the Tribe.

37.2 DEFINITIONS

37.2.1 **Aquifer** means any geologic formation capable of yielding a significant amount of potentially recoverable water.

37.2.2 **Impervious Barrier** means any material or structure on, above, or below the ground that does not allow precipitation or surface water to penetrate directly into the underlying surface.

37.2.3 **Mining** means any activities designed for the extraction of minerals.

37.2.4 **Recharge Area** means areas that collect precipitation or surface water and carry it to aquifers. Recharge areas may include areas designated as Zone 1.

37.2.5 **Toxic or Hazardous Material** means any substance or mixture of physical, chemical, biological, or radiological characteristics posing a significant threat to water supplies or other hazards to human health if such substance or mixture were discharged to land or water on the Hoopa Valley Indian Reservation. Toxic or hazardous materials include, without limitation, synthetic organic chemicals, petroleum products, heavy metals, radioactive or infectious wastes, acids and alkalis, and all substances defined as toxic or hazardous by the Environmental Protection Agency's federal regulations, and is to also include such products as solvents and thinners in quantities greater than those associated with normal household use.

37.2.6 **Zone 1** means a 100 to 400 foot protective radius around public supply wells. The size of the protective radius depends on the approved yield of the well. The Tribe will use EPA-approved standard zoning radii of 100 ft. for 1,000 gallons per day (gpd); 200 ft. for 5,000 gpd; 300 ft. for 20,000 gpd; 400 ft. for wells pumping 100,000 gpd or more.

37.3 ESTABLISHMENT AND DELINEATION OF WELLHEAD PROTECTION AREAS

For the purpose of this Ordinance, there are hereby established within the exterior boundaries of the Hoopa Valley Indian Reservation certain groundwater protection areas, consisting of aquifers and/ or recharge areas which are delineated on a map. This map is at a scale of 1 inch to 1,000 ft. and is entitled "Wellhead Protection Overlays" created in 1994. This map is hereby made a part of the Hoopa Valley Wellhead Protection Ordinance (bylaw) and is on file at the Hoopa Valley Planning Department and at the

DRAFT

U.S. E.P.A. Region IX Office.

37.4 WELLHEAD PROTECTION BOUNDARY DISPUTES

If the location of the Wellhead Protection Zone 1 in relation to a particular parcel is in doubt, resolution of boundary disputes shall be through the Hoopa Valley Realty Department in conjunction with the Hoopa Valley Planning Department.

Disputants shall be afforded notice and an opportunity to be heard after prima facie showing by the Tribe as to the prohibited activities occurring in the Wellhead Protection Zone 1, the burden of proof shall be upon the owner(s) of the land in question to show where the boundary should properly be located. At the request of the owner(s), the Hoopa Valley Tribe may engage a professional engineer (civil or sanitary), hydrologist, geologist, or surveyor to determine more accurately the boundaries of the Zone 1 with respect to individual parcels of land, and may charge the owner(s) for all or part of the cost of the investigation.

37.5 USE REGULATIONS

In the Wellhead Protection Zone 1 the following regulations shall apply:

37.5.1 Permitted Uses. The following uses are allowed within the Zone 1, provided that all necessary special permits, orders, or approvals required by the Hoopa Valley Tribe are obtained:

A. Conservation of soil, water, plants, and wildlife;

B. Outdoor recreation, nature study, boating, fishing, and hunting where otherwise legally allowed;

C. Foot, bicycle and/or horse paths, and bridges;

D. Normal operation and maintenance of existing water bodies and dams. Splash boards, and other water control, supply, and conservation devices;

E. Maintenance, repair, and enlargement of any existing structure, subject to Section B (prohibited uses) and Section C (special permitted uses);

F. Residential development, subject to Section B (prohibited uses) and Section C (special permitted uses);

G. Farming, gardening, nursery, conservation, forestry, harvesting, and grazing, subject to Section B (prohibited uses) and Section C (special

DRAFT

permitted uses);

H. Construction, maintenance, repair, and enlargement of drinking water supply related facilities such as, but not limited to, wells, pipelines, aqueducts, and tunnels.

37.5.2 Prohibited Uses. The following uses are prohibited within a Zone 1:

A. Landfills and open dumps;

B. Storage of liquid petroleum products, except the following:

i. Normal household use, outdoor maintenance, and heating of a structure, such items are propane tanks for heating, gas cans for lawn or yard equipment, automobile maintenance products, small quantities of paint and thinner, and other such similar items;

C. Landfilling of sludge or septic system waste;

D. Storage of chemicals unless such storage, including loading areas, is within a structure designated to fully contain any accidental spills;

E. Storage of animal manure unless covered or contained in accordance with tribal regulations, as may be from time to time adopted, or, in the absence of tribal regulations, the specifications of the United States Soil Conservation Service, found in volume 7 of the Code of Federal Regulation;

F. Automobile graveyards and junkyards;

G. Installation of new private or public cess pools or septic tanks. However, the following activities are allowed:

i. The replacement or repair of an existing treatment works that will not result in a design capacity greater than the design capacity of the existing treatment works;

ii. The replacement of existing subsurface sewage disposal system(s) with wastewater treatment works that will not result in a design capacity greater than the design capacity of the existing system(s);

H. Industrial and commercial uses which discharge processed wastewater directly to septic tanks;

I. Storage of commercial fertilizers, as defined in the Hoopa Valley Tribal

DRAFT

Code, unless such storage is within a structure designed to fully contain any accidental spills;

J. The use of septic system cleaners which contain toxic or hazardous chemicals, as defined by EPA guidelines;

K. The application of pesticides, including herbicides, insecticides, fertilizers fungicides, and rodenticides, for non-domestic or non-agricultural uses in accordance with Tribal Forest Managements Plans, as may, from time to time, be adopted.

37.5.3 Uses and Activities Requiring a Special Permit. The following uses and activities are permitted only upon the issuance of a special permit by the departments which comprise the Hoopa Valley Special Permit Granting Authority:

A. Enlargement or alteration of existing uses that do not conform to the Wellhead Protection Ordinance;

B. The application of fertilizers for non-domestic or non-agricultural uses. Such applications shall be made in a manner so as to minimize adverse impacts on groundwater, to the satisfaction of the Special Permit Granting Authority, due to nutrient transport, deposition, and sedimentation;

C. Those activities that involve the handling of toxic or hazardous materials in quantities greater than those associated with normal household use, permitted in the Zone 1 (except as prohibited under Section B) such activities shall require a special permit to prevent contamination of groundwater;

D. The construction of dams or other water control devices, ponds, pools or other changes in waterbodies or courses, created for swimming, fishing, or other recreational uses, agricultural uses, or drainage improvements. Such activities shall not adversely affect water quality or quantity.

37.6 PROCEDURES FOR ISSUANCE OF SPECIAL PERMITS

A. The Special Permit Granting Authority (SPGA) under this Ordinance shall be the Hoopa Valley Planning Department or other department so delegated by the Tribal Council. Such special permits shall be granted if the SPGA determines, in conjunction with the Hoopa Valley Fisheries Department, Public Utilities District, and the Water Quality Department, that the intent of this Ordinance, as well as its specific criteria, are met. The SPGA shall not grant a special permit under this section unless the petitioner's application materials include, sufficiently detailed, information

DRAFT

to support positive findings in relation to the standards given in this section.

B. One copy of the application shall be furnished by the applicant for each department comprising SPGA. Upon receipt of the appropriate number of copies of the special permit application, the SPGA shall transmit one copy each to the Water Quality Department, the Public Utilities District, and the Hoopa Valley Tribal Fisheries Department, for their written recommendations. Failure by any agency to respond in writing within 35 calendar days of receipt from the SPGA shall indicate approval and no desire to comment by said agency.

C. The SPGA may grant the required special permit only upon finding that the proposed use meets the following standards, those specified in Section 6 of this Ordinance, and any regulations or guidelines adopted by the Tribal Council. The proposal must:

1. In no way, during construction or thereafter, adversely affect the existing or potential quality of water that is available in the Wellhead Protection Zone 1, and

2. Be designed to avoid substantial disturbance of the soils, topography, drainage, vegetation, and other water-related natural characteristics of the site to be developed.

D. The SPGA may adopt regulations to govern design features of projects.

E. The applicant shall file a sufficient number of copies of a site plan and attachments with the SPGA. The site plan shall be drawn at a proper scale as determined by the SPGA and be stamped by a professional engineer. All additional submittals shall be prepared by qualified professionals. The site plan and its attachments shall at a minimum include the following information where pertinent:

1. A complete list of chemicals, pesticides, herbicides, fertilizers, fuels, and other potentially hazardous materials to be used or stored on the premises in quantities greater than those associated with normal household use;

2. For those activities using or storing such hazardous materials, a hazardous materials management plan shall be prepared and filed with the hazardous materials coordinator of the Hoopa Volunteer Fire Department, fire chief of the Hoopa Volunteer Fire Department, member departments of the SPGA, and the Hoopa Valley Planning/Water Quality Department. The plan shall include:

DRAF

a. Provisions to protect against the discharge of hazardous materials or wastes to the environment due to spillage, accidental damage, corrosion, leakage, or vandalism, including spill containment and clean up procedures;

b. Provisions for indoor, secured storage of hazardous materials and wastes with impervious floor surfaces.

3. Proposed down-gradient location(s) for groundwater monitoring well(s), should the SPGA deem the activity a potential groundwater threat.

F. No special permit shall issue except after public comment.

37.7 ENFORCEMENT

Written notice of any violations of this Wellhead Protection Ordinance shall be served by the Hoopa Valley Planning Department or department so designated by the Tribal Council on the responsible person after detection of a violation. Notice to the assessed owner and/or operator of the property shall be deemed notice to the responsible person. Such notice shall specify the requirement or restriction violated and the nature of the violation, and may also identify the actions necessary to remove or remedy the violations, preventive measures required for avoiding future violations, and a schedule of compliance. A copy of such notice shall be submitted to the Hoopa Tribal Planning/Water Quality Department, Hoopa Tribal Fisheries Department, and also to the Public Utilities District. The cost of containment, clean-up, or other action of compliance shall be borne by the owner and/ or operator of the premises. For situations that require remedial action to prevent adverse impact to the water resources within the Hoopa Valley Indian Reservation, the Hoopa Tribal Planning Department may order the owner and/ or operator of the premises to remedy the violation. If said owner and/or operator does not comply with said order, the Hoopa Valley Planning Department, in conjunction with Tribal Police will be authorized to enter upon such premises under the terms of the special permit or otherwise, may act to remedy the violation. The remediation cost shall be the responsibility of the owner and/or operator of the premises.

37.8 AUTHORITY TO ENTER AND INSPECT PREMISES AND RECORDS

37.8.1 In order to carry out the purposes of this Ordinance, any duly authorized representative of the Tribe has the authority to enter and inspect any property, premises, or facility involved in any wellhead protection or violation of this Ordinance on any lands within the exterior boundaries of the Reservation. Such inspection may include:

A. Obtaining samples of soil, rock, vegetation, air, water, or other substances

DRAFT

deemed necessary;

B. Setting up and maintaining monitoring equipment for the purpose of assessing compliance with applicable regulations, or health or safety hazards.

C. Photographing any equipment, sample, activity, or environmental condition.

37.9 SEVERABILITY

If any provision of this Ordinance or its application to any person or circumstance is held invalid, the remainder of the Ordinance or application of its provisions to other persons or circumstances shall not be affected, and to this end, the provisions of this Ordinance are severable.

37.10 SOVEREIGN IMMUNITY PRESERVED

Nothing in this Ordinance shall be interpreted as a waiver of the Tribe's sovereign immunity from unconsented lawsuit, or as authorization for a claim for monetary damages from the Tribe.

CERTIFICATION

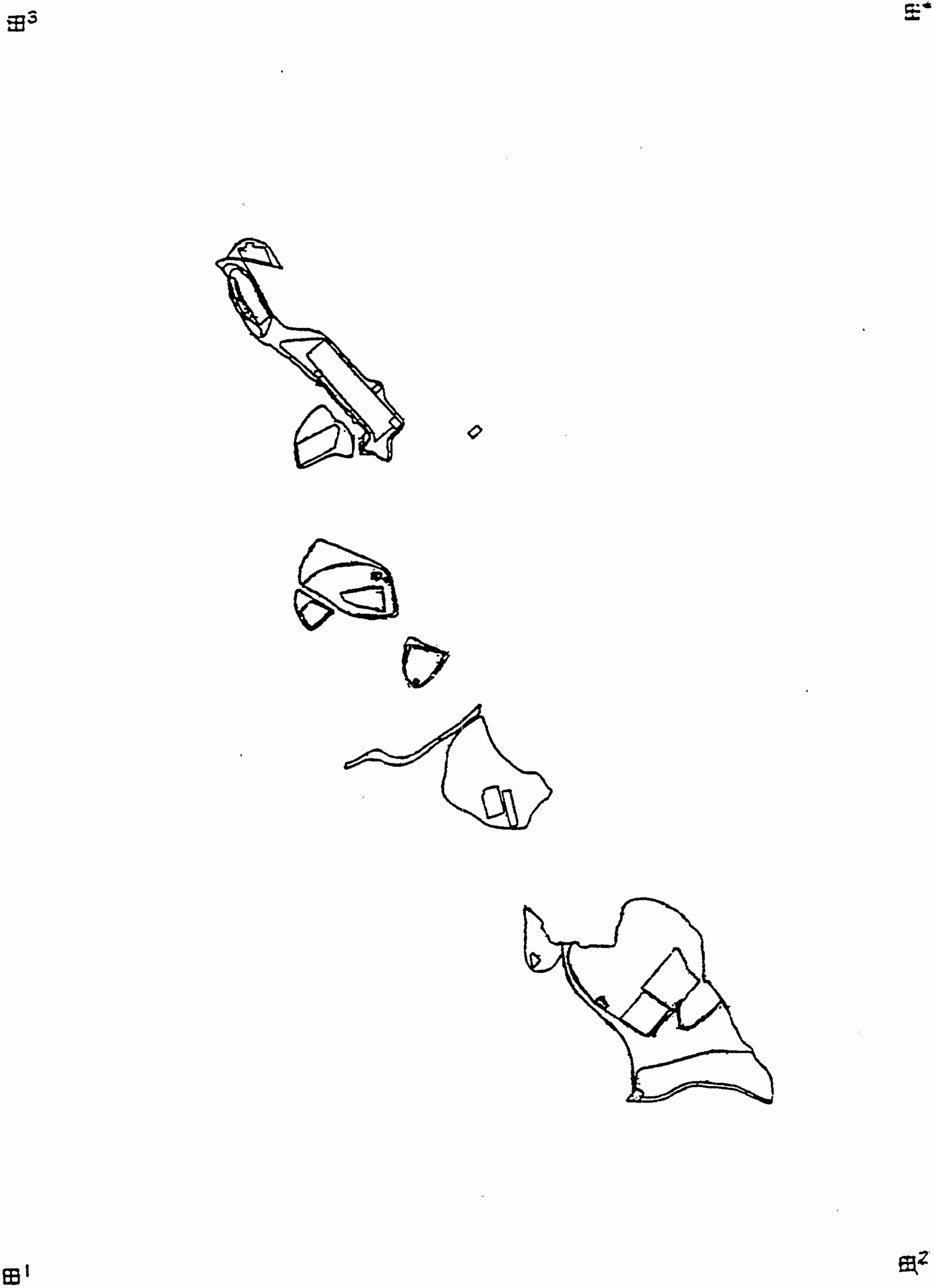
I, the undersigned, as Chairman of the Hoopa Valley Tribal Council, do hereby certify: that the Hoopa Valley Tribal Council is composed of eight (8) members of which _____ (_) were present, constituting a quorum, at a Regular Meeting thereof, duly and regularly called, noticed, convened, and held on this _________ (__th) day of _________, 1995; that this Ordinance was duly adopted by a vote of _____ (_) in favor, _____ (_) opposed, and _____ (_) abstaining; and that since its approval this Ordinance has not been rescinded, amended, or modified in any way.

DATED THIS __TH DAY OF ___________, 1995.

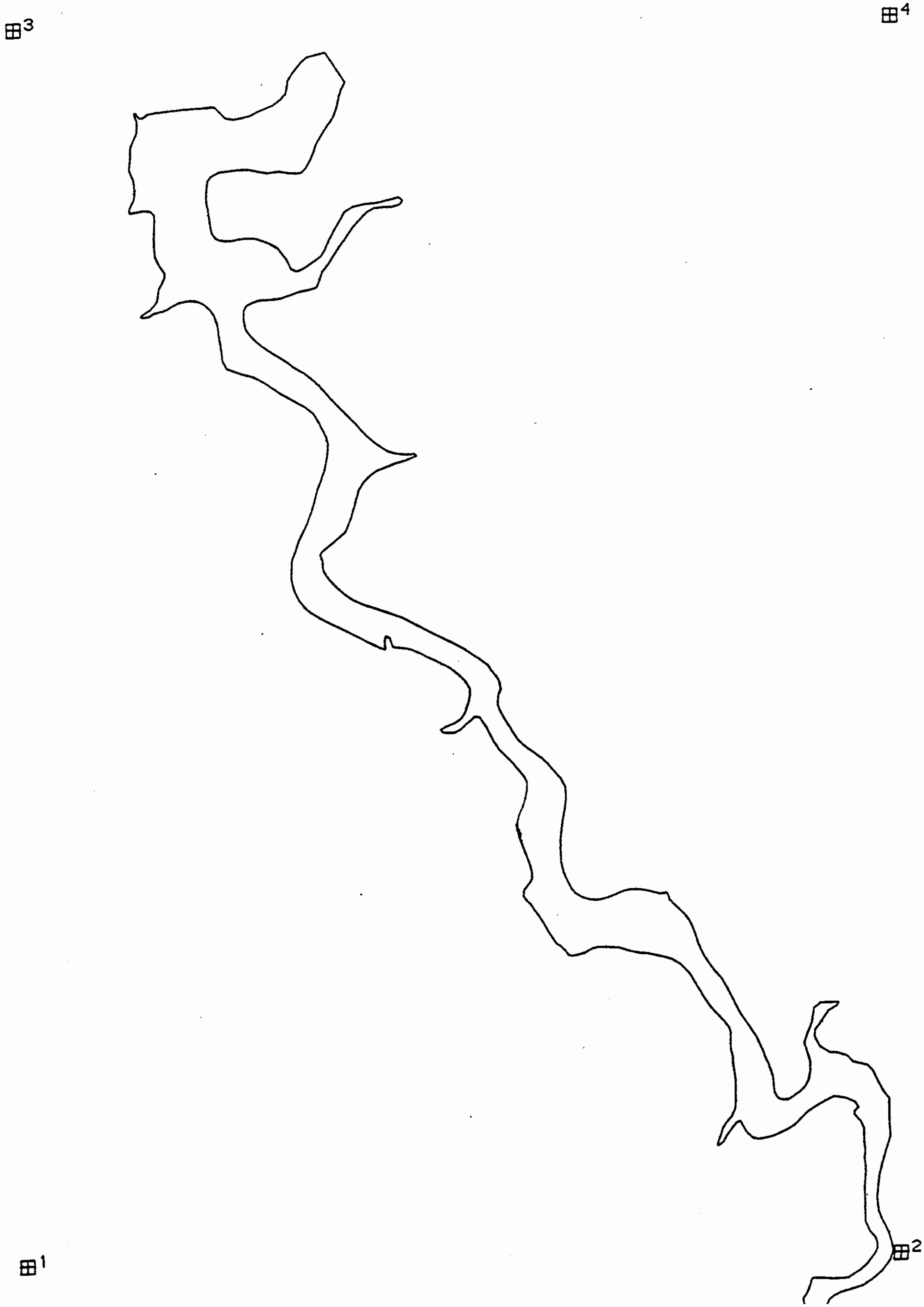
____
DALE RISLING, SR., CHAIRMAN
HOOPA VALLEY TRIBAL COUNCIL

ATTEST: ____________________________
MARLA McLEOD
EXECUTIVE SECRETARY

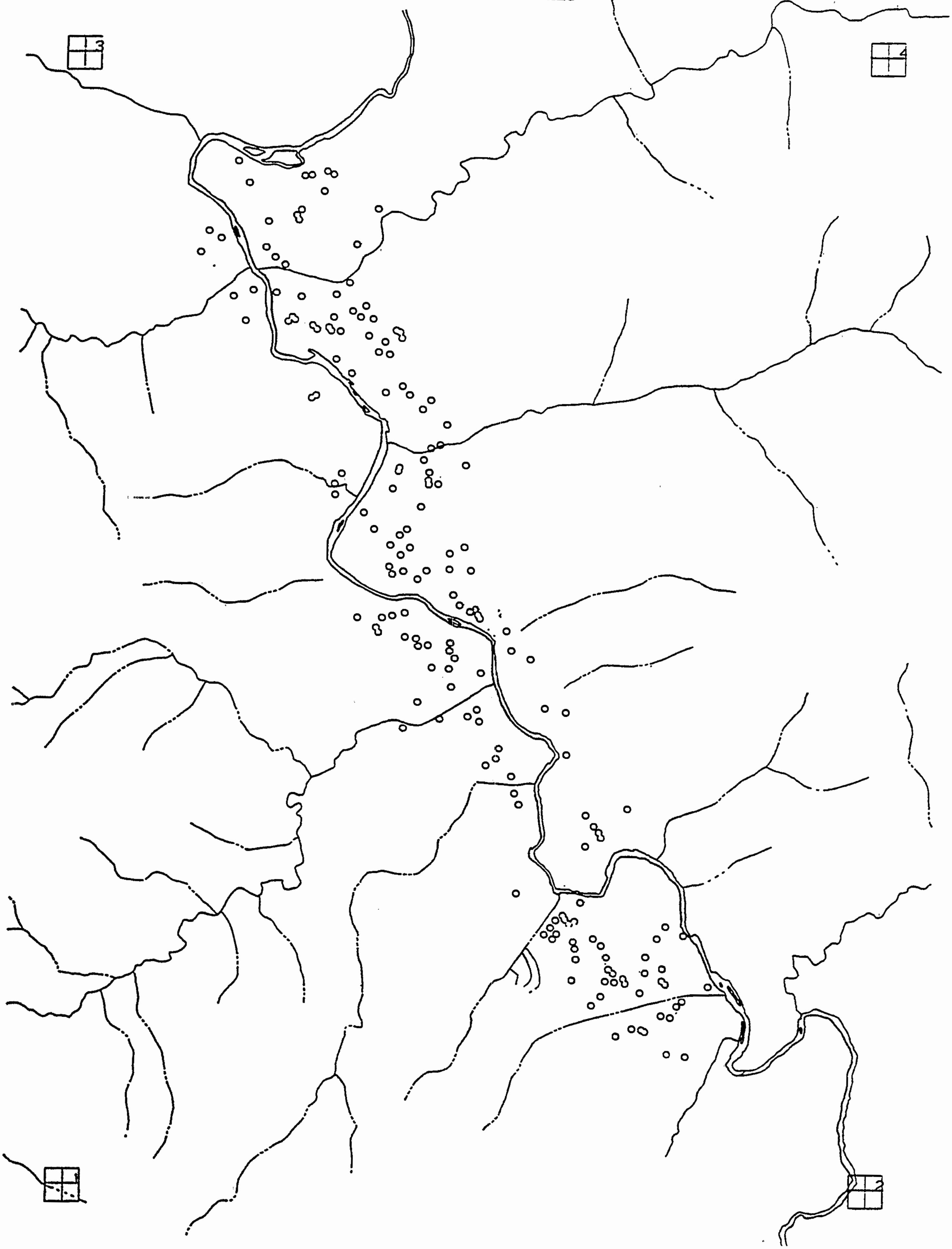
HAZARDOUS WASTE SITES



100 YEAR FLOODPLAIN

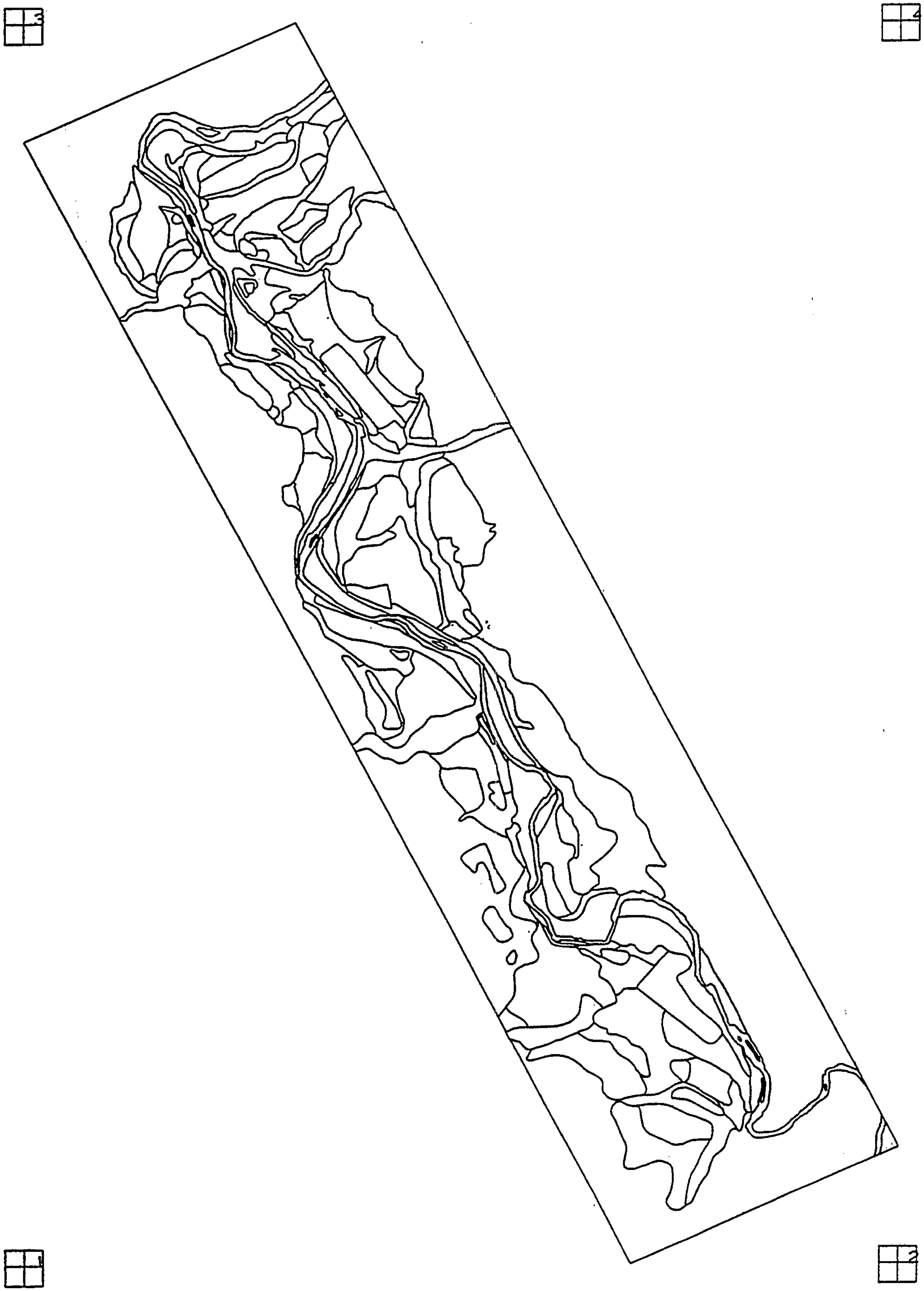


STREAMS AND WELLS



SEPTIC TANKS

SOIL TYPE BOUNDARIES



WELLHEAD PROTECTION AREA PROJECT
FOR THE TULALIP TRIBES
MARYSVILLE, WASHINGTON

Prepared for:

Tulalip Tribes
Environmental Program
7615 Totem Beach Road
Marysville, WA 98271

Prepared by:

Science Applications International Corporation
606 Columbia Street N.W., Suite 300
Olympia, WA 98501

Contract No GCB - 330
SAIC Project No. 01-1099-05-3210

June 1994

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF CONTENTS (cont'd)

Page

LIST OF FIGURES

1.0 INTRODUCTION

The U.S. Environmental Protection Agency's (EPA's) Wellhead Protection Program was legislated under the 1986 amendments to the Safe Drinking Water Act (SDWA). The program requires public water supply purveyors in partnership with local jurisdictions, water users, and interested parties to develop a program to protect current and future underground drinking water supplies. The program requires delineation of land surface areas that contribute recharge to public supply wells. These are called zones of contribution. The program also requires regulation of the land uses within those zones to eliminate or reduce the potential for contaminant sources to adversely affect local groundwater quality.

The Wellhead Protection Program establishes a partnership among federal, state or tribal, and local jurisdictions. In Washington State, five major components comprise the WHP program including the following elements:

- Delineate the wellhead protection area for each well or wellfield;
- Identify and locate potential sources of groundwater contamination within the wellhead protection area;
- Reduce the likelihood that potential contaminant sources will pollute the drinking water supply by preparation of a management plan;
- Provide a contingency plan for the provision of alternate sources of drinking water in the event that contamination does occur; and
- Include public participation while the program is developing.

Determination of a wellhead protection area comprises two phases: a technical phase and a policy phase. The first is a hydrogeologic delineation of the zone of contribution for a well or wellfield. (See Glossary for definition of zone of contribution.) The second is a policy statement of the amount of land area within the zone of contribution and surrounding potential recharge area to include in a wellhead protection area. This project delineated the zone of contribution for Wellfield Number 1 to provide the Tulalip Tribes the technical information necessary to establish a wellhead protection area. Specifically, the following tasks were performed for this project:

- Delineation of a zone of contribution for a four-well field (Wellfield Number 1) in the Tulalip Creek Basin;

- Identification of potential pollutant sources within the zone of contribution and a broader recharge area;

- Development of mitigative measures or Best Management Practices (BMPs) for the identified sources;

- Evaluation of the impacts of gravel mining operations on groundwater quality and suggested management practices and mitigative measures to reduce the contribution of pollutants from gravel mining operations should such an operation be located within the wellhead protection area; and

- Examination of tools available to estimate nitrogen loading from septic systems in the recharge area.

The delineation of the zone of contribution for the wells included a review of the data obtained from Tulalip Reservation records, a U.S. Geological Society (USGS) Report (Drost, 1983), and a recent USGS study (Thomas, pers. comm.) to obtain the necessary hydrogeologic data. An analytical flow model was utilized to simulate three scenarios, including steady-state (infinite time), 10-year, and 25-year times of travel to the well. (See the Glossary in Appendix C for definition of "time of travel".) The results of the delineations are provided in Section 2.0.

Identification of the potential pollutant sources included a site visit to identify sources within and adjacent to the zones of contribution and a discussion with tribal representatives of potential future land uses within the 25-year time of travel. The information obtained during the source identification is presented in Section 3.0.

Section 4.0 provides a discussion of Best Management Practices (BMPs) and mitigative measures that can assist the Tulalip Tribes in managing the activities within the wellhead protection area.

Section 5.0 of this report describes potential impacts of gravel mining activities on groundwater quality and measures that can be taken to protect groundwater. Currently, tribal representatives are investigating the commercial viability of gravel sources on tribal land. No specific site has been identified, and no business has been named to mine the gravel.

Since septic tanks are a potential source of groundwater pollution and all the residences near the zone of contribution rely on septic systems for domestic waste disposal, methods of estimating their cumulative effect on the aquifer are reviewed in Section 6.0. Nitrogen, a constituent of wastewater from septic tanks, is used as an indicator parameter to assess the impact of multiple septic systems on the aquifer because it provides a conservative estimate of relative degradation of groundwater quality. Nitrogen loading models can be used to establish an optimum septic tank density that minimizes groundwater quality degradation and still meets development interests. Section 6.0 also estimates costs to prepare a nitrogen loading model for a delineated wellhead protection area.

Section 7.0 lists the conclusions and recommendations resulting from the wellhead protection area project for the Tulalip Tribe.

There are three Appendices that supplement the written material in this report. The zones of contribution for maximum and minimum values of a given parameter simulated during the model sensitivity analysis are depicted in Figures A-1 through A-12 located in Appendix A. Appendix B provides the Best Management Practices (BMPs) and mitigative measures for groundwater protection. The BMPs are intended to be removed, reproduced, and distributed as educational tools. A glossary of specialized terms used in the report is found in Appendix C. The lay reader is directed to the Glossary as terms are identified in the text.

2.0 ZONE OF CONTRIBUTION DELINEATION

EPA developed the Wellhead Protection Area model (WHPA model) to assist water purveyors in delineating wellhead protection areas. Section 2.1 describes the two modules within the WHPA model used for delineation of the wellhead protection area for the four wells within Wellfield Number 1 on the Tulalip Reservation. Sections 2.2 through 2.5 describe the input parameters to each of the modules of the WHPA model, the simulation results delineating zones of contribution for Wellfield Number 1, a sensitivity analysis for the various input parameters used, and a summary, respectively.

Wellfield Number 1 is comprised of four water supply wells in close proximity to each other. The delineation of the most realistic zone of contribution would thus be facilitated by using an analytical flow model that can account for interference between the four wells. The WHPA model is an analytical flow model developed by the EPA to be used to assist technical staff with the task of zone of contribution delineation and ultimately development of the wellhead protection area. Implementation of a numerical flow model requires detailed hydrogeologic data, but can provide the ability to model complex hydrogeologic interactions if the added cost is warranted. Since the zones of contribution delineated using the WHPA model did not intercept either fork of the Tulalip Creek, a numerical flow model was not deemed necessary to assess vertical flow components from partially penetrating conditions.

2.1 THE WHPA MODEL

The primary objective of the Wellhead Protection Area model developed by the EPA is to assist technical staff with the task of wellhead protection area delineation. This section describes the assumptions inherent to the WHPA model, the two modules of the WHPA model, Multiple Well Capture Zone (MWCAP) and General Particle Tracking (GPTRAC), and the respective purposes and assumptions inherent to each module.

Two major assumptions common to all computational modules of the WHPA model are: 1) flow in the aquifer is horizontal; and 2) flow in the aquifer is at steady-state. Temporal variations in sources and sinks (e.g., non-continuous pumping) are not considered steady-state conditions. Thus, the WHPA model is most applicable to continuously pumped water supply wells. Other assumptions common to the two modules include the assumptions that all wells and stream boundaries are fully penetrating, and that there is no vertical component of flow (i.e., flow is not three-dimensional).

The WHPA model assumption that all stream boundaries are fully penetrating is the most likely assumption to be violated and may lead to unrealistic predictions. Natural streams are nearly always only partially penetrating and often have a clogging layer of the fine-grained material that underlies the stream bed. Because the model assumes the stream boundary is fully penetrating, the capture zone predicted by the model expands in width along the stream, but does not extend beyond the stream. In reality, because the stream may be only partially penetrating, the actual capture zone may extend beyond the stream. In addition, the model assumes that flow from the stream is constant, that is, not affected by a zone of reduced hydraulic conductivity established by the sediment layer of the stream bed. Because the stream boundary acts as a source of water to the well, the capture zone is smaller than a capture zone not influenced by stream inflow. Thus, a stream, such as Tulalip Creek, acts as a condition that limits the size of the capture zone. However, the assumption that Tulalip Creek is fully penetrating may exaggerate the condition and predict a smaller capture zone than actually exists.

The MWCAP module of the WHPA model can be used to delineate a capture zone based on either steady-state or time-dependent conditions. Steady-state zones of contribution are defined as the surface or subsurface area surrounding a pumping well that supplies groundwater recharge to the well over an infinite period of time. This type of capture zone forms an open-ended shape in the upgradient direction due to the fact that, given enough time, any particle of water upgradient of the well, within the zone of contribution boundaries will eventually travel to the well. This zone of contribution could be limited by a groundwater divide (see Glossary for definition). The steady-state assumption is the most environmentally conservative type of delineation and thus covers the largest area.

Time-dependent capture zones can be delineated using either the MWCAP or the GPTRAC modules and depict a zone of contribution within a given time limit. Capture zone periods of 10 and 25 years are recommended for zone of contribution delineations. In general, time-dependent capture zones are considered less environmentally conservative (enclose smaller areas) than steady-state capture zones. Time-dependent capture zones can approach the size and shape of a steady-state solution when the time interval is very large.

In this study, two modules of the WHPA model, the MWCAP and GPTRAC modules, were used to analyze the hydrogeologic system at Tribal Wellfield Number 1. MWCAP was used to assess the influence of the nearby Tulalip Creek. Although multiple wells within a study area may be specified, MWCAP assumes that the wells operate independently of one another. Consequently, increased drawdown due to interferences of multiple wells pumping simultaneously is ignored in MWCAP.

The GPTRAC module accounts for interferences produced by multiple pumping wells and accommodates a wider range of aquifer and boundary conditions than the other modules. GWPRAC can only predict time-dependent capture zones. GPTRAC provides for simulation of the impacts of a semi-confined aquifer on the zone of contribution that is not available in the MWCAP module (see Glossary for definition of semi-confined). Only time-dependent zones of contribution can be accounted for in GPTRAC. Because GPTRAC can account for the effects of well interferences and semi-confined conditions, GPTRAC was selected to delineate a more realistic time-dependent zone of contribution for the conditions present at Wellfield Number 1.

2.2 HYDROGEOLOGIC PARAMETERS

The hydrogeologic parameters used to delineate the zone of contribution for Wellfield Number 1 and the sources of these data are listed in Table 1. Table 2 displays data for each well in the wellfield reported in *Water Resources of the Tulalip Indian Reservation, Washington* (Drost, 1983). The four wells in Wellfield Number 1 are designated Well #4, Well #5, Well #6, and Well #7 by the Tulalip Reservation. These designations will be used in this report. The well numbering system used by the USGS in the State of Washington designates these same wells 30/4-10L2, 30/4-10L3, 30/4-10L4, and 30/4-10L5, respectively. These well designations contain the township, range, section, 40-acre tract within that section, and serial number.

The parameters in Tables 1 and 2 are based on the best available information and professional judgement. The groundwater flow direction and hydraulic gradient were determined using the water levels reported by Drost (1983) and in personnel communication (Thomas, 1993). The most recent water levels taken at the Tulalip Reservation were measured in 1992 by USGS personnel using a steel tape. Using the six 1992 water levels in selected wells in the north central portion of the Reservation, a south southwesterly flow direction and a gradient of 0.0156 were determined. A potentiometric surface (see Glossary for definition) based on all twenty water levels from non-pumping wells taken during the 1970's showed a southward groundwater flow from the northern reservation border changing to a southwestward flow in the vicinity of the Tulalip Wellfield Number 1. The overall flow direction and gradient determined from the 1970 potentiometric surface concurred with those determined from 1992 data.

A step drawdown pump test was conducted in Well #7 in June 1988 by Carpenter Drilling. In this type of test, the pump rate is increased incrementally in a series of steps, and the headloss hat occurs at each pumping rate a water flows through the well screen is calculated. Cooper and Jacob's form of the Theis equation (Todd, 1980) and the least squared method of analysis, were used to calculated the aquifer transmissivity (see Glossary for definition) resulting from the pump test.

Table 1

INPUT PARAMETER VALUES USED IN WHPA MODELS

PARAMETER	VALUE	SOURCE OF PARAMETERS USED
Minimum x-coordinate of study area	0	7 1/2 minute maps
Maximum x-coordinate of study area	15,840 ft	7 1/2 minute maps
Minimum y-coordinate of study area	0	7-1/2 minute maps
Maximum y-coordinate of study area	15,840 ft	7-1/2 minute maps
Largest allowable step length	50	Suggested in the WHPA Handbook, Blandford and Huyakorn, 1991.
Transmissivity of the aquifer	1116 ft^2/day	Estimated using a step drawdown test for Well #7 and the lithology along with Anderson & Woessner, 1992; Freeze & Cherry, 1979; and Todd, 1980.
Regional hydraulic gradient	0.0156 ft/ft	Estimated using USGS, 1992 groundwater elevation data from pers. comm. Thomas, 1993 and water levels from 1969 to 1982 from Drost, 1983.
Bearing of ambient groundwater flow	249 degrees	Estimated using USGS, 1992 groundwater elevation data from pers. comm. Thomas, 1993 and water levels from 1969 to 1982 from Drost, 1983.
Aquifer Porosity	0.30	Estimated based on the lithology and Anderson and Woessner, 1992; Freeze and Cherry, 1976; and Todd, 1980.
Aquifer saturated thickness in vicinity of Wellfield #1	67 ft	Average thickness of sand Unit #5 according to borehole logs from Drost, 1983.
Associated boundary type	stream	Fully penetrating stream boundary's effect on the zone of contribution for Wellfield #1 was model tested.

Table 1 (Continued)

PARAMETER	VALUE	SOURCE OF PARAMETERS USED
Capture zone type option	steady state and time-related	Both capture zone types were simulated.
Time values associated with time-related capture zones	3,650 and 9,125 days	Suggested times (10- and 25-year) in the WHPA Handbook, Blandford and Huyakorn, 1991.
Number of pathlines to be computed	10	Visual inspection
Flag indicating if capture zone boundary is plotted	Yes	Visual inspection
GPTRAC-specific data:		
Aquifer type	semi-confined	Borehole Logs in vicinity of Wellfield #1 from Drost, 1983.
Confining bed hydraulic conductivity	0.1 ft/day	Estimated based on the hydraulic conductivity of the aquifer and lithology and values from Anderson & Woessner, 1992; Freeze & Cherry, 1979; and Todd, 1980.
Confining bed thickness	30 ft	Borehole Logs in vicinity of Wellfield #1 from Drost, 1983.
Areal recharge rate	0.0017 ft/day	Reported recharge is 7.4 inches/year in a 4-square mile recharge area from Drost, 1983.

Table 2

WELL-SPECIFIC INPUT VALUES FOR WHPA MODULES

PARAMETER	WELL #4 30/4-10L2	WELL #5 30/4-10L3	WELL #6 30/4-10L4	WELL #7 30/4-10L5
X-Coordinate (Feet)	7231.6	7084.6	6910.8	7298.4
Y-Coordinate (Feet)	2588.0	2408.0	2180.0	2108.0
Total Well Depth (Feet)	95	118	96	103
Screened Interval (Feet)	84 - 94	80 - 95	88 - 95	86 - 101
Screened Length (Feet)	10	15	7	15
Well Radius (Feet)	0.33	0.33	0.33	0.33
Pump Rate: Ft^3/day (gpm)	32,535 (170)	43,061 (225)	32,535 (170)	43,061 (225)
Saturated Thickness at Well (Feet)	62	72	61	74
Perpendicular Distance from left fork of Tulalip Creek (Feet)	1408	1202	950	1262
Orientation of Stream Boundary from N-S (Degrees)	23.5	23.5	23.5	23.5
Perpendicular Distance from the right fork of Tulalip Creek Using Nearest Reach (Feet)	1617	1684	1785	1390
Orientation of Stream Boundary from N-S (Degrees)	161.0	161.0	161.0	161.0
Perpendicular Distance from the right fork of Tulalip Creek Using Line Through Middle of Meanders (Feet)	2037	2102	2157	1760
Orientation of Stream Boundary from N-S (Degrees)	154.5	154.5	154.5	154.5

The calculated transmissivity was 1,116 ft^2/day, which is within the range of values found in the literature for aquifers with similar lithologies. Porosity (defined in Glossary) was estimated using the literature values for similar materials (Anderson and Woesser [1992], Freeze and Cherry [1976], and Todd [1980]).

From an evaluation of the borehole logs for the wells in Wellfield Number 1 and the USGS cross section F-F' (Drost, 1983), the average saturated thickness of the Unit 5 aquifer was determined to be 67 feet in the vicinity of the wellfield. The aquifer thickens to the north reducing the size of the capture zone in that area. Therefore, using an average thickness of 67 feet would overestimate the capture zone size. The borehole logs and cross-section evaluation was used to confirm the presence of a semi-confining layer (leaky) of an approximate thickness of 30 feet as identified by Drost (1983). These semi-confined conditions were simulated in the GPTRAC module. The pump rates for the four wells in Wellfield Number 1, provided by Tom Gobin of the Tulalip Reservation staff (pers. comm., 1993), are estimates for pumping rates that occur 10 to 15 hours per day. In the model, these pumping rates were applied over a 24-hour period. Therefore, the simulated capture zone size will be larger than the actual capture zone for the four wells pumping fewer hours per day.

2.3 SIMULATION RESULTS

The MWCAP and GPTRAC modules of the WHPA model are sensitive to the hydrogeologic parameters and other factors used in the simulations. Two complicating factors affect the use of the WHPA model for zone of contribution delineation in Wellfield Number 1. First, all wells in the wellfield pump intermittently. The estimated pumping period is 10 to 15 hours a day to maintain the volume of the holding tank at a minimum of 50 percent capacity. The model predictions, however, are based on a 24-hour pumping period (i.e., continuous pumping). As a result, the WHPA model simulations in all scenarios depict greater areas of contribution than actually contribute to the well. Secondly, two stream boundaries that are not fully penetrating exist in proximity to the Tulalip water supply wells, the effects of which are discussed in Section 2.1.

The MWCAP module was used to simulate the steady-state zone of contribution for each well in Wellfield Number 1, as shown in Figure 1. The delineation for the steady-state zone of contribution is the largest area simulated, and shows the source of water for each well pumping individually. Combined these individual zones of contribution represent the most environmentally protective area that is simulated herein.

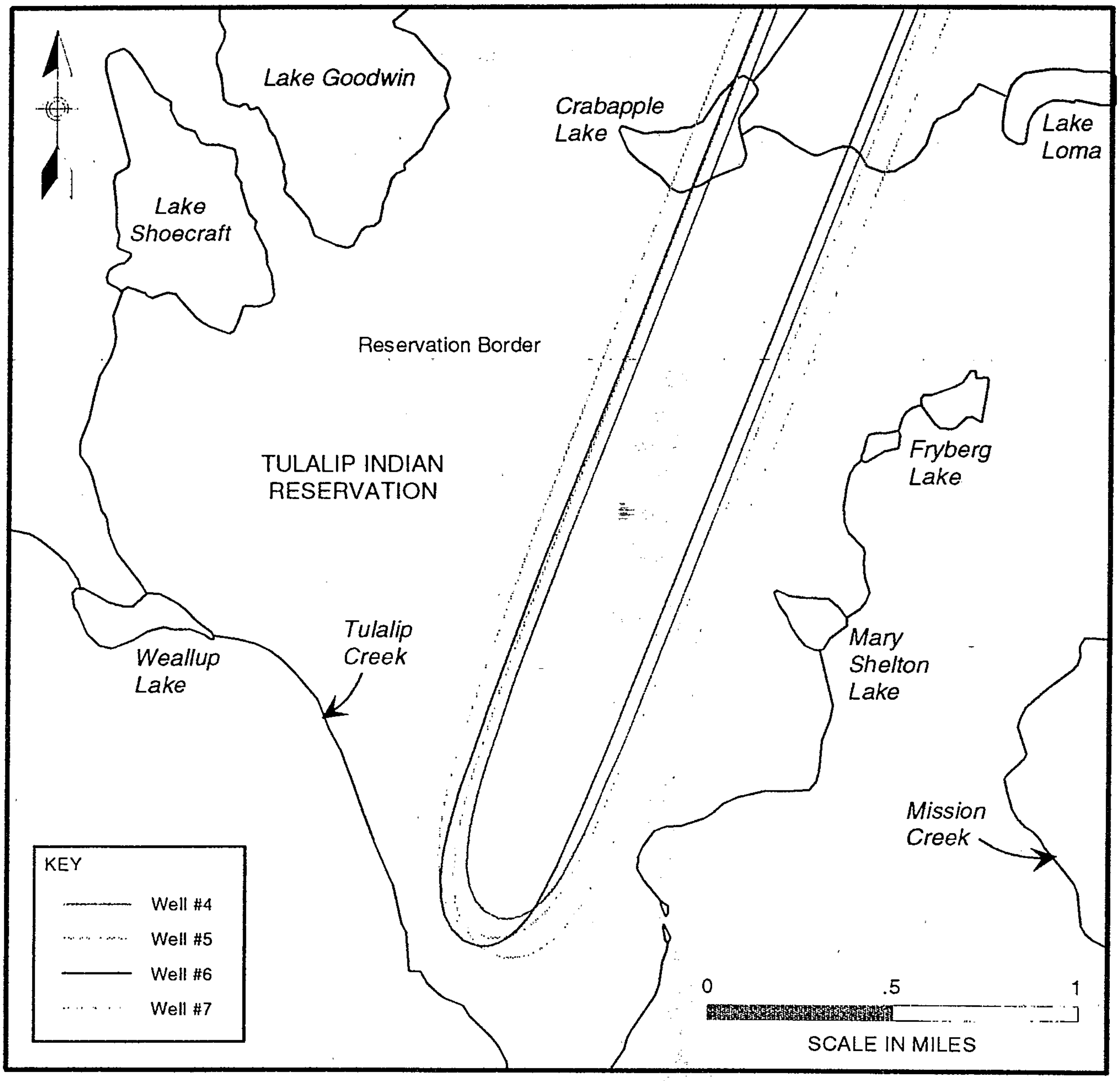


Figure 1

STEADY STATE ZONE OF CONTRIBUTION FOR
EACH OF THE FOUR WELLS IN TRIBAL WELLFIELD NUMBER 1
(MWCAP Module)

The MWCAP module was also used to determine the potential impact of a fully-penetrating stream in the location of the Tulalip Creeks. MWCAP permits the input of the stream boundary angle from north-south and the distance from each of the pumping wells. When MWCAP was run for all simulations for either fork of Tulalip Creek, it was determined that the stream boundaries do not substantially impact the shape or size of the zones of contribution. Unless the water level or potentiometric surface in Wellfield Number 1 declines in the future, or the total well discharge increases, stream flow is not part of the water supply drawn from this wellfield. Thus, use of this simulation demonstrated that the creeks exerted no influence on the capture zone due to the orientation of the capture zone.

The effects of well interference from the four pumping wells are not negligible since the cones of depression (see Appendix C for definition) overlap. GPTRAC accounts for well interference and, therefore, was used to delineate time-dependent zones of contribution for a 10- and a 25-year time of travel. This module also takes into account the upper semi-confining unit (i.e., the Unit 4 till and Unit 2 silt and clay interbeds identified by the USGS in cross section F-F' [1983]). The 10-year zone of contribution is depicted in Figure 2 and represents the least environmentally protective approach based on the shorter time frame. Figure 3 presents the time-dependent simulation for a 25-year time of travel. The colors represent the influence of each individual well, taking into consideration well interference. The 25-year delineation (Figure 3) is the recommended zone of contribution for Wellfield Number 1, because it is more environmentally protective.

2.4 SENSITIVITY ANALYSIS

Most of the hydrogeologic parameters used in the model affect the size and shape of the zone of contribution to some degree. A sensitivity analysis was performed using a range of values for each parameter for which some uncertainty about the exact value of the parameter exists. Simulations were run using a reasonable minimum and maximum value for each parameter tested; and except for the parameter being tested, all other parameter values were held constant. The results are shown in Table 3 and Figures A-1 through A-12 in Appendix A. The implications of the sensitivity analyses are discussed in this section.

The minimum total well discharge was derived by multiplying the volume pumped in 10 hours at the average pumping rates by 0.417 (10 hours/24 hours). To simulate increased pumping, the well discharges from two hypothetical wells (designated well #8 and well #9) were added to the total discharge, increasing the pumping rate by 170 and 225 gallons per minute, respectively. The simulations run with a minimum and maximum well discharge are shown in

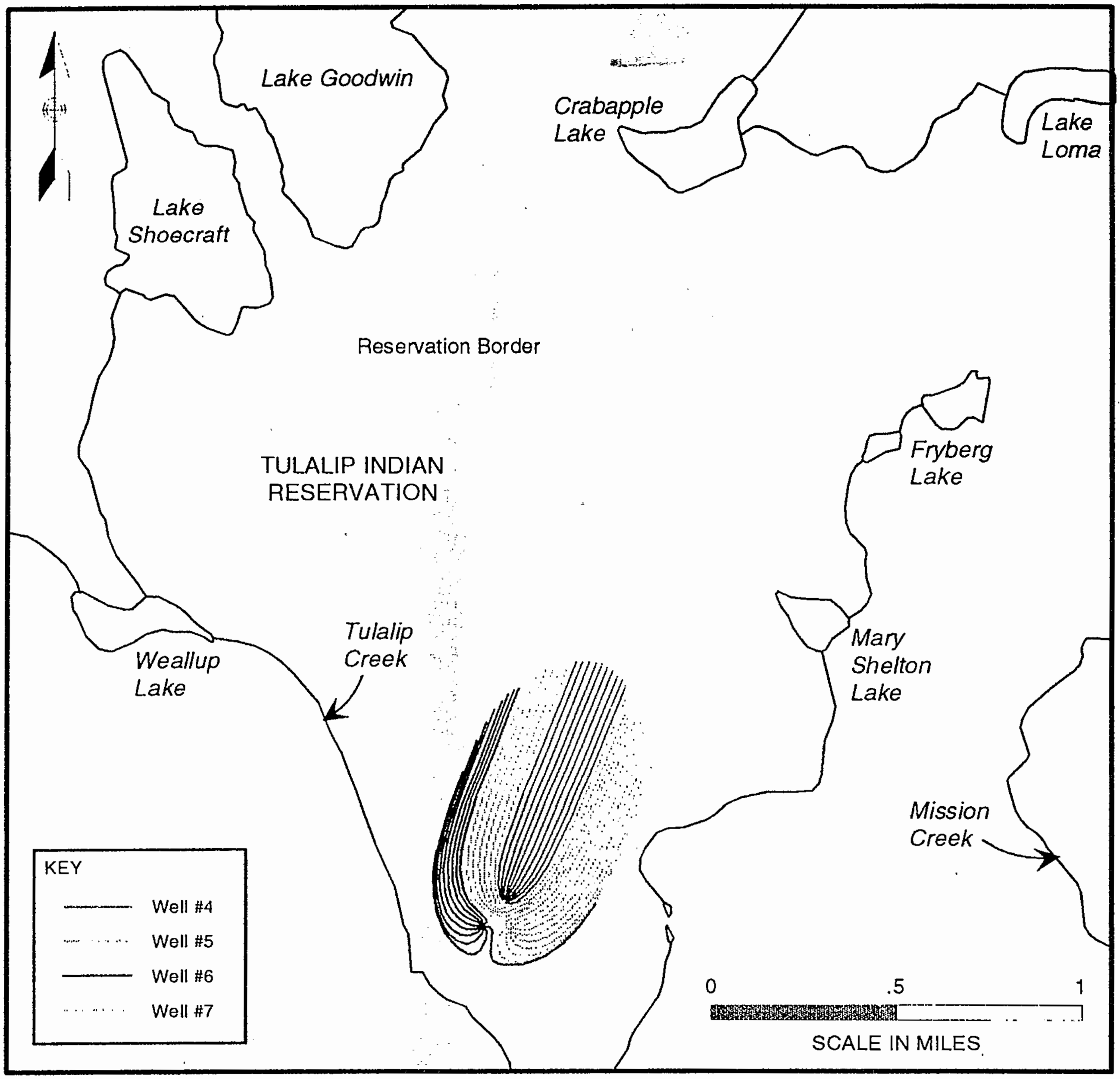


Figure 2

10-YEAR TIME-DEPENDENT ZONE OF CONTRIBUTION
(GPTRAC Module)

DIV203\FIG01.DRW 3/10/94

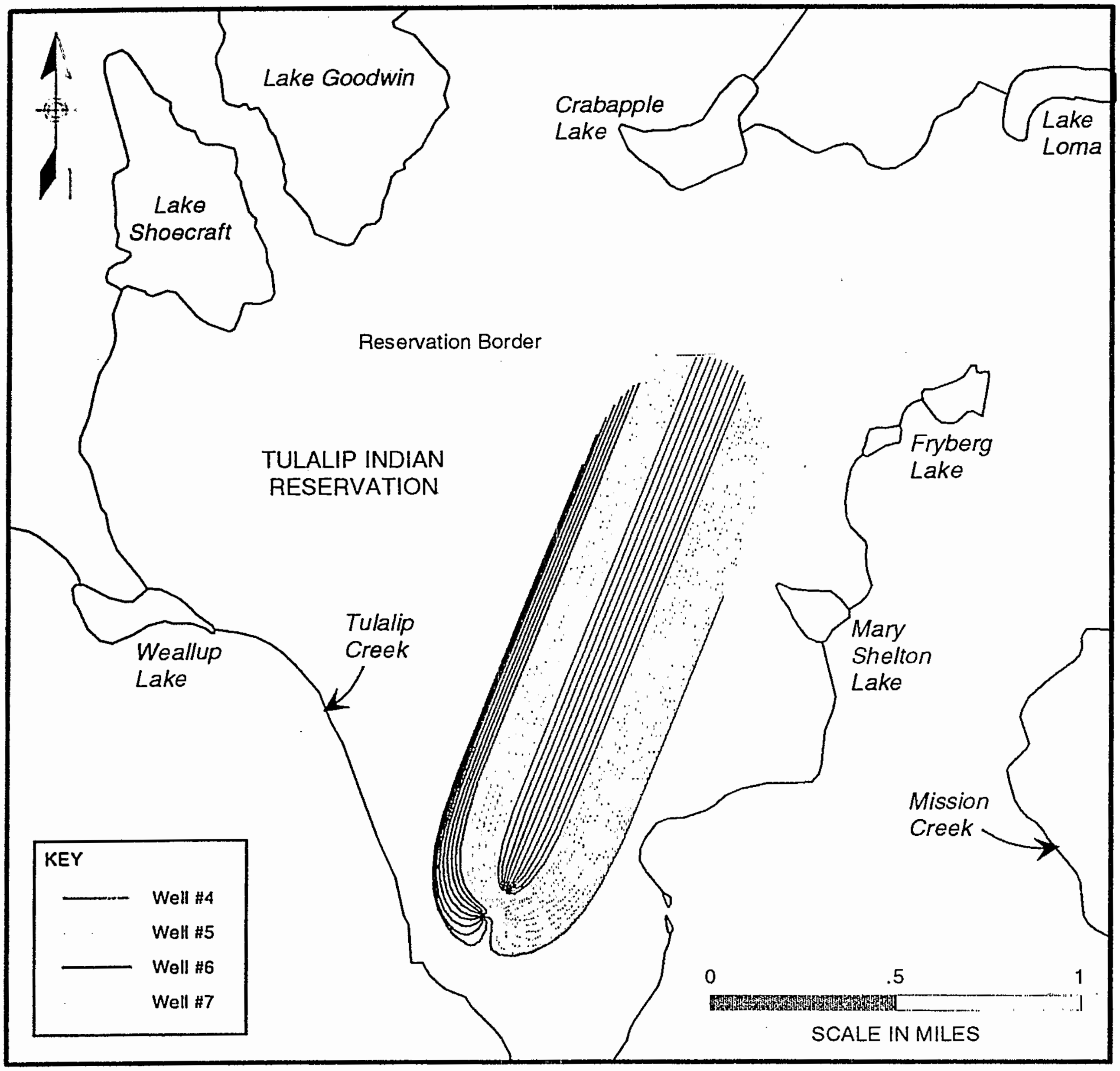


Figure 3

25-YEAR TIME-DEPENDENT ZONE OF CONTRIBUTION
(GPTRAC Module)

DIV203-FIG01 DRW 3/10/94

Table 3

SENSITIVITY ANALYSIS: INFLUENCE OF INPUT PARAMETERS ON CAPTURE ZONE

PARAMETER	MINIMUM VALUE	OBSERVED EFFECT ON CAPTURE ZONE	MAXIMUM VALUE	OBSERVED EFFECT ON CAPTURE ZONE
Well Discharge (Total)	62,997 ft^3/day	Thinner but only slightly shorter in length.	226,788 ft^3/day	Thicker, but only slightly longer.
Transmissivity	112 ft^2/day	Shorter and wider (egg-shaped); zone of influence of each well is increased.	2000 ft^2/day	Extends to the northern reservation boundary and is slightly thinner; zone of influence of each well is decreased.
Hydraulic Gradient	0.0040	Shorter and much wider; zone of influence of each well is increased.	0.0234	Longer and slightly thinner; zone of influence of each well is decreased.
Confining Layer Thickness	5 feet	Thinner and slightly shorter; zone of influence of each well is decreased.	100 feet	Thicker and slightly longer; zone of influence of each well is increased.
Confining Layer Hydraulic Conductivity	0.01 ft/day	Thicker and slightly longer; zone of influence of each well is increased.	1.0 ft/day	Thinner and slightly shorter; zone of influence of each well is decreased.
Effective Porosity	0.20	Longer (velocity increase), same width.	0.40	Shorter (velocity decrease), same width.

Figures A-1 and A-2, respectively. As the pumping rate of the well increases, the zone of contribution will increase in all directions.

Figure A-3 shows the effect of reduced transmissivity (i.e., each well draws from a broader area). An increase in the transmissivity, as shown in Figure A-4, would decrease the width of the zone of contribution size, because the well would derive more water from each unit of the aquifer in the zone of contribution. Thus, the zone of contribution increases in length with increased transmissivity.

Likewise, an increase in the groundwater gradient would decrease the width and lengthen the zone of contribution. The results of using a minimum and maximum hydraulic gradient in the sensitivity analysis are shown in Figures A-5 and A-6. As depicted in Figures A-3 through A-6, accurate data for transmissivity and hydraulic gradient are critical to an accurate delineation of the zone of contribution. Under steady-state conditions, an increase in the hydraulic gradient would increase the seepage velocity and the ambient flow rate. Increases in the seepage velocity or the flow rate would alter the location and orientation of the pathlines.

Decreasing the thickness or increasing hydraulic conductivity of the semi-confining unit would affect the zone of contribution in the same way. The simulations showing maximum and minimum thickness of the semi-confining unit are shown in Figures A-7 and A-8. The simulations showing the minimum and maximum semi-confining unit hydraulic conductivity are shown in Figures A-9 and A-10, respectively. The zone of contribution is made larger by either an increase in the thickness (Figure A-8) or a decrease in the hydraulic conductivity (Figure A-9) of the semi-confining unit. Decreasing the thickness of the semi-confining unit (Figure A-7) or increasing its hydraulic conductivity (Figure A-10) would simulate the conditions of an unconfined aquifer.

Steady-state zones of contribution are not dependent upon porosity or thickness. For the time-dependent zones of contribution, porosity and aquifer thickness do not affect the position or orientation of the pathlines. However, porosity and thickness do affect the velocity of groundwater flow along each pathline. Therefore, decreases in porosity (Figure A-11) or aquifer thickness parameters would increase the groundwater velocity resulting in a longer (more environmentally protective) zone of contribution. The simulation run with the maximum porosity, depicted in Figure A-12, again shows no change in width but a shorter zone of contribution.

2.5 SUMMARY

Steady-state, 10-year, and 25-year time of travel simulations were performed and analyzed for Wellfield Number 1 zone of contribution delineation. The most environmentally protective zone of contribution, the steady-state capture zone, extends beyond the reservation property. Figure 1 depicts the source of water for each individual well. The zone of contribution delineated in the steady-state model extends beyond the reservation property. The Tribes may determine that a steady-state zone of contribution is not practical to regulate.

Because GPTRAC accounts for the effects of well interference in the wellfield, GPTRAC was used to delineate the time-dependent zones of contribution for the Wellfield Number 1. Because of the smaller zone of contribution defined, the 10-year zone of contribution (Figure 2) is not as protective of the water supply as the 25-year zone of contribution. The 25-year zone of contribution shown in Figure 3 is recommended for use as the delineated wellhead protection area for Wellfield Number 1. The 25-year delineation provides a greater measure of protection than the smaller, 10-year zone of contribution. Unlike the steady-state zone, the 25-year zone of contribution is of limited areal extent, and activities within the area are distinctly manageable.

3.0 POLLUTANT SOURCES

The following section presents the results of a site visit conducted to inventory potential pollutant sources within the delineated zone of contributions depicted in Figures 1 through 3 for the four wells located in Wellfield Number 1 of the Tulalip Reservation. The site visit indicated that very few *visible* potential sources were identified within the delineated areas. A small gravel pit was identified approximately one mile northeast of the wellfield. The area in the vicinity of Mary Shelton and Fryberg Lakes are areas of potential concern because of light residential use. Potential sources of contaminants include: septic wastes, lawn and garden chemical applications, and indiscriminate dumping of solid and household hazardous wastes. In addition, recreational use of the lakes (i.e., boating or fishing) could contribute petroleum products to the list of potential pollutant sources. Because so few sources exist within the zone of contribution, other potential sources that are considered within a broader recharge area are discussed.

3.1 OWNERSHIP AND LAND USE

Land ownership within the area of interest (legal sections 1, 2, 3, 10, and 11) includes Trust Property (tribal ownership) and Individual Property (individual tribal member ownership), nontribal homeowners, and the City of Everett. The City of Everett property currently remains inactive. However, the city has proposed that this property be used for land application of sewage sludge. This proposed land use met with great public opposition, and consequently, the sludge application proposal has not been implemented.

The primary land use within this area is forestry. Initial cuttings of trees, mainly evergreens occurred in the 1920s to 1930s. Seedlings of maple, douglas fir, and cedar were then planted in the logged area. These species are not currently being logged in the area.

3.2 POTENTIAL POLLUTANT SOURCE INVENTORY

The land uses described above were evaluated and the potential pollutants associated with these activities were inventoried as part of the site visit. Table 4 provides a list of the potential pollutants of concern by land use.

Table 4

LAND USES AND ASSOCIATED POTENTIAL POLLUTANTS

LAND USE	POTENTIAL POLLUTANT
Residential	
Household Activities	solvents paints household cleaners
Septic Systems	nitrates bacteria and viruses household cleaners
Auto Care/Repair	oils greases solvents antifreeze gasoline
Lawn and Garden	pesticides fertilizers
Illicit Dumping	household hazardous waste
Lake Recreational Activities	oil gasoline fecal coliform
Forestry	pesticides fertilizer
Gravel Mining	turbidity alkalinity oils and greases diesel solvents

Homes in the vicinity of Mary Shelton and Fryberg Lakes operate on individual septic tank and drainfield systems. These septic systems are considered the primary potential pollutant source in the recharge area. Estimated septic tank densities located within the 25-year zone of contribution range from zero to 0.23 septic tanks per acre. Future development could increase the density in a portion of the zone of contribution to 0.44 tanks/acre. Land to the northwest of the 25-year zone of contribution has an estimated average septic tank density of 0.85 tanks per acre. Septic tank densities in this area have the potential to increase to 1.23 septic tanks per acre, if the land is not subdivided further than indicated on the current zoning map.

In addition, applications of lawn and garden chemicals (pesticides and herbicides) by homeowners are considered a potential contaminant source. Home automotive repair activities such as changing of oils and antifreeze were observed at several locations within the recharge area. Typical contaminants associated with these activities include: oils, gasoline, degreasers, brake fluid, and antifreeze. Although no evidence was observed during the site visit, indiscriminate dumping of household hazardous waste (bleaches, cleaners, paint, etc.) is known to occur in similar residential areas. Illicit dumping may also occur within the protection zone.

Activities on the lake that could contribute pollutants to the groundwater include motorized boats used for fishing, bank fishing, and other recreational activities. Oil and gasoline products are the potential pollutants from the motorized activities. Fecal coliform bacteria contributed to the lakes from swimming and other human and animal activities may be entering the aquifer depending on the depth and type of sediments in the lakes.

Forestry activities, notably the aerial application of the herbicide Roundup® used to control salmonberry and elderberry growth were identified during the site visit. Application of 1-1/2 quarts Roundup® in 10 gallons of water per acre occurred in the northwest corner of legal Section 11. This area borders the delineated wellhead areas. This application occurred five years ago and has not been reapplied in the area. While Roundup® has not been applied within the delineated wellhead protection area for over 10 years, these activities are also listed on the potential contaminant source inventory.

4.0 BMPs AND MITIGATIVE MEASURES

Best Management Practices (BMPs) and mitigative measures are presented below according to type of activity. The activities that represent the greatest potential for pollution of the drinking water source are, in large part, nonpoint pollutant sources. As with most nonpoint source pollutants, the potential sources are not introduced to the environment through an industrial or municipal pipeline. Instead, actions taken by individuals and under the individual's control create pollutant sources. The cumulative impact of these nonpoint sources can affect a drinking water supply. Because of the dispersed nature of and individual responsibility for nonpoint sources of pollution, the major controlling mechanisms include land use planning and an awareness of all potential contributors.

Land use planning and regulation can control the activities of commercial and industrial businesses that may be located within a wellhead protection area. However, land use planning cannot control the actions of individuals. Education is the key to pollution prevention at the individual level. Heightened individual awareness can enhance behavioral modifications. The BMPs provided in Appendix B are intended to be used as educational tools. Because they are provided in the appendix, the BMPs can be easily removed, copied, and provided in a public forum, or can be used to develop brochures, logos, and buttons in campaigns to raise public consciousness. In areas of primarily residential land use, such as in the case of the delineated 25-year zone of contribution, education that leads to environmentally sound practices at the individual level is a primary method of groundwater pollution prevention.

The BMPs in Appendix B are presented in priority order based on the potential for the category of activity to degrade the quality of the drinking water. Because the predominant land use in the recharge area is residential, the aquifer will be most affected by the cumulative practices of all the residents. Thus, implementation of the BMPs for residential areas are considered the highest priority for implementation. Changing the practices of residents is likely to have the greatest long-term impact on the introduction of contaminants to the aquifer. Protection of the area immediately surrounding the wellfield is considered critical to the short-term protection of the water supply. The BMPs for protection of the wellhead immediately follow those that apply to residential areas.

Implementation of BMPs for transportation corridors and stormwater drains can diminish the potential impacts of individual spill incidents on the groundwater quality. Thus these BMPs, while important, are of a lesser priority than those for households and wellhead areas.

Because forestry activities that can cause contamination of the groundwater are regulated by federal statute, the forestry BMPs were given a lower priority. Forest practices such as application of pesticides are regulated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), landowners can be encouraged to develop and implement Integrated Pest Management (IPM) plans to reduce the need for pesticide application.

The location of the lakes outside of the 25-year time of travel and the large volume of water in the lakes, reduces the importance of implementation of the BMPs applicable to recreational activities on lakes.

The Tulalip Reservation may be the location of a commercially viable source of gravel, and mining operations may be proposed. Gravel mining may have an adverse impact on the quality of the groundwater downgradient of the mine, particularly if mining occurs below the water table. Mining has been documented to increase the turbidity and concentrations of inorganic constituents in downgradient wells. Depending on the associated activities such as concrete or asphalt batch plant processes, vehicular traffic and maintenance, other pollutants can inadvertently be introduced to the groundwater. Section 5.0 describes impacts and presents options for establishing BMPs and mitigative measures to prevent groundwater pollution from future planned or unplanned mining operations.

Land use planning can control the type of septic systems and the density of septic systems installed. In Thurston County, for example, a loading model was used to assess the optimum density of septic systems that could be installed over the protected recharge area to maintain the current concentration of nitrate in the groundwater (Golder, 1990). The density proposed and ordained in Thurston County was one septic system for five acres, based on technical justification (Golder, 1990). Such justification would be required for the specific conditions of the wellhead protection program for the Tulalip Reservation. Section 6.0 discusses methods for establishing optimum septic tank density in areas where groundwater protection is a concern.

5.0 IMPACTS OF GRAVEL MINING ON GROUNDWATER AND BMPS

The potential impacts to groundwater quality and quantity as the result of gravel mining vary widely. The degree of impact depends on the size and type of mining operation as well as the associated activities that take place on site. To evaluate these environmental effects, each gravel mining operation should be viewed as the sum of the environmental effects of the component activities. The following section provides a summary of various types of gravel mining practices and mining processing and discusses direct and post mining effects to water resources. This section also presents mitigative measures (including treatment technologies) and BMPs that can be used to reduce potential impacts to groundwater as a result of mining and associated activities.

5.1 MINING PRACTICES

The three basic types of gravel mining operations are defined on the basis of their relationship to the water table. They include: dry pit mining, wet pit mining, and dredging. Dredging is not generally practiced in northwestern Washington and, therefore, is not discussed.

In dry pit mining, gravel is extracted above the water table. When gravel excavation is well above the water tables (and associated activities such as vehicle maintenance or concrete batch processing plants do not occur on site) the risk of groundwater contamination and impacts to quantity is relatively low. However, the protective overburden is removed, and these excavated areas can be sensitive to the introduction of contaminants. But because dry pit mining is generally limited to a process of loading unconsolidated materials, the associated activities do not pose serious risk of introducing contaminants. A high potential risk of groundwater contamination occurs when solid wastes are deposited at abandoned open pit gravel mines. The types of wastes typically found at these sites vary widely and include wood waste, liquid industrial waste, paint waste, demolition materials, and household wastes. Leachate from these wastes can infiltrate through soils and degrade groundwater quality. Management practices such as limiting access to the area can reduce the risk of groundwater contamination. Filling in the pit with clean inert substances after mining is completed would also minimize groundwater degradation.

Wet pit mining involves the excavation of gravel below the water table. In wet pit mining, the gravel is normally excavated using either a drag-line or drag scraper. The main portion of the excavator is located above the water and only a bucket enters the water. Potential contaminants that could be introduced as a result of this mining process and their sources are provided in Table 5.

Groundwater turbidity may be increased due to physical disturbance of the aquifer materials during mining. Turbidity may also be increased by incidental generation of highly turbid runoff due to erosion of disturbed areas. The turbid water can enter the groundwater either by direct discharge into exposed groundwater or by infiltration through coarse materials. Sediment clogging of the aquifer media by turbid waters is a key factor in determining how far gravel mining-related turbidity will travel through an aquifer. Sediment clogging is an important mechanism in reducing the hydrologic connection between the mining operations and the aquifer system. Mining should be started at the downgradient side of the deposit. This will preserve the clogging layer as mining proceeds upgradient. Development of the clogging layer can be enhanced by early reclamation of the downgradient face of the excavation to increase vegetative growth.

One risk of excavating into an aquifer is the potential for destroying the hydrologic barrier (confining layer) that separates aquifers. If such a barrier is destroyed, the water in the two aquifers can mix, potentially affecting the water quality or water levels in both aquifers.

When a lake is formed by excavating gravel out of the aquifer, a shift in the local groundwater levels can result. Groundwater levels immediately adjacent to the pit will be lowered at the upgradient end of the lake and raised at the downgradient end of the lake. The magnitude of the impact can be approximated by multiplying one-half the length of the lake by the local groundwater gradient. In addition, gravel removal from below the water table can cause short-term decreases in the groundwater level in proportion to the volume of gravel removed. After mining has ceased, one beneficial effect is to increase the storage capacity in the area of the lake (Landberg, 1982). Thus, more water can be extracted from wells near the lake with less drawdown in the water table because of the large amount of water available in the lake.

Water chemistry effects have been studied by various researchers such as Rasmussen (1985), Perjes (1982), Kothari (1985) and Perry (1986). These authors concluded that the mere presence of a lake resulting from previous gravel mining operations did not necessarily degrade groundwater quality. The authors determined that lake water generally has a higher pH, and lower alkalinity, calcium and magnesium hardness, iron and manganese, and total dissolved

Table 5

SOURCES AND ASSOCIATED POLLUTANTS FROM GRAVEL MINING OPERATIONS*

SOURCE	CONTAMINANTS
Spills or leaks from equipment and storage tanks	Hydrocarbons Oils and grease Hydraulic fluid Fuels
Blasting	Nitrate
Seepage from working face Storm water runoff from disturbed areas, Stripping and digging operations Runoff form overburden, waste piles, and stock piles Dust suppressing activities that generate runoff or infiltration	Turbidity Suspended solids
Dust suppression	Ligninsulfonate

*Source: Ecology, 1993

solids concentrations than water from upgradient and downgradient wells. The changes in the water quality of the groundwater exposed as lake water result from oxidation reactions due to exposure to air and biological processes. However, if contaminants are allowed to enter this water during or following mining, the lake can serve as a conduit to the hydrologically connected groundwater.

5.2 GRAVEL PROCESSING OPERATIONS

Associated activities such as concrete or asphalt batch processing, truck washing, equipment maintenance, and spills and leaks of oils, grease, fuels and hydraulic fluid from tanks and other equipment can potentially infiltrate soils and impact groundwater resources. These associated activities are discussed in this subsection.

Concrete batch plants sometimes associated with gravel mining operations produce process wastewater with a pH typically in the range of 11 to 12 (Ecology, 1993). Some cement additives contain constituents that have a high biochemical oxygen demand or high nitrate concentrations and can result in these contaminants reaching groundwater. Storm water discharges from concrete batch plants can also introduce these same contaminants into the groundwater. Gravel processing equipment and trucks require routine cleaning, lubrication and general maintenance. Potential contaminants that could be introduced as a result of gravel processing operations and their associated contaminant sources are provided in Table 6.

Treatment technologies for wastewater generated in concrete batch plants typically include the use of settling basins, ponds, or clarifiers (sometimes in conjunction with flocculation) for the removal of suspended solids. Skimming of the pond surfaces or oil/water separators are used for removal of oil and grease. Sulfuric acid addition often provides pH adjustment.

Asphalt batch plants are potential sources of hydrocarbon contamination of both groundwater and surface water. Asphalt batch facilities that use a wet scrubber to reduce air emissions discharge suspended solids and oil and grease to a cooling and settling ponds. Unlined ponds can adversely affect groundwater quality by allowing wastewater to infiltrate without treatment. Trucks are cleaned and maintained onsite using solvents or detergents and may present the potential for diesel fuel to be spilled. If this water is not directed to a lined treatment pond, it may collect and percolate into groundwater, or it may mix with other process wastewater.

Table 6

SOURCES AND ASSOCIATED POLLUTANTS FROM GRAVEL PROCESSING OPERATIONS*

SOURCE	CONTAMINANT
Spills, leaks from equipment and storage tanks Maintenance shop Asphalt batch plant (scrubber water) Drive-through truck washers	Hydrocarbons Oils and grease Hydraulic fluid Fuels Degreasers Solvents Detergents
Concrete batch plant mix water Cement bagging operations Concrete truck wash water Concrete batch plant wash water	pH increase Dissolved solids
Residue from blasting	Nitrate
Concrete batch plant Cement bagging operation Stormwater runon/runoff Asphalt batch plant scrubber water Concrete truck wash water washing, screening or crushing rock discharge from settling ponds	Turbidity Suspended solids
Concrete batch plant mix water Concrete truck wash water Cement bagging operations	Concrete admixtures with: organics nitrates chlorides dissolved solids

* Source: Ecology, 1993

Treatment technologies for asphalt batch plants typically include the use of settling ponds for suspended solids removal. Skimming of the pond or oil/water separators can be used for removal of oil. Treated wastewater can also be recycled.

Vehicle washing should occur over paved areas and wastes generated should be treated in a lined sedimentation basin prior to discharge. Vehicle maintenance should also be performed over paved areas where drips and spills can be easily contained. Vehicles that are stored onsite should have drip pans placed beneath them to collect any fluids.

5.3 SUMMARY

In summary, gravel mining and associated activities can adversely affect groundwater quality. Gravel mining, in general, poses moderate risks to groundwater quality and quantity (Thurston County, 1990). Each mining operation has a different set of mining and processing activities associated with it. Therefore, the potential impacts to groundwater from an operation must be determined by examining the specific activities at a facility. Each associated activity can have different effects on the groundwater quality and requires careful consideration about the most appropriate management practices and treatment technologies. To minimize the risk of groundwater quality degradation, oversight of project design and approval should include assessing the activities and requiring treatment technologies appropriate to the activities at the site.

Regulatory oversight should continue during operations to ensure practices minimize the potential for groundwater contamination. The oversight could include groundwater monitoring during operations and following closure to provide detection and early intervention should contamination occur.

6.0 SEPTIC TANK DENSITY AND GROUNDWATER PROTECTION

The Tulalip Reservation currently relies solely on groundwater as the source of drinking water (except in the southeast corner of the reservation). In sparsely populated areas septic tanks provide a sanitary and economical means for disposing of domestic sewage. Extensive development can make reliance on septic tanks as the only means of domestic sewage disposal impractical if the water quality of the aquifer is to be protected. In an effort to better protect the groundwater resources of the Tulalip Reservation, the density of septic tanks in use should be monitored and possibly limited. This chapter provides an approach for estimating the septic tank density for an given area that would preclude degradation of the groundwater quality in the uppermost aquifer at the Tulalip Reservation.

6.1 GROUND WATER QUALITY STANDARDS AND GUIDANCE

The antidegradation policy is a provision in the Ground Water Quality Standards (Chapter 173-200 Washington Administrative Code [WAC]) that is legislatively mandated for state groundwater in the Water Pollution Control Act (Chapter 90.48 Revised Code of Washington [RCW]). While these policies and standards do not apply to tribal groundwater, the Tulalip Tribe may choose to implement parallel laws and policies. The purpose of the state waste quality law is to protect and maintain existing and future groundwater quality, by allowing the absolute minimum level of degradation. The antidegradation policy goes beyond merely preventing the violation of the drinking water standards or other numeric criteria. This policy prohibits degradation of groundwater quality unless two specific conditions are met. First, a discharge to the ground must meet the state technology-based standard of "all known, available, and reasonable methods of prevention, control, and treatment." Second, the activity potentially causing the water quality degradation must be determined to be in the overriding public interest. If these conditions are met, the antidegradation policy places a restrictive cap on the level of degradation allowed (i.e., the numeric criteria).

According to Kimsey (1992), the Washington Department of Ecology (Ecology) received numerous requests from local governments, developers and consultants for guidance in designing onsite domestic disposal systems which would be in compliance with the Ground Water Quality Standards. Ecology responded with an options paper that listed various alternatives. The Department of Health (Health) recommended that a committee comprised of representatives from Health, Ecology, and local health districts be assembled. The Ground Water and Septic Systems

(GWASS) Committee was organized to determine how onsite sewage disposal systems could be managed to meet the intent of the antidegradation policy in the Ground Water Quality Standards.

6.2 GROUNDWATER QUALITY PROTECTION

The options paper provided the following alternatives to protect groundwater from contamination by septic systems: 1) hook-up to a regional sewer system, 2) use alternative onsite systems which provide additional biological and chemical treatment, 3) use alternative onsite systems which are nondischarging, and 4) establish a density requirement that controls the mass loading of contaminants to the subsurface (Kimsey, 1992). If conventional septic systems are the method of onsite sewage disposal, then population density is the most important factor in controlling groundwater contamination from that source. In other words, controlling the number of septic tank systems in a given area based on the mass loading of contaminants from residential areas is the easiest and most comprehensive method of protecting groundwater quality from the cumulative impacts of conventional septic systems.

Major contaminants of concern in domestic wastewater include nitrogen species, pathogenic microorganisms, metals and organic compounds (although there are many others). Nitrate is often selected as the indicator parameter to evaluate the relative impacts on groundwater quality. Nitrate is extremely mobile due to a high solubility; it is anionic in form and is non-reactive, therefore, nitrate is an environmentally conservative estimate (an indicator of worst case conditions) of the relative degradation of the water quality of the aquifer. Nitrate is also a contaminant of interest because elevated concentrations above the 10 milligrams per liter of nitrate-nitrogen federal and state maximum contaminant level can cause methemoglobinemia in infants (see Glossary for discussion of disease). Excessive ingestion of nitrate may also cause cancer in adults.

Nitrogen contamination of groundwater resulting from onsite sewage disposal systems depends upon the density of households, the contaminant loading in the wastewater discharged, local soils and geology, the depth of the aquifer, the direction and rate of groundwater flow,and the ambient concentration of nitrate in groundwater. Nitrate contamination is extremely difficult to remediate, and therefore, groundwater protection is important.

Computer models can be used to determine relative impacts of domestic sewage on groundwater quality. Random-Walk is one numerical model that can be used to simulate contaminant transport including the effects of advection, dispersion, and the reactions of chemical constituents in groundwater. Statistical models can also be utilized to estimate reasonable nitrogen loading based on average parameters and associated uncertainty values.

By examining mass loading in septic tank wastewater in a series of contaminant transport simulations, Ecology attempted to determine the area necessary to meet the intent of the antidegradation policy in the Ground Water Quality Standards (Kimsey, 1992). The Random Walk computer modeling program was used as a predictive tool by Ecology to estimate the area necessary to assimilate contaminants from septic tank systems, and thus, the area necessary to protect the groundwater quality. By assuming average conditions statewide, Ecology was able to apply the model results to the majority of situations found across the state. Degraded groundwater in this model is defined as an increase in ambient nitrate concentration in groundwater of 2 milligrams of nitrate-nitrogen per liter (mg NO_3-N/L), or the level which would cause an exceedance of the criterion (10 mg NO_3-N/L) whichever is more stringent. The area necessary to assimilate contaminants released from an onsite sewage system based on the degree of contaminant loading and site conditions was calculated and a set of curves was plotted (Kimsey, 1992). Knowing the existing water quality and site conditions, these curves can be used to determine the minimum land area requirements for a site (Kimsey, 1992).

Thurston County examined potential sources of nitrate including septic systems in the recharge area of McAllister Springs (Golder, 1990). The purpose of the study was to develop a hydrogeologic understanding of the McAllister Springs Geologically Sensitive Area and to determine the relationship between land use and groundwater quality. A statistical analysis of groundwater data was performed and nitrogen loading from land use activities including septic systems, lawn fertilizers, agriculture and stormwater runoff was analyzed. The nitrogen loading from septic tanks was determined to be minor in comparison to the loading from agricultural activities (Golder, 1990). Septic tank loading was estimated at 45 mg/L NO_3-N with an average per capita wastewater production rate of 45 gallons per day (Golder, 1990). The Thurston County study resulted in establishment of a limit of one residence (septic system) per five acres. While these data may be useful, an optimum septic tank density would need to consider site-specific conditions and other land uses within a wellhead protection area.

6.3 RECOMMENDED APPROACH

Based on the delineated 25-year zone of contribution, a septic tank density analysis is not recommended for protection of Wellfield Number 1. However, an analysis of this type would be useful for the protection of private well owners in the vicinity. The site conditions including location, climate, land use, hydrology, geology, hydrogeology, and potential contaminant sources found within a wellhead protection area provide the framework for a septic tank density analysis to protect groundwater quality. All existing groundwater quality data should be evaluated for baseline geochemistry, trends, and contaminants of concern. Demographic indicators such as housing density and average number of persons in each household should be studied. For the reasons discussed in Section 6.2, nitrate is a good indicator parameter for evaluating potential degradation of groundwater quality from septic tank sewage disposal. A statistical analysis of the nitrate data for years prior to and following additional development should be performed. Nitrogen loading from septic tank wastewater disposal activities upgradient of Wellfield Number 1 can be estimated. The curves for average nitrate concentration versus nitrogen mass developed using Random Walk (Kimsey, 1992) can be used to estimate the minimum land area requirements between septic tanks. If a more detailed analysis is warranted, an analytical or numerical groundwater flow and/or contaminant transport model may be warranted.

6.4 SCOPE AND COST OF PROJECT IMPLEMENTATION

The tasks and associated estimated costs for establishing an optimum septic tank density are presented under two options in Table 7. Please note these are estimates only. Both options include sampling to develop baseline nitrate data. In the first, these data are used to implement the Kimsey (1982) approach to establish a septic tank density based on typical aquifer characteristics. The second option would utilize the nitrate data as input to a numerical flow model with contaminant transport capabilities such as Random Walk.

All of the tasks described may not need to be performed. The location and gathering of the available data could be performed or facilitated by the Tribal representatives. The collection of field and laboratory data would be dependent on the amount and quality of the existing data. The actual scope of the project would need to be determined in collaboration with Tribal representatives.

Table 7

COST ESTIMATES TO EVALUATE OPTIMUM SEPTIC TANK DENSITIES

TASK	DESCRIPTION	ESTIMATED COST
OPTION A - IMPLEMENTATION OF KIMSEY APPROACH		
I	Project Management	$3,087
II	Locate, gather, and evaluate existing nitrate data. (Sources include USGS and Supply well analysis.)	2,340
III	Ascertain need for additional data	620
IV	Sample 12 wells four times each over a one year period for nitrate-nitrogen	12,600
V	Implement Kimsey approach with statistical analysis	3,400
VI	Write draft and final reports.	1,484
TOTAL A		12,191
OPTION B - RANDOM WALK MODEL		
I	Project Management	$3,087
II	Locate, gather, and evaluate existing nitrate data. (Sources include USGS and Supply well analysis.)	2,340
III	Ascertain need for additional data	620
IV	Sample 12 wells four times each over a one year period for nitrate-nitrogen	12,600
V	Perform Random Walk or similar model	6,803
VI	Write draft and final reports.	4,452
TOTAL B		$29,902

7.0 CONCLUSIONS AND RECOMMENDATIONS

This project identified zones of contribution for the Tulalip Wellfield Number 1. The delineation depicts three capture zones based on MWCAP and GPTRAC modules of the EPA WHPA model. The first scenario includes use of MWCAP for a steady-state capture zone (Figure 1). The GPTRAC module was used to predict time-related capture zones for a 10-year time of travel (Figure 2) and a 25-year time of travel (Figure 3).

The most environmentally protective capture zone (the protection zone that covers the largest area) is the steady-state capture zone depicted in Figure 1. However, because the capture zone extends beyond the Tribal boundary, it is not practical to regulate activities within it. Since the GPTRAC module accounts for the effects of multiple well interferences in the wellfield, this module was utilized to delineate the time-dependent zones of contribution. Figure 2 depicts the least environmentally protective zone of contribution, the GPTRAC 10-year time of travel scenario. The 25-year zone of contribution, depicted in Figure 3, is the more environmentally protective time-dependent capture zone and does not seem to be economically prohibitive. While the 25-year time of travel is recommended as a wellhead protection area, the final decision for the extent of a wellhead protection area is a policy decision, based on careful consideration of technical merits of the various scenarios and the needs and interests of the Tulalip Tribes.

Sources of potential pollutants comprise primarily residential activities. Activities that may adversely effect the groundwater quality include: inappropriate disposal of household chemicals and solid waste, automotive repair, lawn and garden activities, and septic systems. Other sources of potential pollutants can come from poor management of wellhead areas, transportation corridors, stormwater disposal, and forestry practices.

BMPs were developed for the types of pollutant sources identified. These BMPs were designed to be used in educational campaigns. Pages of BMPs in Appendix B can be withdrawn, reproduced, and used as they are presented; or the information can be used in brochures or on displays.

Mitigative measures are presented that may be implemented should a commercial source of gravel be developed in the wellhead area. Gravel mining and associated activities can adversely affect groundwater quality. The potential impacts to groundwater from an operation must be determined by examining the specific activities employed at a facility. Useful technologies include collection of wastewater and runoff and diversion into lined settling ponds. Machinery and vehicular repairs should be performed over an impervious surface and wastewater directed to an oil/water separator.

Section 6.0 describes methodologies to establish an optimum septic tank density in the wellhead protection area and provides an estimated cost to perform an optimum density study.

8.0 REFERENCES

Anderson, M.P. and Woessner, W.W. 1992. Applied Groundwater Modelling Simulation of Flow and Advective Transport, Academic Press, Inc.

Banton, D. and Kenrick, M. 1990. The Thurston County Health Department on Hydrogeologic Evaluation of McAllister Springs Geologically Sensitive Area, Golder Associates, September 10, 1990.

Blandford, T.N. and Huyakorn, P.S. 1991. WHPA - A Modular Semi-Analytical Model for the Delineation of Wellhead Protection Areas. Prepared for the U.S. Environmental Protection Agency, March 1991.

Carpenter Drilling, 1988. A Pump Test Analysis using Jacob's Form of Theis Equation and Least Squares Method.

Drost, B.W., 1983. Water Resources of the Tulalip Indian Reservation Washington, U.S. Geological Survey, Water-Resources Investigations. Open-file Report 82-648.

Ecology. 1993. Draft General Permit Fact Sheet for Process and Storm Water Associated with Gravel Operations, Rock Quarries, and Similar Mining Facilities Including Stock Piles of Mined Materials, Concrete Batch Operations and Asphalt Batch Operations. Department of Ecology, Olympia, Washington. August 18, 1993.

Freeze, R.A., and Cherry, J.A. 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Gobin, T. 1993. Tulalip Reservation. Personal communication with Kerry Schwartz, Science Applications International Corporation. 1993.

Golder Associates, Inc. 1990. Hydrogeologic Evaluation of McAllister Springs Geologically Sensitive Area. Prepared for Thurston County Health Department. September 10, 1990.

Kimsey, M. 1992. Ground Water and Onsite Sewage Disposal Systems: Establishing Density Criteria to Protect Ground Water Quality, Washington State Department of Ecology, Water Quality Program, December 3, 1992.

Kothari, N. 1985. Evaluation of Gravel Extraction on Groundwater Movement and Quality. South Dakota State University M.S. Thesis.

Landberg, J. 1982. Hydrogeological Consequences of Excavating Gravel Pits Below the Water-table in Glaciofluvial Deposits. Chalmers University of Technology, Gotenborg, Sweden and University of Gotenborg Doctor of Philosophy Thesis.

Mulla, D. J., Hermanson, R. E., and Maxwell, R. C. Undated. Pesticide Movement in Soils-Groundwater Protection. Washington State Cooperative Extension Publication Number EB1543. College of Agriculture and Home Economics Washington State University, Pullman, Washington.

Perjes, T. 1982. Hydrogeological and Environmental Analysis of the Relationship Between Surface Mining and Riverine Water Wells. International Mine Water Association First Conference (Budapest, Hungary. April 19-24.

Perry, M. L. 1986. Impacts of Large-Scale Gravel Excavations, Precipitation and Runoff on Groundwater Movement and Quality. South Dakota University M.S. Thesis.

Rasmussen, J. R. 1985. Seasonal Effect of Large-scale Gravel Excavation on Groundwater Quality. South Dakota State University M.S. Thesis.

Revised Code of Washington, Chapter 90.48 RCW. Water Pollution Control Act.

Thomas, B. 1993. U.S. Geological Survey, Washington. Personal communication with Kerry Schwartz, Science Applications International Corporation. 1993.

Thurston County. 1990. The Direct and Cumulative Effects of Gravel Mining on Ground Water within Thurston County, Washington, public review draft. Ground Water Management Program, Environmental Health Division, Thurston County Public Health and Social Services Department.

Todd, D.K., 1980, Groundwater Hydrology. John Wiley & Sons, New York, New York.

Washington Administrative Code, Chapter 173-200 WAC. Ambient Water Quality Standards for Ground Waters of the State of Washington.

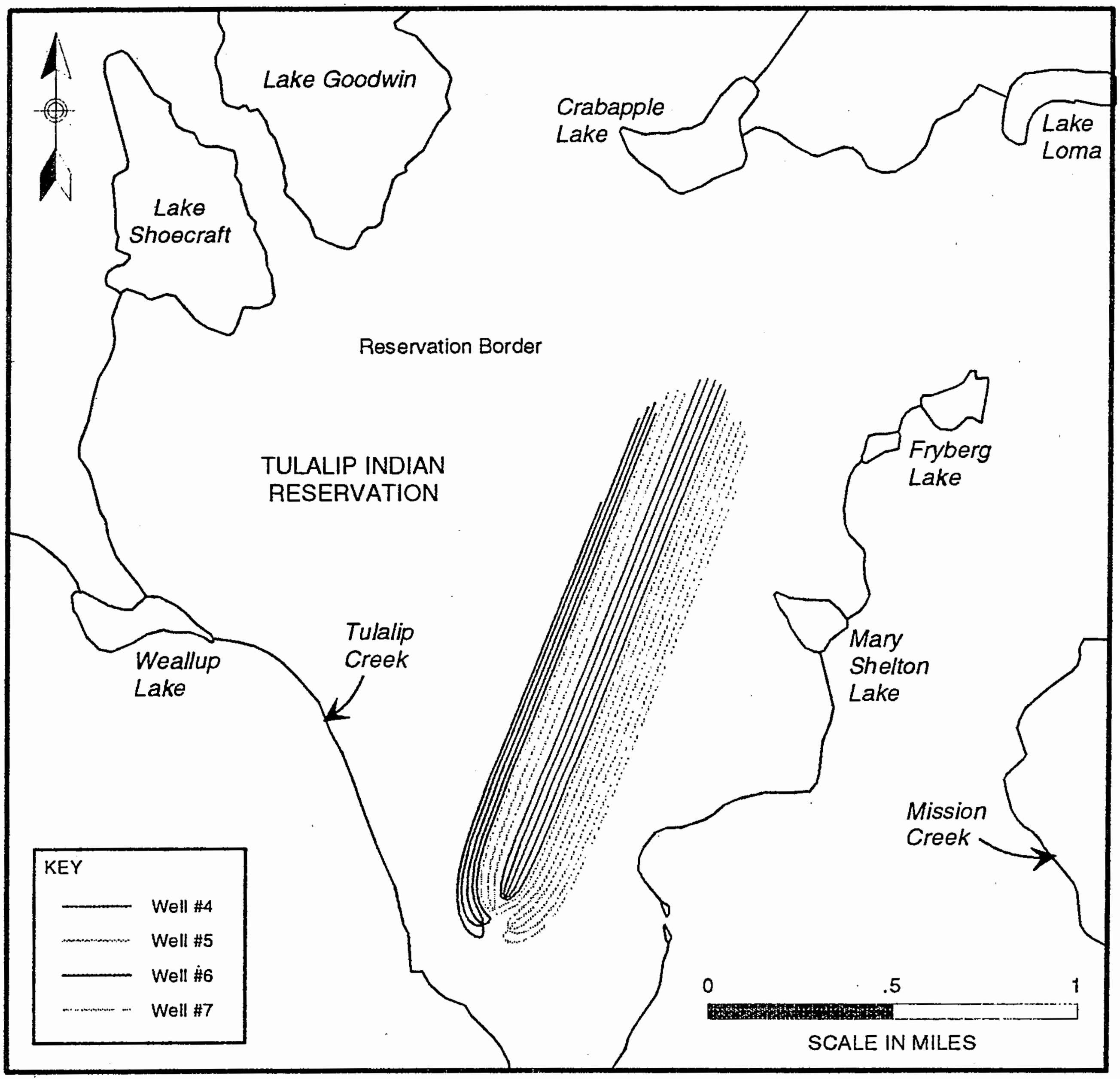


Figure A-1

25-YEAR ZONE OF CONTRIBUTION SENSITIVITY ANALYSIS - MINIMUM WELL DISCHARGE

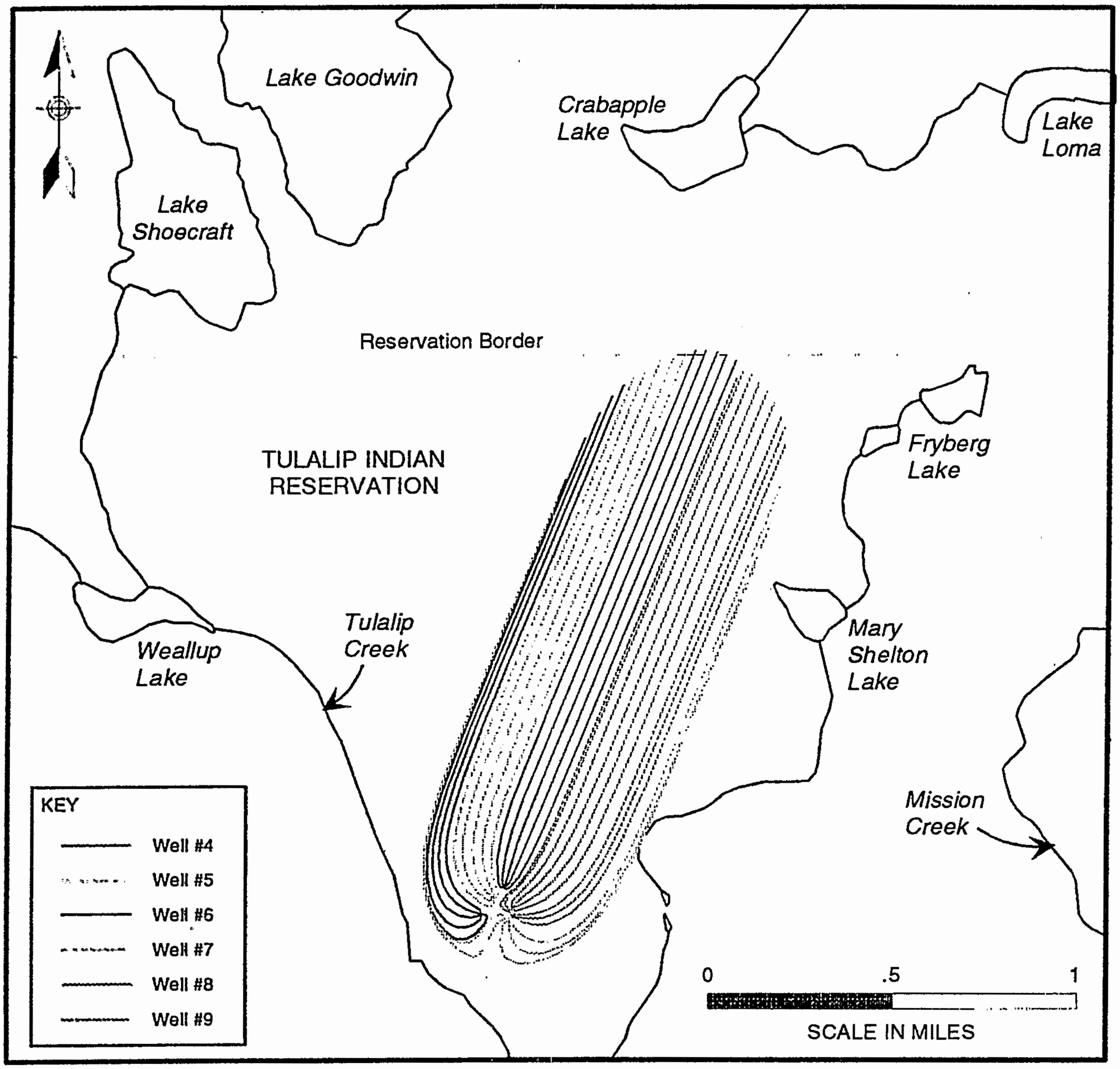


Figure A-2

25-YEAR ZONE OF CONTRIBUTION SENSITIVITY ANALYSIS - MAXIMUM WELL DISCHARGE

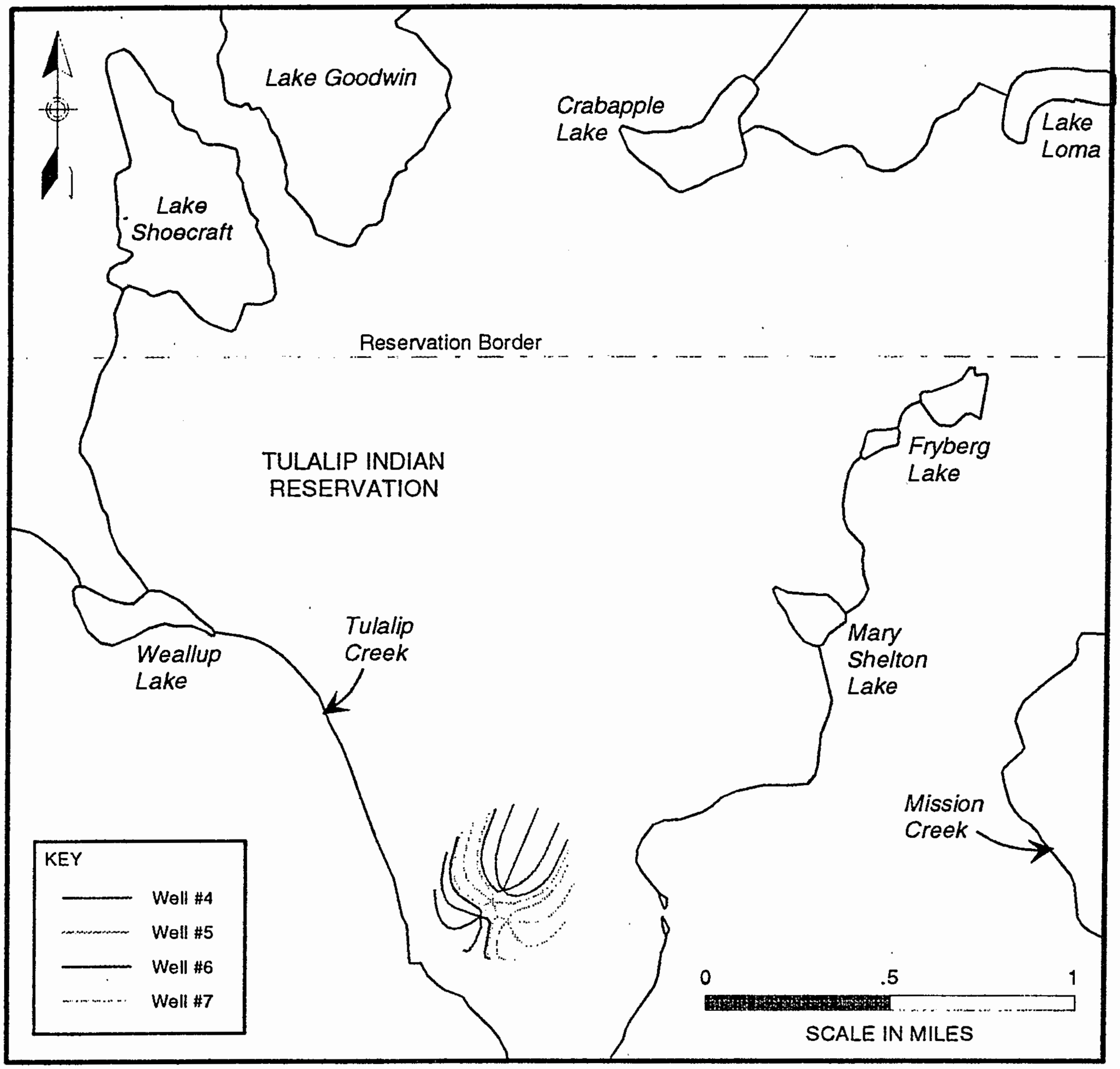


Figure A-3

25-YEAR ZONE OF CONTRIBUTION
SENSITIVITY ANALYSIS - MINIMUM TRANSMISSIVITY

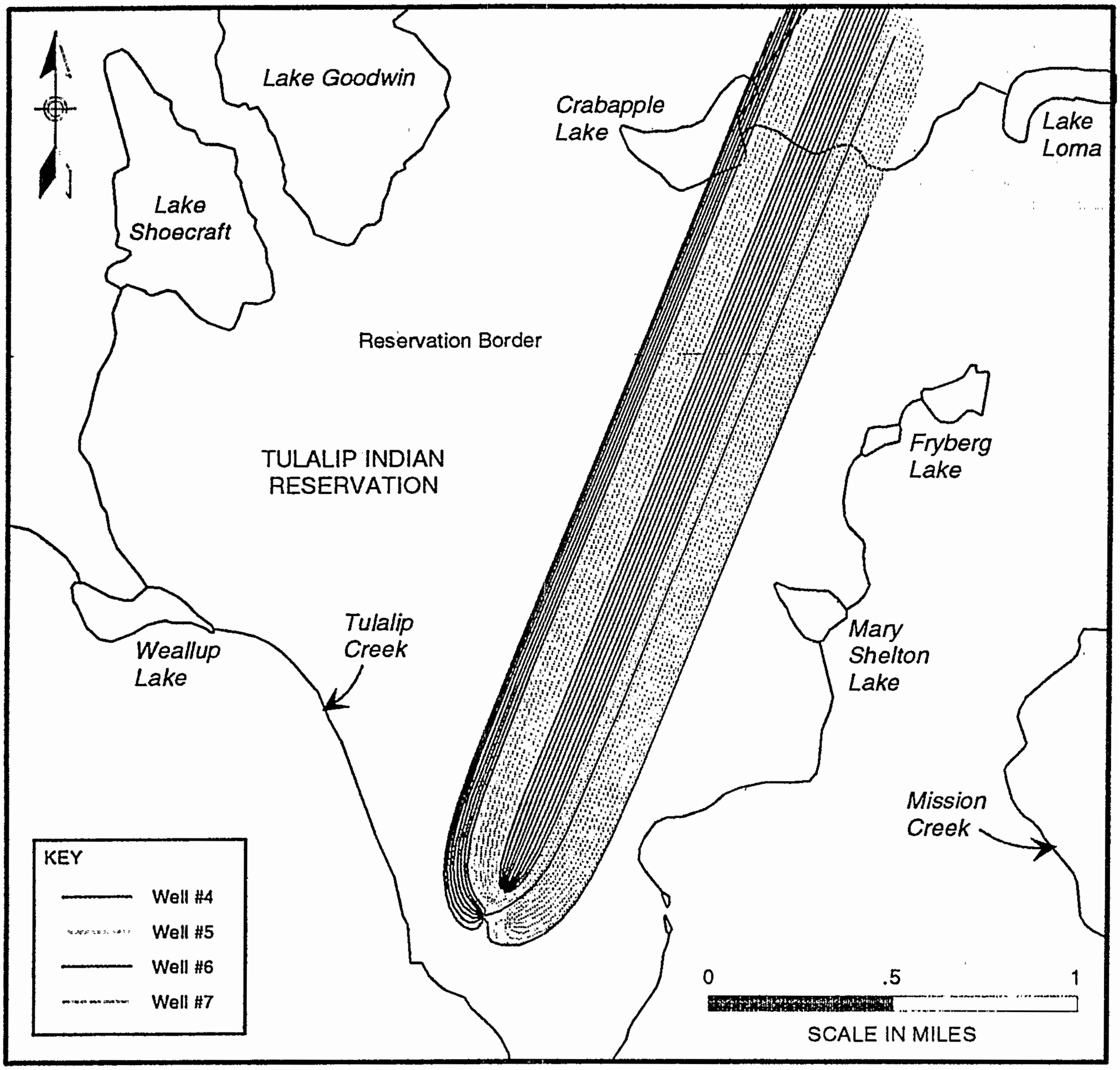


Figure A-4

25-YEAR ZONE OF CONTRIBUTION
SENSITIVITY ANALYSIS - MAXIMUM TRANSMISSIVITY

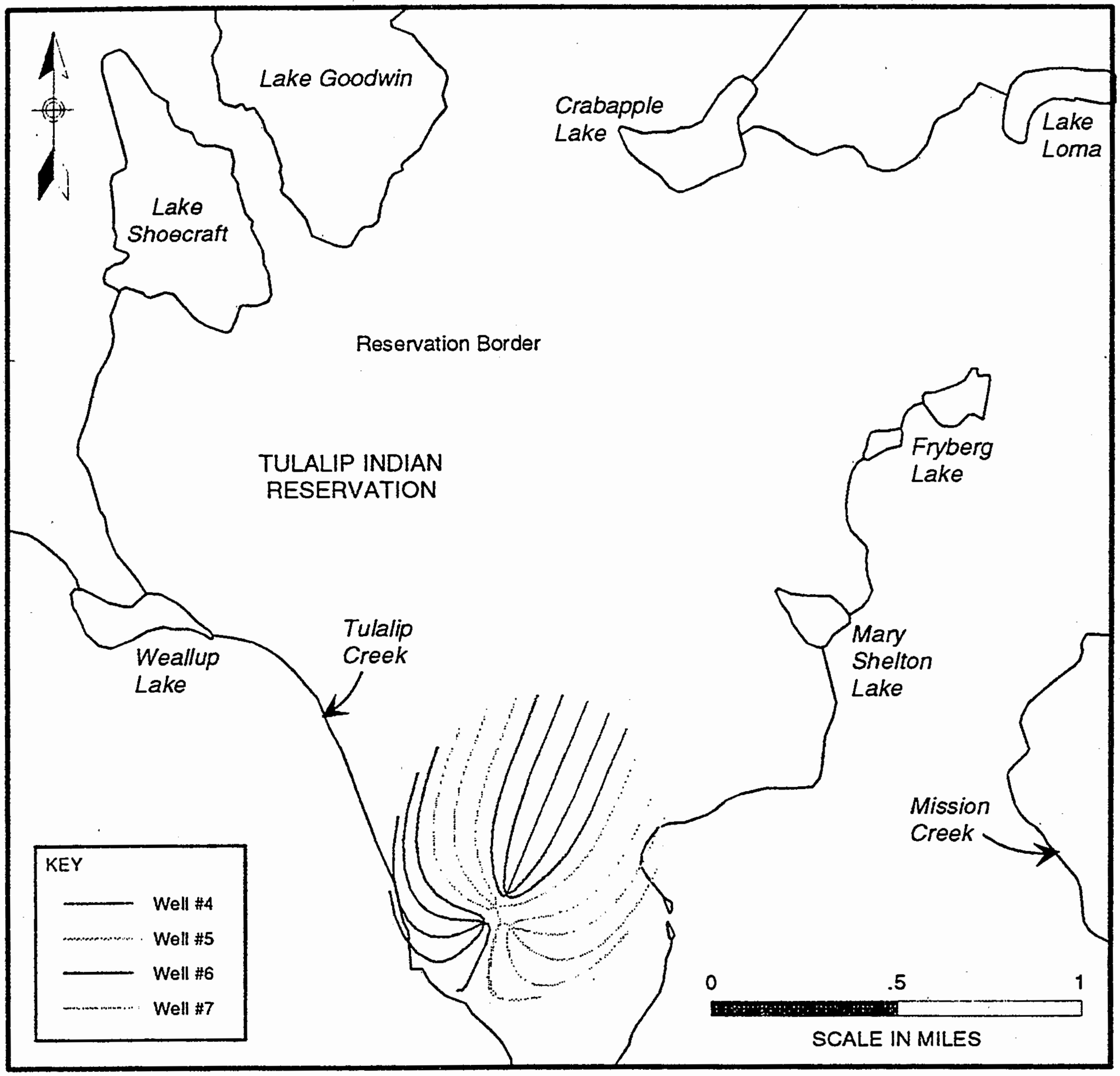


Figure A-5

25-YEAR ZONE OF CONTRIBUTION SENSITIVITY ANALYSIS - MINIMUM HYDRAULIC GRADIENT

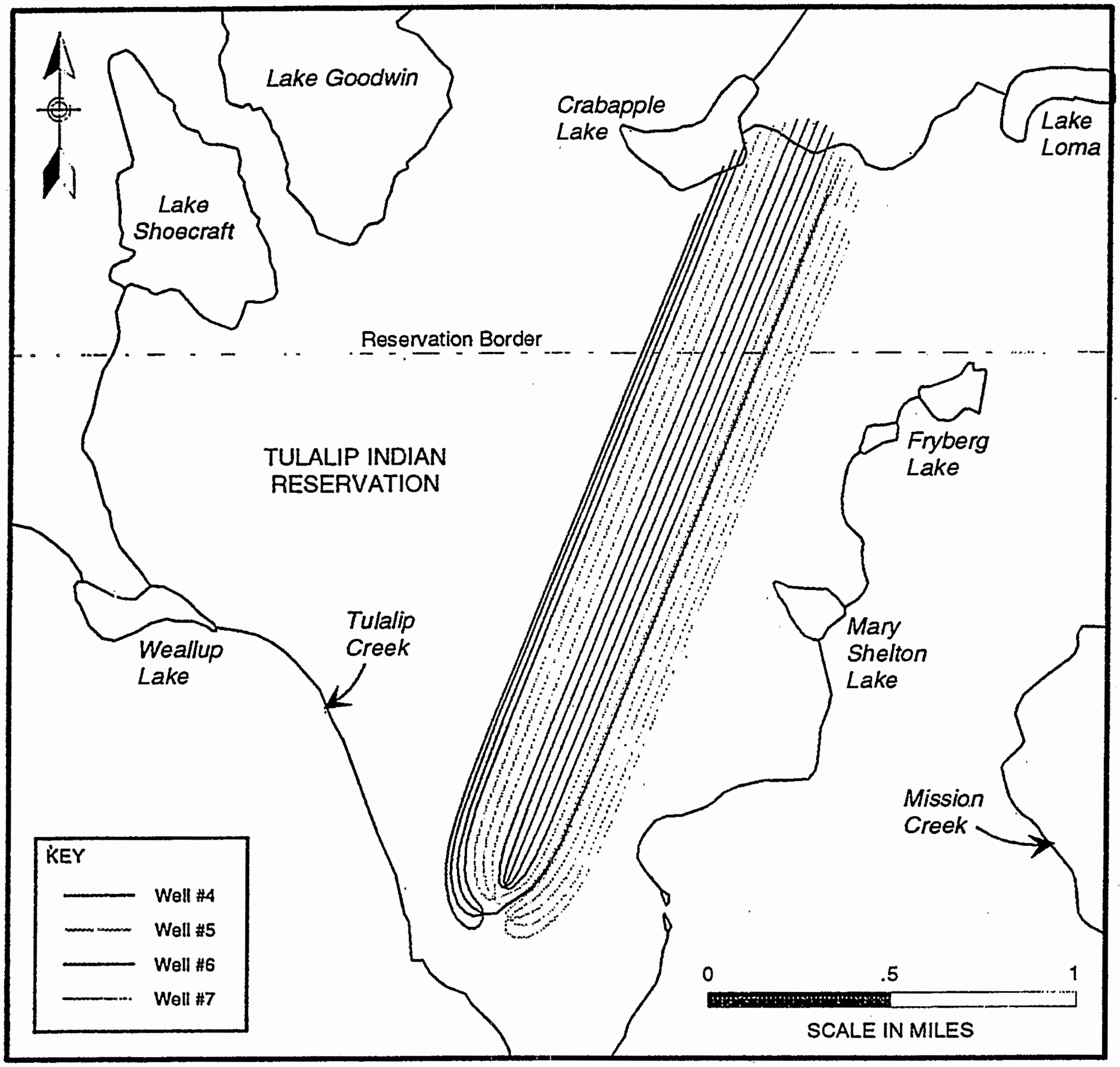


Figure A-6

25-YEAR ZONE OF CONTRIBUTION SENSITIVITY ANALYSIS - MAXIMUM HYDRAULIC GRADIENT

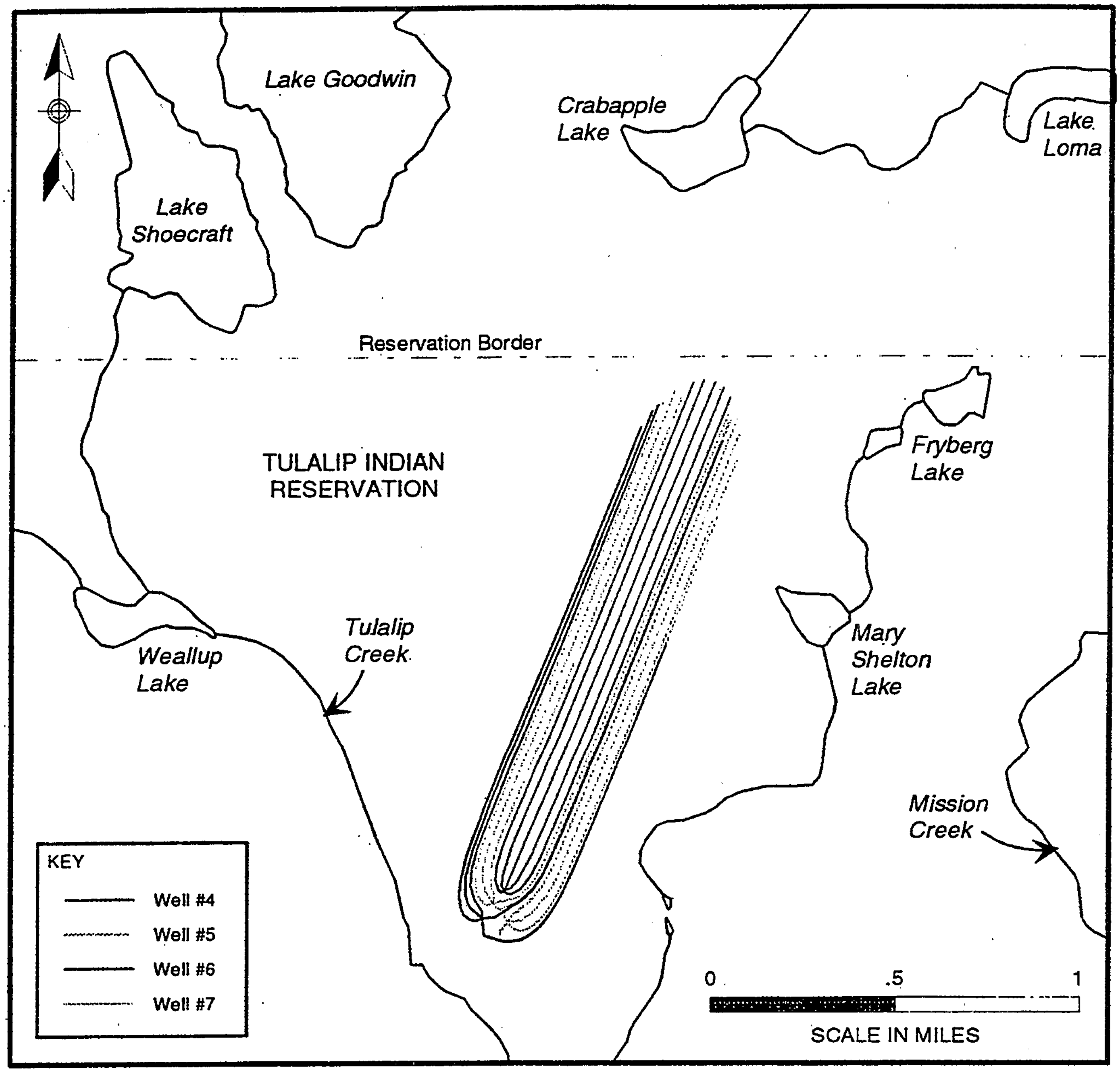


Figure A-7

25-YEAR ZONE OF CONTRIBUTION SENSITIVITY
ANALYSIS - MINIMUM CONFINING LAYER THICKNESS

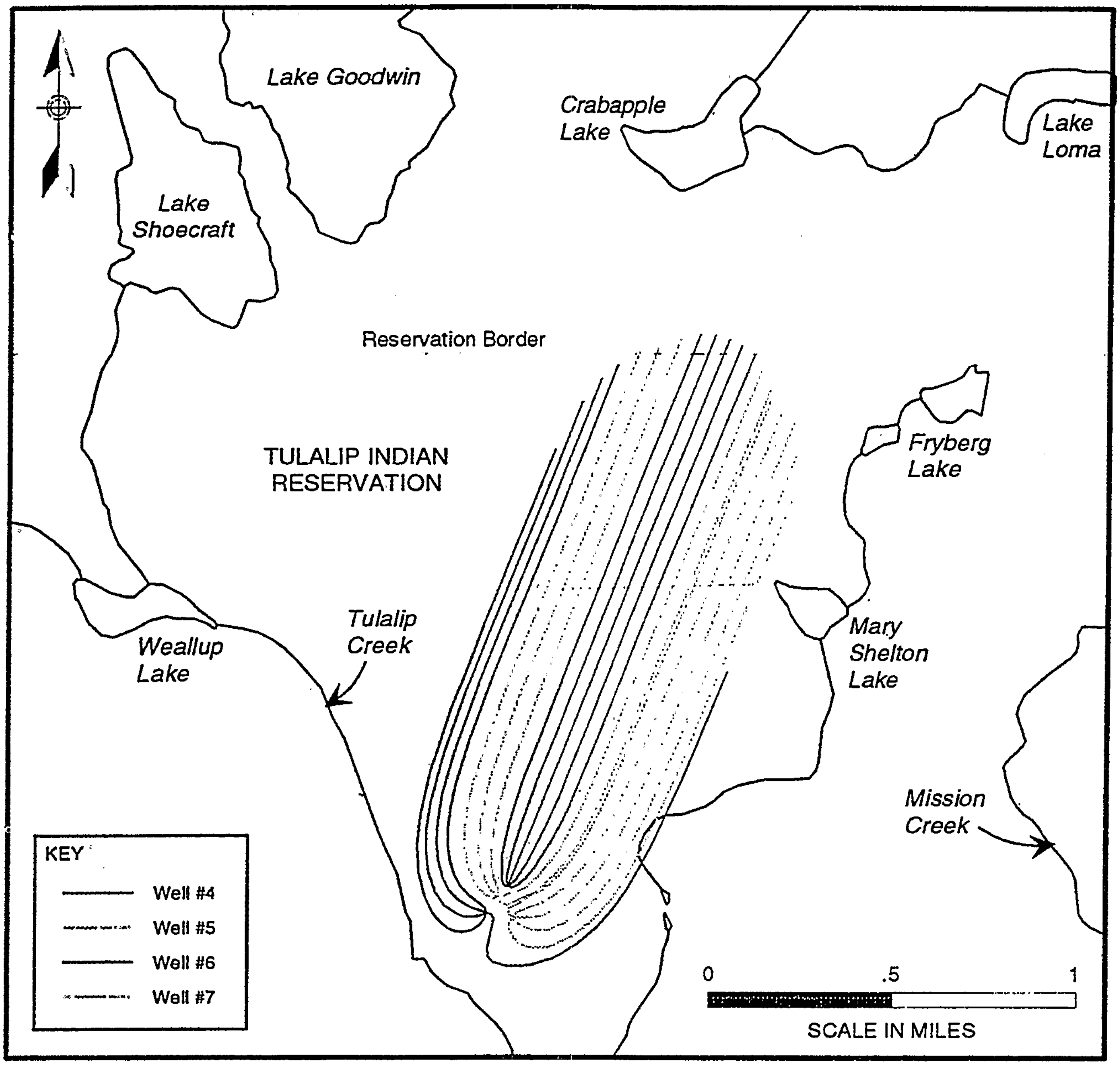


Figure A-8

25-YEAR OF CONTRIBUTION SENSITIVITY ANALYSIS - MAXIMUM CONFINING LAYER THICKNESS

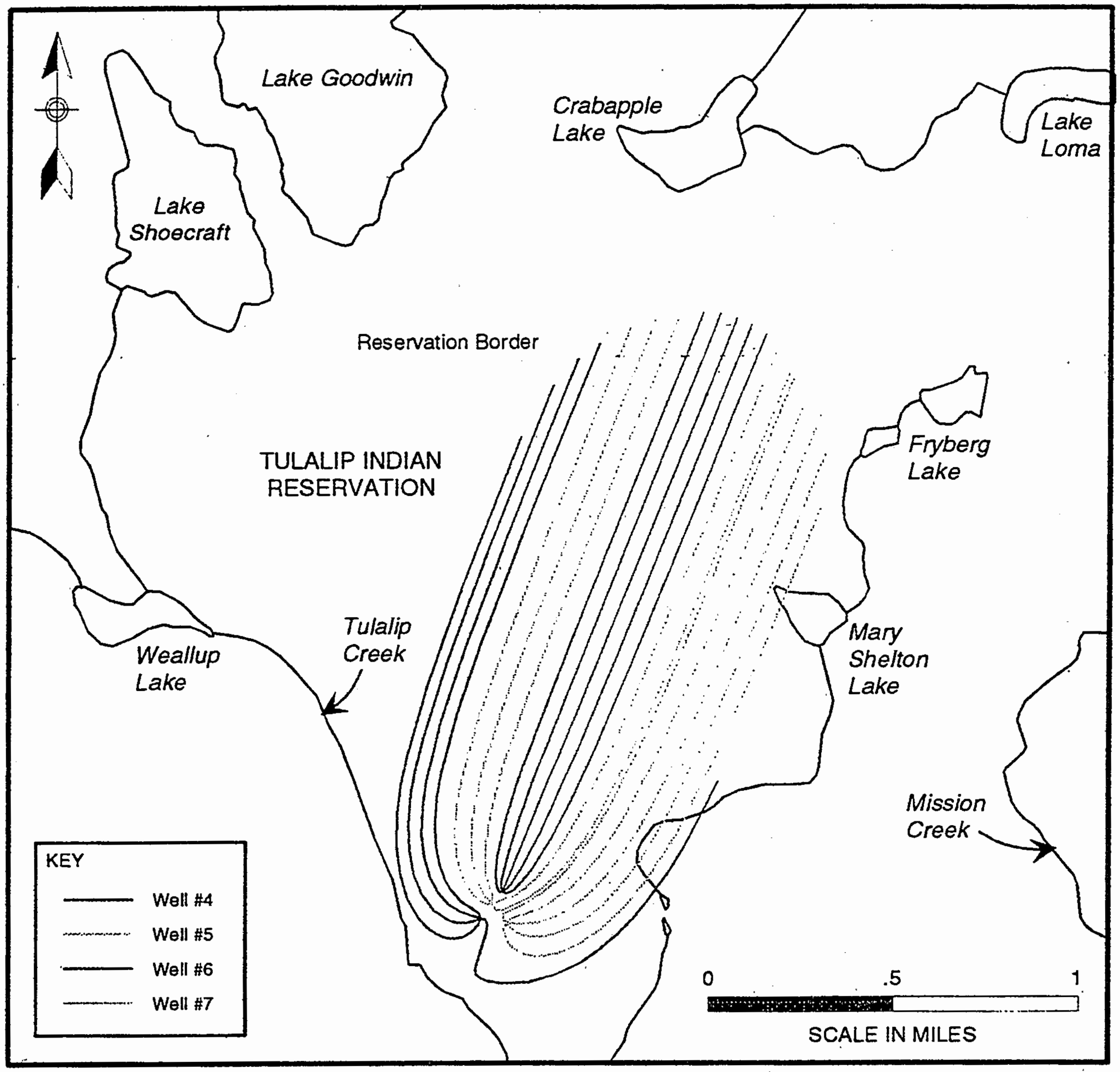


Figure A-9

25-YEAR ZONE OF CONTRIBUTION SENSITIVITY ANALYSIS - MINIMUM CONFINING LAYER HYDRAULIC CONDUCTIVITY

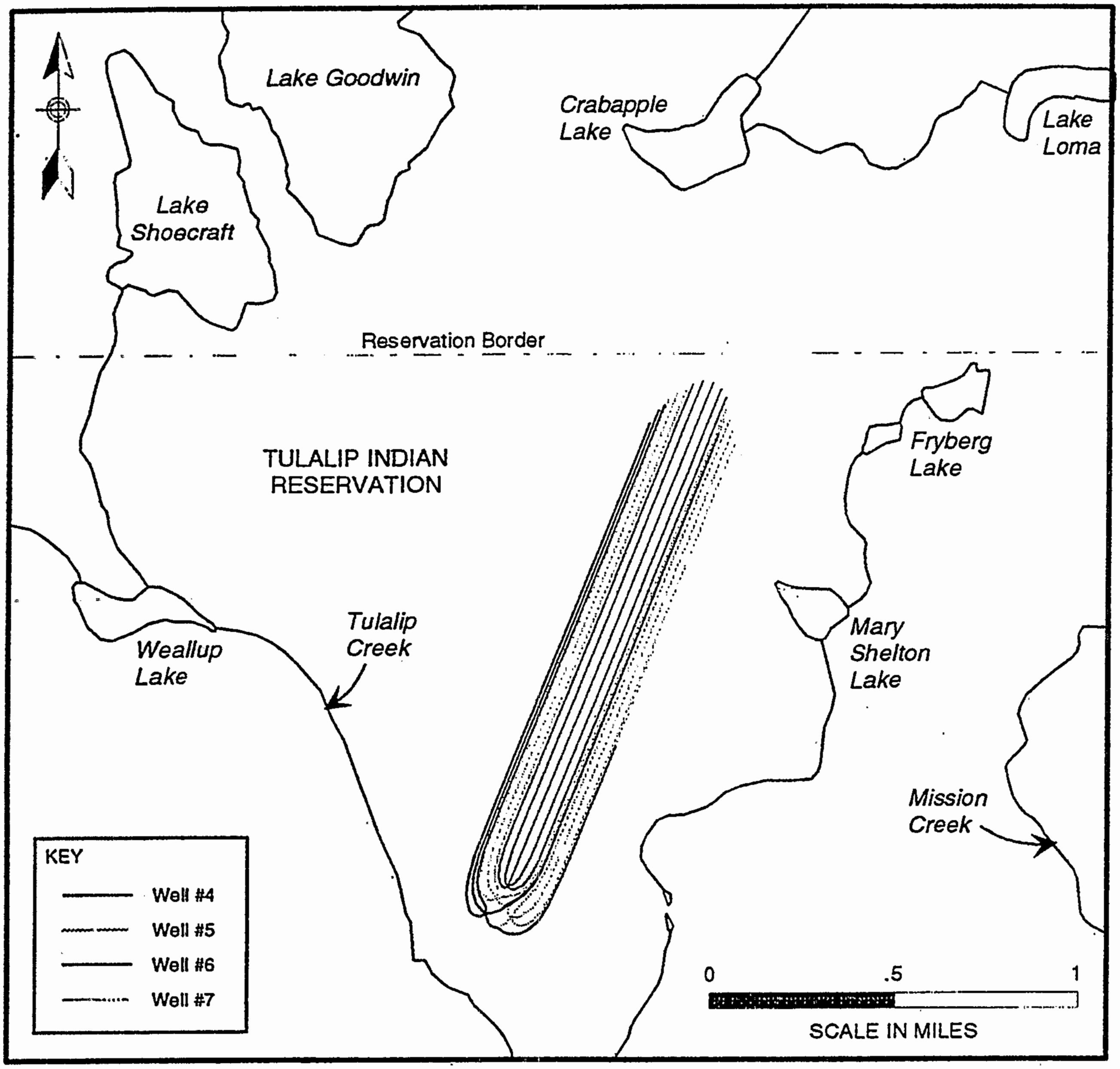


Figure A-10

25-YEAR ZONE OF CONTRIBUTION SENSITIVITY ANALYSIS - MAXIMUM CONFINING LAYER HYDRAULIC CONDUCTIVITY

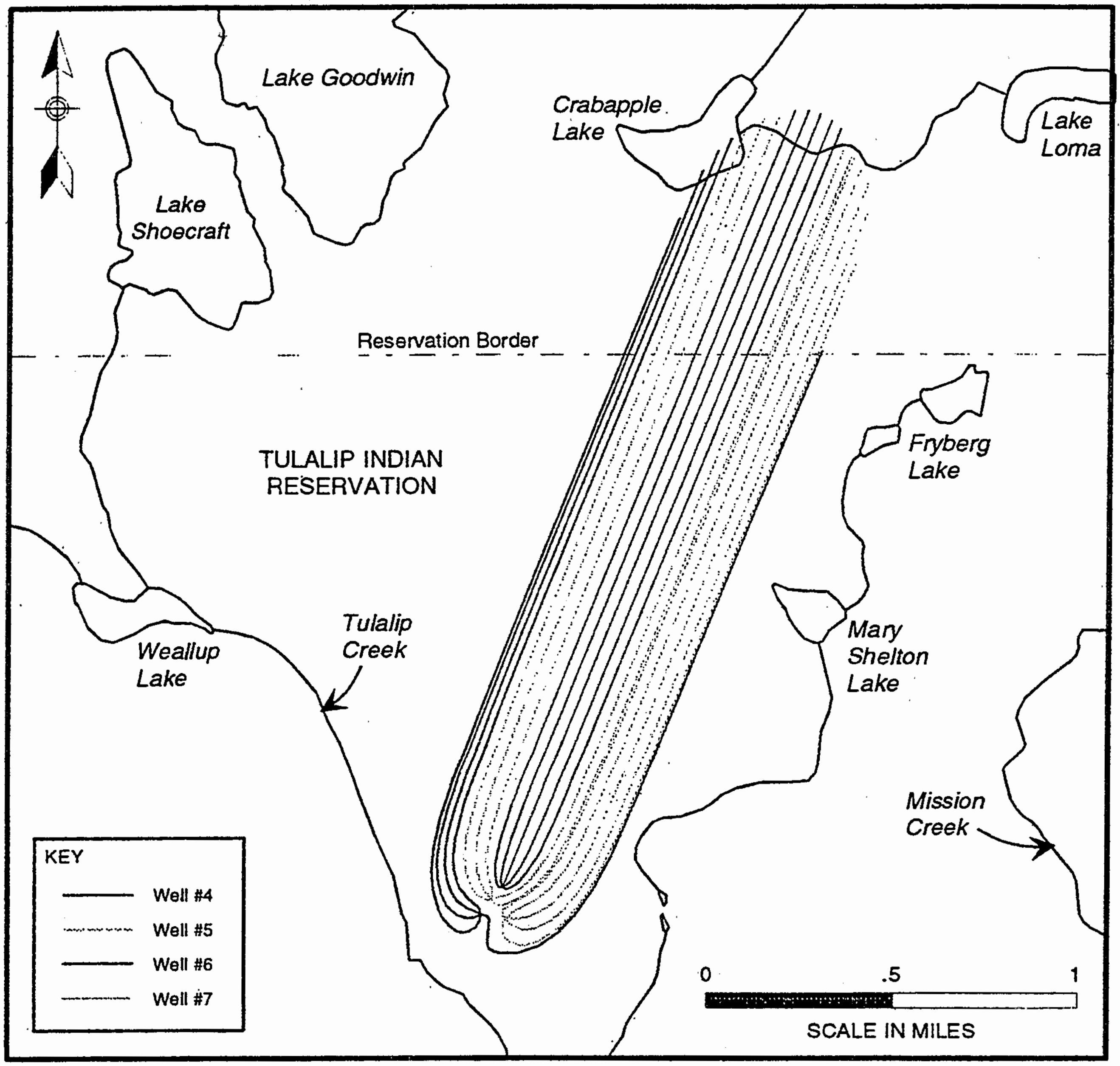


Figure A-11

25-YEAR ZONE OF CONTRIBUTION SENSITIVITY ANALYSIS - MINIMUM EFFECTIVE POROSITY

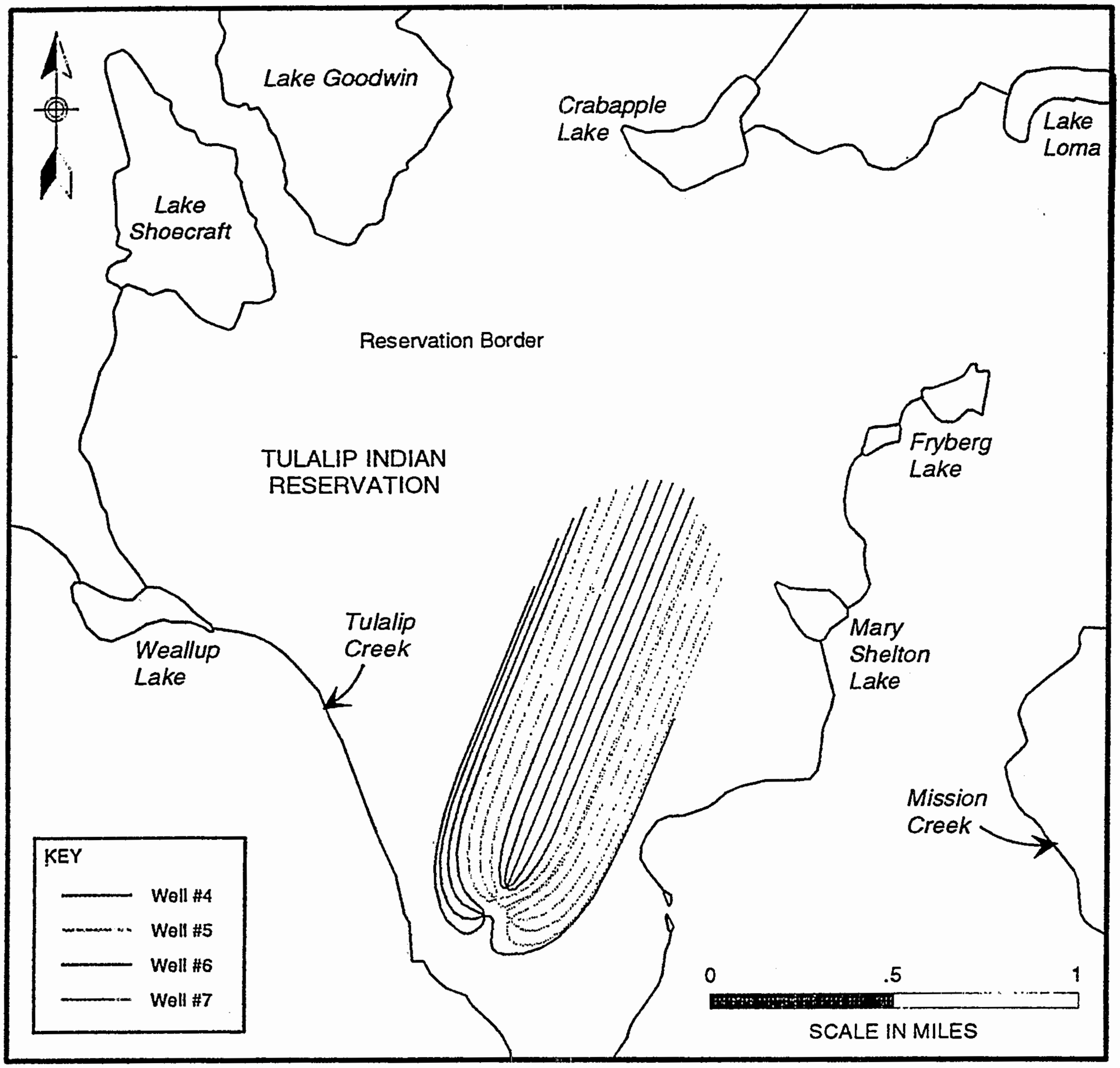


Figure A-12

25-YEAR ZONE OF CONTRIBUTION SENSITIVITY ANALYSIS - MAXIMUM EFFECTIVE POROSITY

BMPS FOR LAWNS AND GARDENS

LAWNS

Leave grass clippings on lawn to release nutrients as they decay.

Fertilize lawn with fertilizer that is time-released.

Apply water only when the weather does not provide enough natural moisture. Apply enough water to soak roots (not more than an inch per week even in the dry season).

Aerate lawn twice per growing season.

De-thatch lawn when thatch exceeds 1/2-inch thickness.

NUTRIENTS FOR LAWNS AND GARDENS

Apply fertilizer to match plant and soil needs. (Test soil to determine fertilizer needs.)

Read the label of fertilizer before you buy it.

FOLLOW FERTILIZER LABEL. DO NOT OVER FERTILIZE.

Time fertilizer application to match the garden needs.

DO NOT APPLY FERTILIZERS IN THE FALL.

Do not over water following fertilizer application. Nitrates can be leached to the groundwater.

BMPS FOR LAWNS AND GARDENS

PEST CONTROL FOR LAWNS AND GARDENS

APPLY CHEMICAL PESTICIDES ONLY AS A LAST RESORT; USE PHYSICAL AND BIOLOGICAL MEANS FIRST.

PHYSICAL MEANS OF PEST CONTROL

Time plantings so that plants peak at a time when the pest population does not peak

Recognize pests and remove the pests when their populations are small.

Prune infested plant parts and remove from area.

Remove insects by hand.

Establish barriers such as plant collars, wire mesh or tanglefoot to prevent access to pests.

Solarize soil (Place two layers of clear plastic sheeting over soil in hottest time of year. Allow soil to absorb heat and kill fungus and insect larvae for 4 to 8 weeks.)

BMPS FOR LAWNS AND GARDENS

BIOLOGICAL MEANS OF PEST CONTROL

Plant companion plants that deter plant predation.

Use pheromone traps or sticky traps to remove pests.

Select plants adapted to the northwest climate.

Rotate crops from year to year using different plant families in different garden locations.

CHEMICAL MEANS OF PEST CONTROL

USE CHEMICAL PESTICIDES ONLY AS A LAST RESORT. Insecticidal soaps are relatively non-toxic to the environment. Mineral-based chemicals are less toxic than botanical pesticides.

Use the appropriate pesticide to remove the pest.

USE THE LEAST PERSISTENT AND LEAST LEACHABLE PESTICIDE (See Table 4-1 for examples)

Read the label of pesticide before you buy it.

FOLLOW label directions. DO NOT OVER APPLY PESTICIDES.

BMPS FOR LAWNS AND GARDENS

PERSISTENCE AND MOBILITY OF VARIOUS PESTICIDES*

PESTICIDE PERSISTENCE		
Nonpersistent (half-life < 30 days)	Moderately Persistent (half-life > 30 days but < 100 days)	Persistent (half-life > 100 days)
Aldicarb (Temik®)	Atrazine (AAtrex®)	Bromacil (Hyvar®)
Alachlor (Lasso®)	Carbofuran (Furadan®)	DBCP (Nemagon®)
Butylate (Sutan®)	DCPA (Dacthal®)	Dieldrin (Alvit®)
Dicamba (Banvel®)	Glyphosate (Roundup®)	Diuron (Karmex®)
Metalaxyl (Apron®)	Metribuzin (Sencor®)	Picloram (Tordon®)
	Pronamide (Kerb®)	
	Simazine (Princep®)	
	Terbacil (Sinbar®)	
	Triallate (Fargo®)	
	Trifluralin (Treflan®)	

PESTICIDE MOBILITY		
Mobile (coefficient[a] < 30)	Moderately Mobile (coefficient > 30 but < 300)	Immobile (coefficient > 300)
Aldicarb (Temik®)	Alachlor (Lasso®)	Butylate (Sutan®)
Carbofuran (Furadan®)	Atrazine (AAtrex®)	DCPA (Dacthal®)
Dicamba (Banvel®)	Bromacil (Hyvar®)	Dieldrin (Alvit®)
Metalaxyl (Apron®)	DBCP (Nemagon®)	Diuron (Karmex®)
Picloram (Tordon®)	Metribuzin (Sencor®)	Glyphosate (Roundup®)
	Simazine (Princep®)	Pronamide (Kerb®)
	Terbacil (Sinbar®)	Triallate (Fargo®)
		Trifluralin (Treflan®)

* Source: Mulla, D.J. et al. Undated.

a Coefficient = Mobility coefficient as defined in Mulla, D.J. et al. (Undated) is an expression of the tendency to move with water through the soil media. The higher the coefficient the lower the mobility.

BMPS FOR LAWNS AND GARDENS

Do not mix chemical pesticides over pervious ground or within 100 feet of a well.

During mixing do not place end of hose into mixing container, because water can siphon back into well.

Mix only the amount of pesticide needed. Do not dispose of excess pesticide to septic system, within 100 feet of a well, near a water course, or to pervious ground. Dispose of excess pesticide in appropriately labeled container on a Snohomish County Hazardous Waste Collection Day.

Store chemical pesticides under a roof, away from precipitation, and away from extreme temperature changes.

BE PREPARED FOR A SPILL. Keep kitty litter or other absorbent available.

In the event of a spill:

> Stop the source of the spill.
> Contain the spill with sorbent.
> Cleanup the sorbent and contaminated soils.

BMPS FOR HOUSEHOLDS

CHEMICAL USE AND DISPOSAL

Use non-toxic products for cleaning in households. Less-toxic product substitutions can include:

USE:	AS A REPLACEMENT FOR:
Ammonia	Disinfectant
Dish of vinegar or lemon juice	Air Freshener
Borax	Bleach
Baking soda	Scouring Powder
Baking soda and toothbrush	Tile cleaner
Baking soda	Toilet bowl cleaner
Cornstarch paste	Stain Remover
Vinegar (2 tablespoons per quart of water)	Glass cleaner

DO NOT POUR PESTICIDES, PAINTS, SOLVENTS, THINNERS, GASOLINE, USED OILS, ANTIFREEZE, OR OTHER CHEMICAL PRODUCTS, OR RINSATE FROM CHEMICAL PRODUCTS ON THE GROUND OR INTO SEPTIC TANKS.

Store chemicals indoors.

Re-use paint thinner by allowing paint solids to settle in closed container and slowly pouring off upper layer of thinner.

PROTECTION OF WELLHEADS

These BMPs and mitigative measures apply to private as well as community wells. The area immediately surrounding each well is a potential pathway for pollutants to enter the groundwater.

WELL CONSTRUCTION

Ensure well is properly sealed at the surface.

Properly seal abandoned wells.

If well is greater than 15 years old, use a downhole video camera to assess integrity.

ACTIVITIES AROUND WELLHEAD

Do not mix, store, or apply pesticides, herbicides or other chemicals within 100 feet of the well.

Do not wash vehicles or equipment within 100 feet of well head.

Direct stormwater away from the wellhead.

Protect the well from unauthorized entry with fencing.

BMPS FOR HOUSEHOLDS

Allow moisture from small quantities of latex paint to evaporate, then dispose of cans in a garbage can or landfill.

SPILLS

For spills of chemicals to ground,

Stop the source of the spill immediately
DO NOT FLUSH WITH WATER
Control spill using absorbent such as kitty litter
Remove contaminated sorbent and soils
Dispose of contaminated absorbent and soils in trash

SOLID WASTE

Store solid waste in appropriate trash bins and dispose of at a landfill

Recycle as much as possible

BMPS FOR SEPTIC TANKS

SEPTIC TANK USE

DO NOT POUR EXTRA CLEANING CHEMICALS, PAINTS, SOLVENTS, PESTICIDES, OR OTHER HOUSEHOLD CHEMICALS INTO DRAINS THAT DISCHARGE TO THE SEPTIC SYSTEM.

DO NOT USE SEPTIC TANK ADDITIVES.

Do not flush materials that are difficult to decompose (e.g., hair, baby diapers, tampons, cigarette butts) into the septic system.

Install water-saving devices to reduce the amount of wastewater generated.

Balance water use activities evenly over a week to reduce the hydraulic loading to the septic system. For example, do not wash several loads of laundry, run the dish washer, and discharge a bath tub all within a short period of time.

SEPTIC TANK AND DRAINFIELD MAINTENANCE

Pump septic tank every 3 to 5 years. In the interim inspect to ensure sludge has not accumulated to more than one-third the depth.

If a garbage disposal is used, pump the septic more frequently than once every 3 to 5 years.

Maintain accurate inspection and tank pumping records.

BMPS FOR SEPTIC TANKS

Protect the drainfield. Encourage grass to grow over the drainfield.
Don't allow soils over drainfield to become compacted by using area to graze large animals, store heavy equipment, or as a patio. Do not cover drainfield with impermeable surface such as plastic or paving.

DO NOT PARK ON DRAINFIELD

Divert stormwater from roofs and runoff away from drainfield.

PROTECTION OF WELLHEADS

SPILLS

In the event of a spill in the vicinity of the well:

Eliminate source of spill.
Confine spill and direct away from wellhead.
DO NOT FLUSH WITH WATER.
Clean up spill with absorbent.
Excavate contaminated soils

STORM DRAIN PROTECTION

STORM DRAINS

Storm drains can function to directly recharge the aquifer or surface waters. Care should be taken to ensure that wastes are not inadvertently or intentionally disposed of to storm drains. A public education campaign can serve to heighten awareness in the community.

DO NOT POUR CHEMICALS SUCH AS USED OILS, SOLVENTS, PAINT OR PAINT WASTE, AND HOUSEHOLD CLEANERS DOWN STORM DRAINS.

Stencil all drains with signs that state: DO NOT POUR CHEMICALS DOWN DRAIN.

Develop and maintain grassy swales for stormwater designed for 10-year storm event, where feasible

FORESTRY

FOREST PRACTICES

An integrated pest management plan should be developed and implemented for forestry practices.

Ensure any pesticides applied to forest lands are applied by certified pesticide applicators.

Ensure pesticides are applied at times and frequencies specified on the label and at application rates no greater than specified on the label.

During tree harvesting, use equipment that will result in the least compaction of soil as possible.

Replant the area quickly.

BMPS FOR TRANSPORTATION CORRIDORS

BMPS FOR TRANSPORTATION CORRIDORS

Prepare a spill plan for petroleum products being transported across highway in the recharge area.

Delegate specific spill responders and an emergency coordinator and train them.

Coordinate with local spill response agencies before a spill.

Purchase and provide easy access to spill response equipment such as absorbent pads and booms for spills.

Provide the local population with emergency phone numbers to report spill events.

Contain and confine spill. DO NOT WASH SPILLS DOWN WITH WATER. Remediate as quickly as possible.

RECREATIONAL USE OF LAKES

Lakes located in the recharge zone of an aquifer can serve as windows for entry of pollutants from the lake into the groundwater. Care should be taken to minimize the addition of such pollutants as diverse as oils, aquatic pesticides, and bacteria from human or animal use.

SPILLS PREVENTION AND CONTROL

Prepare a spill plan for motor fuel spills on lakes.

Designate a spill coordinator and spill responders.

Provide training for spill responders.

Provide local population with emergency phone numbers to report spills.

Post emergency numbers in boat launching areas and marinas.

Purchase and provide easy access to sorbent pads and booms for spills on the lake.

Control and contain spill with sorbent pads.

Remediate spills as quickly as possible.

GLOSSARY

Alkalinity - the amount of carbonate or hydroxide of usually lithium, sodium, potassium, rubidium, cesium, or francium, the aqueous solution of which is characteristically basic in reactions.

Anionic - negatively charged chemical species that attract positive ends of the water molecules.

Aquifer - rock or soil in a subsurface formation that is sufficiently permeable and saturated to yield significant quantities of water to wells.

Aquitard - a confining layer that slows but does not prevent the flow of water to or from an adjacent aquifer; a leaky confining layer.

Best Management Practices (BMPs) - suggested methods of implementing an activity or set of activities that provide a greater degree of protection for the resource.

Biochemical Oxygen Demand (BOD) - the amount of dissolved oxygen required by bacteria to decompose organic material under aerobic conditions; the BOD is considered a useful expression of pollutant loads.

Cone of Depression - a depression of the groundwater table surface or the potentiometric surface that has the shape of an inverted cone and develops around a well that is being pumped.

Confining Layer - a hydrogeologic unit of impermeable or distinctly less permeable material bounding one or more aquifers, an aquitard.

Downgradient - in the direction of groundwater flow.

Drawdown - effect of pumping that extends a given distance radially from the well, with the radius a function of well construction, pumping rate and duration, and aquifer properties.

Groundwater - water contained in the interconnected pores below the ground surface and in the saturated zone.

Recharge - water that percolates down from the land surface through the unsaturated zone to the water table.

Semi-confined Layer - aquifers that lose or gain water through adjacent less permeable layers.

Steady-state Zone of Contribution - the surface or subsurface area surrounding a pumping well that supplies groundwater recharge to the well over an infinite period of time.

Suspended Solids - undissolved particles that are carried with the flow of water, greater in diameter than 50 angstroms and removable by filtration.

Time of Travel - the time required for a particle of water or a contaminant to move in the saturated zone from a specific point to a well.

Time-dependent Zone of Contribution - the surface or subsurface area surrounding a pumping well that supplies groundwater recharge to the well over a set period of time.

Transmissivity - the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

Turbidity - a measure of water clarity based on the amount of total solids (dissolved and suspended) in water.

Unconfined Aquifer - conditions in which the upper surface of the zone of saturation forms the water table.

Upgradient - in the opposite direction of groundwater flow.

Water Table - the top surface of the water saturated zone or potentiometric surface in an unconfined aquifer.

Well Discharge - the volume of water pumped from a well in a certain time period.

Wellfield - an area containing two or more wells.

Wellhead - the location where a well enters the ground. Usually a pump is mounted on top of the wellhead inside of a well house.

Wellhead Protection Area (WHPA) - the surface and subsurface area through which contaminants are likely to move toward and reach a water well or wellfield.

Zone of Contribution (ZOC) - the area surrounding a pumping well that contributes water to the well.

Final
Gila River Indian Community
Comprehensive Wellhead Protection Strategy

Prepared for:

Gila River Indian Community
Water Quality Planning Office

Prepared by:

CH2M HILL
and
Lee Wilson & Associates

October 1994

REGISTERED GEOLOGIST
CERTIFICATE NO.
21614
PETER A.
MOCK
Date Signed 10/20/94
ARIZONA, U.S.A.

Section 1
Wellhead Protection Strategy Executive Summary

Introduction

A Wellhead Protection (WHP) Strategy has been developed to provide the Gila River Indian Community (GRIC) with analysis of the existing groundwater conditions, concepts relevant to WHP for GRIC, and a specific set of steps for implementation of a WHP Ordinance. In particular, the strategy has the goal of developing an effective management tool integrated into GRIC's existing structure which GRIC can use to protect their sole source of drinking water: groundwater pumped from wells.

The scope of the present WHP Strategy effort is to address the drinking water wells in Basin A. Basin A contains the largest concentration of drinking water wells and potential contaminant sources (see Attachment L). Given the limited funding available to GRIC, this represents a useful start, and once implemented, allows a quick expansion to address the rest of GRIC (Basins B, C, and D). New wells will also be evaluated with the same process.

WHP was selected by GRIC as a beginning to its water quality management efforts because it is an extremely efficient focusing of efforts on only the most pressing threats to public health at GRIC. Only the wells used for drinking water supply, the areas on the ground which can lead to contaminating them, and contaminants that have a high likelihood of reaching the wells are addressed. This is far more cost effective than the more common regulatory approach of regulating all areas and all contaminants. More complete regulation can be pursued in the future, but WHP places the first several lines of defense in place quickly, and within the current administrative structure at GRIC.

Thresholds and Criteria

The standards for groundwater to be protected at GRIC were identified in an earlier report to EPA, which became part of EPA's report to Congress: the 1992 Community Water Quality Assessment under Section 305[b] of the Clean Water Act. A key finding of GRIC's 305[b] report was that the Community decided to benefit from the huge investment made by EPA in evaluating risk from various chemicals in drinking water and adopted the federal Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs). The one exception was that GRIC reinstituted an older, more stringent fluoride standard to protect children's teeth from mottling.

The criteria selected by GRIC for WHP was the time of travel to the selected wells. The closest zone to the well, Zone 1, was defined as a fixed radius of 200 feet which was assumed to have a essentially immediate travel to the well. Zone 2 was defined as the zone of groundwater which would travel to and be pumped up by the well in a 5-year period (the expected length of time at GRIC to replace a well). The final zone, Zone 3, was defined as the 40-year time of travel zone (the likely service life of a well at GRIC).

The wells selected for protection were those wells within Basin A which were public water supply wells under the definition of such from the SDWA: 15 service connections and/or 25 people served at least 60 days per year which would use the water, at least partially, for drinking. Thirteen such wells in Basin A were identified by GRIC Water Quality Planning Office (WQP) and were carried through the entire WHP Strategy development process.

WHPA Delineation

The delineation of the time of travel zones was a difficult effort because of the complex geology beneath GRIC and the dynamic groundwater flows which change with time from agricultural season pumping and river recharge events. First, an overall groundwater budget was developed for GRIC. Then a computer simulation was developed from the water budget which compared the simulated groundwater levels to over 100 water level measurements made in wells across GRIC. Next, small quantities of groundwater, called particles were tracked in specialized computer simulations of the groundwater system beneath GRIC from the sources of water to the wells of interest. The areas in the simulation containing all of the small quantities of groundwater which ended up at a well after a set period of time defined the time of travel zones. The 5- and 40-year time of travel zones allowed the definition of Zones 2 and 3 around each of the 13 wells in Basin A.

Contaminant Source Inventory

A preliminary inventory of potential contaminant sources was made in and around the zones defined as above. Irrigated fields were found in each zone, as were laterals for delivery of irrigation water. More than 20 septic tanks and more than 20 industrial or commercial loading/use areas were found or thought to exist in WHPAs. Highways, roads, or railroads; and active or abandoned wells were the next most common potential sources found. A preliminary ranking of the potential contaminant sources at GRIC in Basin A in the vicinity of the Wellhead Protection Areas (WHPA) began with sewage treatment facilities, because of the potential for pathogens to move from older, pre-IHS, systems. Next likely would be solvent and fuel storage tanks associated with commercial and industrial facilities. Other rankings are possible, but pathogens, solvents, and fuels were judged to represent the highest hazard to the WHPAs among the potential contaminants and sources reviewed here.

Management Approaches

Two management approaches identified for WHPAs in GRIC were regulatory and non-regulatory. Regulatory approaches included:

- Laws and regulations
- Permits
- Standards
- Monitoring
- Enforcement

and typically use either land use controls (which specify the means) or performance standards (which specify the desired end result). Non-regulatory approaches included:

- Policy statements
- Studies
- Action plans
- Data collection
- Education programs
- Technical assistance
- Best management practice promotion
- Special programs

Land ownership and zoning were compared with the WHPAs delineated in this project. Most of the WHPAs contain some allotted lands which will require communication and approval from allottees to promote various proposed programs. Most of the WHPAs comprise agricultural or open land zoning, which should make for a simple WHP implementation program. Some commercial zoning is found in WHPAs which requires a balancing of requirements.

There were numerous individuals consulted for the federal, state, non-GRIC tribal and other entity programs relevant to GRIC. The more successful programs in Spokane, Washington, and the Santa Clara Pueblo, provided useful ideas for GRIC's program development. The many land use, sanitation, and environmental programs already working at GRIC provide a framework within which WHP can be implemented at minimal additional cost.

Contingency Planning Concepts

A wellhead contingency plan sets forth the response of a water system to a specific contamination event which poses a serious immediate or long-term threat to the water supply; it provides for protection of public health and continuing provision of an adequate water supply. (Contingency plans also may deal with other threats to water service, such as natural disasters and terrorism.)

If a GRIC well were to be contaminated, potential responses would fall into the following categories:

- When there is some indication of pollution (e.g. routine monitoring observes an elevated level of a contaminant, or there is a known pollutant release from a spill or facility), it is sometimes sufficient to expand a monitoring program. Expanded monitoring can involve a greater frequency of measurements (e.g. at a public supply well), testing for additional parameters and/or drilling of special monitoring wells (e.g. between a pollution source and a public supply well).

- When pollution is observed, either at a source or at a well, aquifer remediation (clean-up) is often an option.

- If monitoring demonstrates that a well is contaminated to an unacceptable level, and aquifer clean-up is not a viable option (at least not in the short-term), then there are essentially two choices: install a treatment facility to clean up the water produced by the well; or use a different water supply to supplement (blend) or replace the contaminated well, on a temporary or permanent basis. Analysis of the problem and the best solution will depend on the site-specific aspects of the pollution.

In general, the third category is the most critical for contingency planning, since if a well is producing badly contaminated water, there will be an immediate need to provide a potable supply. Each emergency will differ as to time and form, and options such as clean-up, treatment or replacement can only be analyzed in the context of site-specific data. The option selected by GRIC in any given case would vary depending on the circumstances of the particular situation.

Water Quality Monitoring Considerations

There are five primary approaches that can be taken to groundwater quality monitoring of WHPAs:

- At the public water supply well
- At the boundary of the WHPA
- At point sources
- At non-point sources
- At non-specific locations

Monitoring at the *public water supply well* addresses the critical point of use, but allows widespread contamination of the WHPA prior to detection, and, because monitoring can not practically be conducted continuously, this approach could inadvertently allow use of contaminated water from the well for some time prior to detection.

Monitoring at the *boundary of the WHPA* addresses outside influences on the WHPA and allows for natural processes to attenuate contaminants before they reach the well, but it doesn't address internal sources and is subject to uncertainty in the delineation of the WHPA and changes in the WHPA should conditions change in the future.

Monitoring at *point sources* is the standard method implemented by federal and state agencies (see RCRA for example) for protecting groundwater. It is effective if the monitoring system is properly designed, constructed, and implemented, but is costly to the facility and leads to difficulties in defining a significant difference between natural (or background) concentrations and potential releases.

Monitoring at *non-point sources* has the same advantages and disadvantages as monitoring at point sources, with the additional disadvantage that there is rarely a facility operator to conduct the monitoring. However, existing wells can often be used for this type of monitoring.

Monitoring at *non-specific locations* has the ability to detect unanticipated sources. A drawback to this is that identification of placement rationale (other than blanket or grid coverage) is difficult to develop.

Section 12 describes a specific monitoring plan developed for the WHPAs in Basin A which balances the considerations above and the limited financial resources available to GRIC.

Proposed Actions

Part IV presents the action plan for wellhead protection at GRIC. Section 10 outlines a proposed ordinance for the Wellhead Protection Program and Section 11 discusses individual elements of the ordinance. Part IV also proposes specific management actions for groundwater monitoring (Section 12), development of a contingency plan (Section 13) and implementation of the Wellhead Protection Program (Section 14).

We have purposely not developed the ordinance to its full extent until the major proposed elements of the ordinance can be reviewed and commented on by the Tribe and other parties and individuals. Once the major elements have been accepted by the Tribe, the Water Quality Planning Office will proceed with development of the detailed ordinance.

Proposed Wellhead Protection Ordinance

The GRIC is fortunate in having in place a strong foundation for the WHP program. Because of this, the Water Quality Planning Office can achieve wellhead protection through the coordination and expansion of the existing regulatory programs, by means of: 1) developing and implementing a wellhead protection ordinance; 2) establishing and integrating WHP sensitive overlay zones into other zoning; and 3) regulating potential contaminant sources by imposing Activity Protection Assurance Requirements.

The critical concept in Wellhead Protection is to eliminate or reduce pollution sources within WHPAs, which are the areas that contribute flow to public supply wells. There are three zones for each well:

- Zone 1 is the area in the immediate vicinity of the well (within 200 feet), where a contamination event could effect the water withdrawn from the well within a year or less;

- Zone 2 is the area representing a 5-year travel time to the well, and extends hundreds to thousands of feet from each well; and

- Zone 3 is the 40-year travel time area, which can extend several miles upgradient from a well.

Within the designated WHPA sensitive overlay zones, high risk land uses would be banned and activities posing a moderate or low risk would be regulated to reduce the potential for aquifer contamination. The level of risk is determined by the types and quantities of regulated substances used by the activity. The regulations would involve Activity Protection Assurance Requirements, such as: requirements for the preparation of Emergency Preparedness Plans and/or Hazardous Substance Management Plans; use of Best Management Practices (BMPs) in the construction and operation of a facility; specific performance standards for facility construction and operation; inspection and monitoring requirements, and other regulations as deemed necessary. The requirements would be designed to be more protective in Zones 1 and 2 than in Zone 3, more stringent for higher risk uses than for lower risk uses, and more stringent for new uses than for existing uses.

Prohibited activities would be addressed in the process of reviewing land use actions and other permits.

Groundwater standards are accepted here as current federal MCLs plus the older fluoride standard to protect children's teeth.

Because they are primarily industrial use wells, the WHPAs for the Lone Butte wells, Firebird Lake well, and Tribal Farms wells have less restrictive requirements.

There are two major categories of potential contamination that do not lend themselves to the approach described above - agriculture, and spills and illegal dumping.

- To reduce the potential for pollution from agricultural uses the Tribe would establish a public education program and monitoring program; and it would ensure that wellhead protection concerns are reflected in the groundwater management plan being developed for the pesticide program.

- To address spills and illegal dumping the Tribe has outlined a series of non-regulatory measures that would be implemented by the Tribe to reduce the incidence of illegal dumping such as establishing a telephone hotline. The Tribe is also proposing development of an ordinance, review of the emergency response plan to assure wellhead protection concerns are reflected in that document, and developing guidelines on remediation strategies and standards for common types of spills so that response actions can be taken swiftly.

In addition to the establishment of WHPA zones, the regulation of uses within those zones, and the provisions for special uses, the Water Quality Planning Officer would implement other WHP actions such as reviewing current well construction standards; developing guidelines on how to deal with specific types of contaminant events and establishing standards for effective remediation; preparing a comprehensive contingency plan to deal with a loss of supply; establishing and implementing the groundwater monitoring strategy; and developing a public education program.

Proposed Groundwater Quality Monitoring Plan

Given the financial constraints on the GRIC, three levels of monitoring are proposed, which represent differing levels of cost and protection. The Water Quality Planning office will recommend to the Tribal Council that the Level 3 monitoring be implemented and acted upon, preferably during Fiscal Year 1995.

Level 3 consists of monitoring water pumped from each of 13 WHPA wells for: Field Parameters on a monthly basis; Volatile Organics and Purgeable Aromatics, Fluoride, Nitrate, and Pathogenson a quarterly basis; Pesticides, Herbicides, and Trace Metals on an annual basis; Radioactivity, and Polynuclear Aromatic Hydrocarbons on an every 4 year basis. We estimate 80 person-days per year and $35,000 per year is needed for this level. Monitoring of the new wells will be on the same schedule and for the same parameters as for the WHPA wells in Level 2 described above. The new monitoring wells would be located to test for: the potential for contamination from sources along the Gila River; the potential for contamination from canals or from irrigation deep percolation; and potential point-source contamination. Estimated installation costs for these 4 wells totals $50,000. Increased annual monitoring costs due to adding these 4 wells is $10,000.

Actions for Contingency Plan Development

EPA has developed guidelines for contingency planning for public water supplies. The plan will not be a blueprint for particular actions as such (since each emergency is different), but rather a clear procedure for coordinating a response to different types of events, in order to ensure that the correct actions are taken quickly. The tasks outlined by EPA and presented in this strategy report cover such items as:

- Formation of a planning committee;
- Assessment of the water supply situation;
- Assessment of the potential sources of contamination;
- Assessment of replacement water supply options;
- Identification of local logistical support-personnel, equipment, chemicals, technical services;
- Designation of the lead decision makers; and
- Identification of financial resources.

WHP Implementation

Implementing the WHP management strategy requires four major steps: developing policy; legally establishing the program; establishing the administrative structure to make the program work; and initiating program activities. The recommended strategy can be put in place using existing management authorities and structures and should not entail a great investment of tribal resources, except for additional personnel.

Policy Development. The first step in implementing a successful WHP program at GRIC is consensus-building within the community. As part of this study public meetings have been held to discuss WHP concepts and methods and the Tribe's proposed recommendations for a WHP program at GRIC. Next, the WQP Office will need to work with the staff and Tribal Council to establish tribal policy on WHP. Assuming there is tribal consensus to pursue WHP, the issues to be addressed include: whether to implement the program under Tribal authority or whether to implement the program through EPA; whether to implement it through regulation or policy; and whether to adopt, modify, drop or add to aspects of the recommended strategy.

Legal Considerations. Once Tribal policy is established, the WQP officer will need to work with the Tribal attorney and, as needed, technical staff (primarily representatives from other Tribal offices) to draft the specific ordinances and regulations.

Administrative Structure. The main considerations in establishing the administrative framework for the WHP program are to clarify the role of the Water Quality Planning office and other offices, identify the costs and staffing needs of the program, and identify funding sources.

The WHP program will be centered in the Water Quality Planning Office, which will be responsible for establishing and supervising the program; planning; coordinating with other tribal offices and other entities; advising the Tribal Council on wellhead protection concerns; acquiring funding; maintaining wellhead protection program records and reports; ongoing training and research; and special studies. The efforts of the WQP Office will need to be coordinated closely with the staff of other tribal offices, particularly the Land Use Planning Office; Hazardous Materials Office; Pesticide Control Office; and the Tribal Environmental Health Service Office. In addition, the WQP Office will also need to coordinate with federal, state and local governments.

It is anticipated that the major costs incurred for the program will be limited to the costs of additional staff and the groundwater monitoring program. It is probable that the WHP program will require the addition of one or two more staff persons. The Tribe would need to budget about $31,500 - $33,000 per year/person plus the overhead costs associated with the positions (insurance, telephone, supplies, etc.) which could increase the salary costs by 60 percent or more. The costs for the monitoring program will depend on the level of monitoring selected by the Tribe which, as described above, would range between $10,000 and $45,000 per year plus, for Level III, capital costs of $50,000. Federal and state resources can be used to help implement the WHP program. A management strategy which emphasizes a coordinated management approach, such as recommended here, and which builds on past federal funding efforts, may increase the Tribe's ability to successfully apply for the limited funds.

Program Initiation. The WHP program can be implemented in phases as the Tribe develops the policies and regulations, staffing and other resources required to put the program in place. A recommended approach is provided below which can be modified based on decisions made during the review of the proposed WHP Program.

First the emphasis is on implementing those aspects of the wellhead protection management strategy which provide the most protection for the least amount of effort and which address the sources which pose the greatest potential for contamination of the aquifer. Phase I would be initiated concurrently with establishing the administrative framework for WHP.

Phase I

- Create WHPA sensitive overlay zones around each public supply well
- Prohibit all new high risk uses from locating in WHP zones
- Place a moratorium on moderate and low risk uses locating in WHP zones

Phase II

- Incorporate the regulations/policies of the WHP program into the Land Use Action Review process and other application reviews

- Incorporate WHP considerations into the Hazardous Materials Office's inspection program (including leak detection at existing facilities)

- Develop conditions of approval for moderate and low risk uses and initiate review and approval of moderate and low risk uses requesting location in a WHPA

- Evaluate risks associated with older sewage treatment plants and appropriate monitoring or remediation actions

- Develop "cook-book" procedures for remediation of transportation spills and incorporate into tribal emergency response plan.

- Establish tribal regulations and work with neighboring jurisdictions to implement measures recommended to reduce the incidence of illegal spills

- Incorporate WHP concerns into the GRIC Pesticide Code and the inter-tribal model code which are currently being developed

- Establish the groundwater monitoring plan

Phase III

- Work with existing, non-conforming uses in industrial parks and transportation centers to achieve compliance with the WHP program

- Develop education program on BMPs for agriculture and on-site septic systems

Phase IV

- Work with existing nonconforming uses (other than those addressed in Phase III) to bring them into compliance with the regulations

- Review existing tribal standards and guidelines for groundwater protection to ensure they reflect WHP concerns

- Develop additional public education programs, such as one to explain the safe use, handling and disposal of common household and commercial products which pollute groundwater

Ongoing efforts include updating and maintaining the threats inventory; managing the monitoring program; coordinating with tribal, federal, state and other entities; supporting state and federal efforts to increase management of materials in transit; and as funds are available, developing the contingency plan, and special studies as needed.

Finally, it is felt that the key to a useful program is informed review and update. Therefore it is proposed that the WHP program and its provisions be reviewed on a three-year cycle of review and update.

Summary

The management strategy outlined here emphasizes prevention of groundwater contamination, an approach which is far more effective and less costly than dealing with problems once they occur. This strategy is supplemented by provisions for site-specific monitoring as needed and the overall monitoring program recommended in Section 12, and by the strengthening of current response and remediation efforts.

By prohibiting high-risk activities, and placing Activity Protection Assurance Requirements on moderate and low risk Regulated Substances, the chances for the water supply to be contaminated are sharply reduced. By imposing appropriate controls on contaminant sources developers and others are not unduly restricted in their choice of locations, yet water supplies are substantially protected.

The program can be implemented with current tribal management authorities and structures and should require a relatively modest investment of tribal resources except for additional staff. The approach should strengthen GRIC's ability to successfully compete for federal funding.

PART II
WELLHEAD PROTECTION AREA DELINEATIONS

Introduction

The detailed technical foundation of the WHP Strategy comprises specification of thresholds and criteria for WHP, hydrogeologic and water use data compilation, literature review, water budgets, groundwater flow modeling, and particle tracking. The details are provided in Part II for those readers wishing to examine the technical basis for the WHPA delineations.

Section 2

Wellhead Protection Criteria and Thresholds

Introduction

This section describes the important first step of deciding what, specifically, we want to protect rather than all groundwater resources. The decisions presented here form the basis for all of the technical work described in later sections.

Background

Around any well, such as the public and non-public supply wells in the Community, there is an area, where, if contamination occurs, it will be drawn into the well after some period of time. Such an area is called a "wellhead protection area." If we protect against contamination in that area, then the well is protected from contamination.

A concept for the delineation of these areas is needed which takes into account the local groundwater conditions and amount of water pumped from the wells. The first step in wellhead protection area delineation is selecting the criteria for wellhead protection. The next step is selecting increments of the criteria.

Criteria

EPA has identified five criteria, shown in the following table, that may be used in wellhead protection area mapping. The table shows how these criteria were evaluated for GRIC.

Table 2-1
Analysis of Wellhead Protection Criteria

	Description	Accuracy	Cost/Difficulty	Comments
Distance	From well	Low	Low	Excessive area to protect
Drawdown	Around well	Low	Medium	Excessive area to protect
Travel Time	To well	High	High	Focused
Physical Boundaries	Aquifer	High	Low	Essentially the entire GRIC
Assimilative Capacity	Soil & Aquifer	Low	High	Insufficient

The criteria for wellhead protection at GRIC will be the time-of-travel for potential contaminants moving through the groundwater system to the selected wells. Use of this criteria focuses wellhead protection activities on only those activities which can affect the quality of pumped water during the time periods of interest. The time periods of interest are called thresholds, and they are related to the Community's ability to do something about contamination should it occur.

Thresholds

Because we have selected time-of-travel as the criterion at GRIC, the thresholds for wellhead protection are time-related and, because of the physical characteristics of groundwater flow to wells, result in increasing wellhead protection area sizes with time. Three thresholds will be used for this project. The first threshold is related to immediate or emergency events. In the first threshold, the conservative assumption is that the contaminants would enter the well immediately. A threshold of 200 feet is selected for the first threshold.

In the second threshold, consideration is given to the time required to detect and do something about a release of contaminants. For the conditions at GRIC, a period of 5 years is selected as the typical period from detection of contamination to replacement of the affected well.

In the third and final threshold, consideration is given to the time that a typical well would be in service. In other words, it is desired that a well remain free of contamination throughout its service life. For the conditions at GRIC, a period of 40 years is selected as the typical period of useful life for a production well.