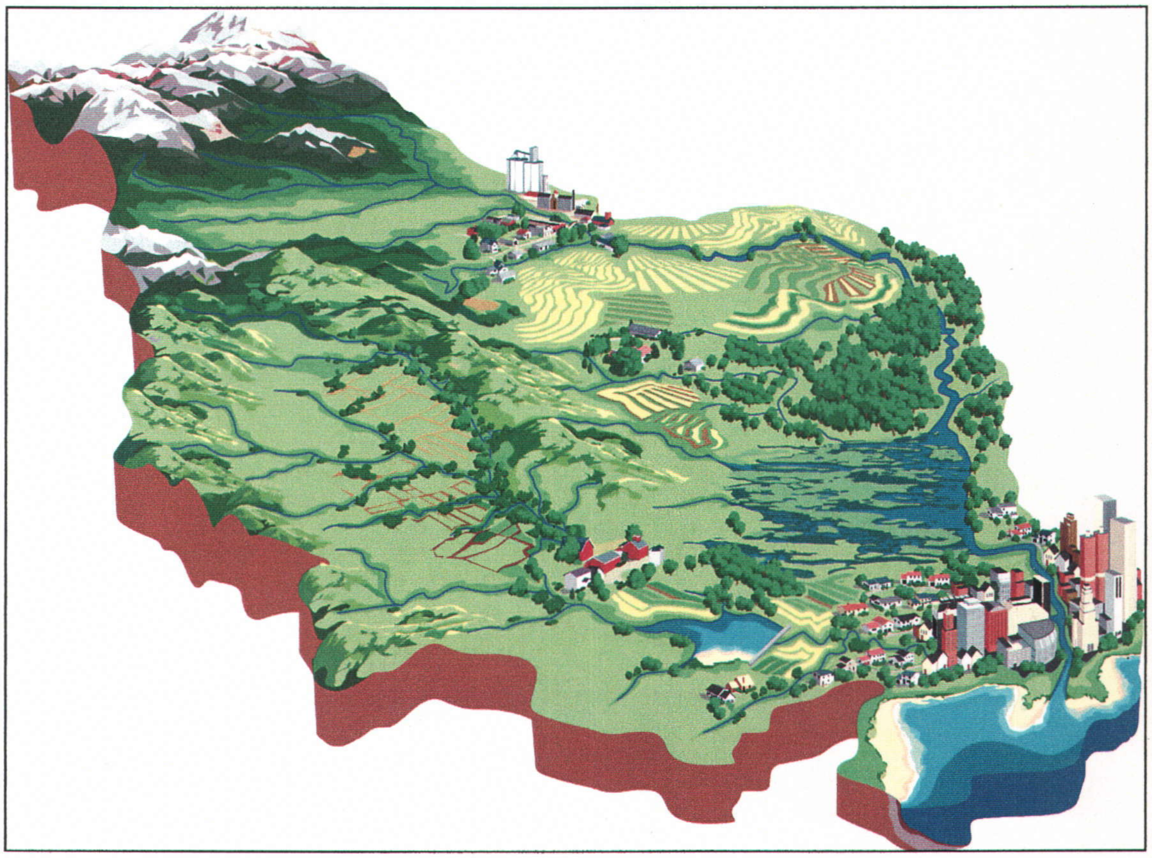
WATERSHED ASSESSMENT FOR TRIBUTARIES TO THE TRUCKEE RIVER

FINAL REPORT



Prepared for
Washoe County Regional Water Planning Commission

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EXECUTIVE SUMMARY

Introduction

Watershed Protection Programs help to safeguard community water supplies, both surface and ground water. The watershed approach is a coordinating effort of environmental management that focuses on public and private sector efforts to maintain or improve water quality of resources within geographic areas. This report addresses the following tributaries to the Truckee River:

- **Northern Carson, Verdi, Peavine creeks**: Hunter, Alum, Tower, Dog, Sunrise, Bull Ranch, Unnamed, Chalk, Peavine, and Evans;
- **The North Truckee Drain**;
- **The South Truckee Meadows creeks**: Evans, Dry, Thomas, Whites, Galena, Jones, Browns, and Bailey; and
- **Washoe Valley creeks**: Winters, Davis, Ophir, Lewers, Franktown, Muskgrove, and Jumbo.

There is a regional concern that water quality degradation detracts from our quality of life and impairs our drinking water quality. The objective of this program is to determine the current "health" of these streams through water quality and stream bank assessment. Based upon this assessment, goals will be made for water quality improvement at various interagency and public meetings. The goals and how to attaint them will be written into watershed management plans that are published, accepted by local authorities and disseminated to the public. The final goal is then to implement these programs. Three agencies were contracted for the assessment and development of watershed protection programs: the Washoe County Department of Water Resources, the Washoe Storey Conservation District and the University of Nevada Cooperative Extension.

Watershed assessment

This report details watershed assessments for the above listed watersheds. Most attention was given to the larger, perennial streams. The assessment included geographic and hydraulic descriptions of the streams, physical descriptions in terms of the geology soils, slope, wetlands, areas prone to flooding, vegetative cover, and land use. Sanitary surveys were conducted to locate, within 300 feet of streams, potential sources of pollution to the streams such as hazardous material, landfills, road de-icing material, pesticides and herbicides at golf courses, and large concentrations of septic tanks. Limited water quality sampling was also undertaken.

During the months of January and February field surveys of the streams were conducted. These surveys made assessments of the "functionality" of these streams. A properly functioning stream, as described by the US Bureau of Land Management (1988), can:

- dissipate stream energy associated with high water flow, thereby reducing erosion and improving water quality;
- filter sediment, capture bedload, and aid floodplain development;
- improve flow-water retention and ground water recharge;
- develop root masses that stabilize streambanks against cutting action;
- develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding and other uses; and
- support greater biodivesity.

The assessment format was adapted from the US Bureau of Land Management (BLM, 1998). Several reaches of each stream were assessed for its functionality. The stream reaches were then rated as "Properly Functioning", "Functioning at Risk", and "Non-Functional" based upon loss of habitat, excessive erosion and water quality degradation, development encroachment, and invasive plant species (Tall Whitetop). Impacted stream zones deemed "Critical" for this report reflect where the stream is no longer functioning properly. "Sensitive" sections refer to a "Properly Functioning Stream at Risk" whereby the stream could easily be rendered "Critical" through improper land use. The results were mapped for the individual watershed study areas. Conclusions and recommendations for each study area are made.

Northern Carson, Peavine, Verdi Creeks

Tower, Hunter, Alum, Dog, Sunrise, Bull Ranch, Unnamed, Chalk, Peavine, Evans

These creeks flow directly to the Truckee River and drain the northern Carson Range (Hunter and Alum), Dog Valley (Dog) and the Verdi Range (Sunrise), and the southern flanks of Peavine Mountain (Bull Ranch, Peavine, Chalk, Evans) as seen in Figure 1.1. Most of these creeks are ephemeral with the exception of Dog Creek and Hunter Creek. The creeks are fed from snowmelt in their respective ranges and from groundwater base flow. Their drainages are orientated north or south towards the Truckee River. While these creeks are mostly ephemeral, their drainages can easily generate large flood flows in excess of 100 cfs or even 1,000 cfs (USGS, 1998).

General

Low-permeability soils are mapped throughout the Chalk, Peavine and Evans watersheds, and the middle to lower watersheds of Bull Ranch, Unnamed, Tower, Alum and Hunter creeks. This is the result of outcropping rocks or the clayey nature of sediments derived from volcanics. Slopes within these watersheds are generally greater than 15 percent. Flooding does not appear to be a problem other than areas adjacent to the Truckee River and the creeks. Within the Carson-Peavine-Verdi Tributaries study area few areas are mapped as wetlands. Large-scale residential development of the Peavine and lower Alum Creek area has occurred such that small wetlands have been drained over the last forty years. Land use within these watersheds is diverse ranging from national forest to areas of high-density residential, commercial and industrial use. Since data for the Truckee River are excluded in this assessment, no known hazardous materials are found within 150 feet of the creeks. A sanitary survey of the Truckee River has been conducted by the University of Nevada, Reno and is currently being finalized (Dean Adams, personal communication).

Overall the water quality is diverse (Table 1). While Dog and Hunter creeks show good quality water, Alum, and in particular Chalk, show very high total dissolved solids (TDS). The Alum water is high in sulfate (420 mg/l), probably derived from the hydrothermally altered volcanics, and calcium (100 mg/l). Chalk water has an alarmingly high level of TDS. The main constituents are sulfate (1800 mg/l), calcium and manganese (360 and 240 mg/l respectively), sodium (236 mg/l) and bicarbonate (344 mg/l). Suspended sediment loads are mostly very low. Nitrogen and bacterial counts are relatively low, exceptions being the bacterial count for Alum and the nitrate concentration for Chalk.

Table 1
General water chemistry

creek/reach	TDS	TSS	TP	NO3	TKN	Fecal coli	Fecal strep	coli/strep Ratio
	mg/l	mg/l	mg/l	Mg/l	mg/l	count	count	
Dog	172	3	0.03	0.0*	0.2	<1	11	<0.1
Hunter	116	5	0.05	0	0.15	2	20	0.1
Alum	740	16	0.11	0	0.58	30	350	0.08
Chalk	3,080	<1	0.26	3.0	0.35	<10	50	<0.2

TDS= total dissolved solids (inorganic chemistry)
TSS= total suspended solids (sediment)
TP = total phosphate (organic phosphate)
TKN=total Kjeldahl nitrogen (organic nitrogen)
Coli= coliform (fecal coliform is feces derived bacteria)
Strep=streptococci (fecal bacteria)
Coli/Strep ratio is feces origin indicator where >1 is human source

<u>Conclusions</u>

Table 2 lists the ratings for each creek, based upon the assessments. Sensitive and critical reaches are mapped on Figure 2.9. The most obvious problem for these creeks is erosion and sedimentation. This is due to development encroaching upon or alteration of the creek channels and stormwater discharges to the creeks. However, most of the degrading activities are located in active construction areas such that the effects are generally temporary problems. An exception is the sewer line above Mogul. Reclamation efforts will alter the stream channel and if not effective, will cause sediment to be transported to the Truckee River. Restoration efforts can be successful for many of the reaches listed critical and or sensitive and are marked with an asterisk.

Table 2
Stream Health Ratings

Creek	reach	
	mid	lower
Tower	good	sensitive
Hunter	good	good
Alum	sensitive	sensitive
Dog	good	sensitive
Sunrise	good	critical
Bull Ranch	good	good
Unnamed	good	sensitive
Chalk	good	sensitive
Peavine	good	none
Evans	good	none

During the field inspections and stream assessments note was made of areas where moderate to significant erosion was occurring. Particular note is made of the following areas as shown on Figure 2.9. Construction site sediment is being discharged to Alum Creek during storm events along Caughlin Parkway. Construction of the sewer line above Mogul in the "unnamed" drainage is built in the channel flood plain placing significant sediment in the channel. This will be carried to the Truckee River during moderate storm events. Erosion of a small drainage channel in Verdi along Hill Lane will jeopardize this road and will discharge animal waste and sediment into the Truckee River as well. Other construction sites within the Chalk Creek drainage are also discharging sediment into the drainage that will eventually be carried to the Truckee River. Only two watersheds harbor invasive plant species. These are Chalk Creek where Tall Whitetop and Scotch Thistle are found and an unnamed drainage near Sunrise Creek where Scotch Thistle is found.

North Truckee Drain

There are no perennial streams in this watershed (Figure 1.1). Truckee River water was imported into Spanish Springs through the Orr Ditch beginning in 1878. Tail water from flood irrigation and springs were collected through the North Truckee Drain and exported back to the Truckee River. This drain is perennial. However, as residential development replaces irrigated lands, the need for the drain may diminish over the next twenty to thirty years.

General

Low-permeability soils dominate this watershed as a result of the clayey nature of sediments derived from the surrounding volcanic laden mountains. Slopes within this watershed are generally low, but development east of the drain ranges up to greater than 15 percent. These areas will also generate substantial runoff during high intensity precipitation events. Natural flooding occurs throughout most of the North Truckee Drain area within Spanish Springs and the lower lands near the Truckee River. Washoe County and the City of Sparks are currently working on flood management programs to help solve this problem (Parsons, 2002; Kennedy Jenks Consultants, 2000). The greatest concentrations of wetlands are within the "headwaters" of the drain, the reason the drain was constructed in the first place. These encompass the northern half of the drain's length within Spanish Springs proper. As development increases within this area, the wetland areas will decrease.

The entire study area is within the City of Sparks. The land in the northern half of the watershed area is a mixture between agricultural lands, brushland and residential development. The southern portion of the watershed is fully urbanized. The northern portion of the study area is currently zoned for single family residences with the commercial properties, mostly golf courses. The southern portion of the drain is zoned single family residential with some commercial properties as is the central portion of the drain. The last 1.5 miles of the drain are zoned commercial and industrial.

Septic tank effluent, as groundwater, may flow to the drain in the northern portions of the study area given the density of septic tanks within the immediate area. The Red Hawk golf course is located within the northeastern portion of the drain, using it for a water feature. Downstream commercial properties are primarily retail stores. At the southern end of the drain, industrial and commercial sites are shown to border the drain. This includes aboveground and underground storage tanks as well as three Resource Conservation and Recovery Act (RCRA) sites. RCRA sites are those that store, use, or generate toxic chemicals and are required to adhere to local, state and federal storage and handling regulations.

As listed in Table 3, the total dissolved solids concentration in the North Truckee Drain (728 mg/l) and the Marina discharge (496 mg/l) to the Drain are relatively high. The lower

Table 3
General water chemistry

creek/reach	TDS Mg/l	TSS mg/l	TP mg/l	NO3 mg/l	TKN Mg/l	Fecal coli Count	Fecal strep count	coli/strep Ratio
N Truckee Drain								
Shadow Lane	728	52	0.18	1.8	1.15	na	800	na
Marina discharge	496	65	0.4	0.1	0.47	1100/100	90/100	12.2/1
@ Truckee	532	6	0.28	0.6	0.53	150/100	180/100	0.8/1

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Coli= coliform (fecal coliform is feces derived bacteria)
Strep=streptococci (fecal bacteria)
/ = analyzed at two dilutions
Coli/Strep ratio is feces origin indicator where >1 is human source

concentration in the Marina discharge dilutes the upstream concentration that eventually flows into the Truckee River. However, this concentration (532 mg/l) is much higher compared to the Truckee River, estimated at 100-150 mg/l.

Nitrogen does not appear to be a problem at the concentrations sampled. The fecal sampling shows high values at Shadow Lane and in the Marina discharge, but rather dilute at the Truckee River. The coliform to streptococci ratio is generally one, meaning that the source is a mixture of livestock and human. However, the Marina sample was analyzed at two different solutions (1:1 and 10:1) and the fecal coliform results were different by an order of magnitude. This may reflect the uncertainty in the analysis procedures. Noteworthy is the fact that during an inspection of the Drain at the confluence with the Truckee River a sediment plume discharging to the Truckee River from the Drain was obvious (see stream assessment dated February 6, 2002).

On January 16, 2002 water from the North Truckee Drain was sampled above the confluence with the Sparks Marina discharge during a moderate rainstorm. The sample was analyzed for total hydrocarbons (oil = 71 mg/l), total suspended solids (232 mg/l), total dissolved solids(312 mg/l), total phosphates (0.36 mg/l), nitrate (0.9 mg/l), and kjeldahl nitrogen (1.6 mg/l). While there is not a November 2001 sample at this location to compare to, it is instructive to compare these concentrations to the Shadow Lane concentrations listed in Table 3. The TDS is one half that found at Shadow Lane as is the nitrate concentration (although the nitrate is low in both samples). Total suspended solids is four times that found in the November 2001 sample which was sampled during dry and low flow conditions. Kjeldahl nitrogen and total phosphate are also elevated, but not significantly. These results mostly show the increase in total suspended solids and oil/grease found in the drain waters as a result of storm drain effects.

Conclusions

During the stream assessment it was noted that the most southern portion of the drain, south of Interstate 80, was being eroded. This is most likely due to lack of a flood plain and excessive flows during storm events. It will be difficult to control further erosion and a source of sediment to the Truckee River without reconfiguring this channel. The invasive plant Tall Whitetop is found in the drain throughout the portion that parallels Sparks Boulevard.

Figure 3.9 shows the results of the drain assessment whereby most of the drain is rated sensitive. This rating is imposed because the drain is at risk from encroachment by present and future development. The drain is at risk from increased stormwater discharge that could result in erosion of the channel, loss of riparian vegetation (for better flood conveyance), and loss of flood plain within the channel. The most southern portion of the drain is rated as critical. This is due to the erosion of the stream banks, the proliferation of Tall Whitetop, sediment being transported to the Truckee River (Marina discharge?), at risk from various sources of pollution, and lack of native vegetation.

Washoe Valley

Winters, Davis, Ophir, Franktown, Lewers, Muskgrove, Jumbo

The perennial creeks of Washoe Valley flow from the Carson Range eastward and discharge into Washoe Lake (Figure 1.1). Jumbo Creek is ephemeral and originates in the Virginia Range, also flowing to Washoe Lake. Outwash from the creek drainages has formed alluvial fans where they emanate from the mountain block canyons. Below the alluvial fans, or where the fans coalesce to form a bajada, the creek waters often disperse into wetlands or infiltrate into the coarse, granitic soils. Historically, the western side of Washoe Valley was irrigated with these waters. Today, residential development and one golf course have only marginally changed the manner of use of these creeks.

General

Soils within this watershed are largely composed of granitic origin and are medium to coarse grained and free of volcanic silts and clays. These types of soils show moderate to very high permeability of infiltration of surface waters. Almost all of the valley floor is from 0 to 5% in slope and immediately becomes greater than 15% above the valley floor boundary. There are few residential areas at risk to flood damage except in the Bellevue area, southwest of the lake, which is prone to flooding. Most of the potential wetland areas are east of Franktown Road and "Old" US 395 and most of the area between "Big" Washoe Lake and Little Washoe Lake. The upper watersheds of the west valley creeks are in forested and brush/shrub lands. Agriculture predominates east of Franktown Road and south of Washoe Lake. On the valley floor, the lake and wetlands dominate the landscape.

Most of the watershed land is under residential development, used for agriculture or is public land (US Bureau of Land Management and US Forest Service). There are very few lands used for retail purposes and one parcel for industrial purposes. The agricultural parcels are used mostly for pasture, hay crops or livestock. Septic systems represent the largest single source of potential pollution to the watershed. The largest concentration of septic systems are located on the eastside of Washoe Lake (New Washoe City) within the Jumbo Creek drainage. There is potential for fertilizers, herbicides and pesticides to be washed into Muskgrove Creek from the golf course.

Conclusions

Invasive plants, such as Tall Whitetop, were not noted during the stream surveys. The upper and middle reaches of Jumbo Creek, upstream of East Lake Blvd, suffer from erosion. This is especially true where a dirt road parallels the creek causing sheet flow into the creek during runoff events. The incision of the creek has created unstable and easily eroded banks without vegetation. Jumbo is considered "non-functional" as a stream (Figure 4.9) and is rated Critical. Restoration efforts should be undertaken to eliminate this erosion and to create better flood protection.

Muskgrove Creek below the Lightening W Golf Course suffers from erosion because of residential encroachment, a straightened alignment and periodic dredging of the channel. Muskgrove Creek is rated Sensitive through the Lightening W Golf Course due to the removal of native vegetation for sod (Figure 4.9). It becomes Critical below Old US 395 due to residential encroachment and erosion. Restoration efforts should also be undertaken to eliminate this problem. Ophir Creek, east of US Highway 395 suffers from alteration of the stream channel and livestock trampling the creek bed and the elimination of vegetation.

South Truckee Meadows Tributaries

Evans, Dry, Thomas, Whites, Galena, Browns and Bailey

These creeks are the largest tributaries to Steamboat Creek, which emanates from Washoe Lake in Washoe Valley (Figure 1.1). These creeks drain the east slope of the Carson Range, Sierra Nevada Mountains. Bailey Creek drains a portion of the Virginia Range on the east side of the South Truckee Meadows. Their primary source of water is snowmelt in the Carson Range during the winter and spring months and groundwater supplied base flow from the Carson Range in the late summer and fall. These creeks represent some of the largest flowing creeks in the community with average flows ranging from 1 to 32 cfs (Widmer, 2000). Flood flows on any of these creeks can easily reach 100 cfs or greater.

General

Soils within these watersheds are composed primarily of fine-grained, volcanic sediments (Bailey, Evans, Dry and Thomas) and coarse-grained, granitic sediments (Galena and Browns). The volcanic rich soils have a greater potential to generate stormwater runoff than the granitic soils. These potentially high runoff soils are located on mid to lower reaches of Evans, Dry and Thomas creeks. Within the Steamboat Tributaries study area the highest density and areal extent of the wetlands are located east of US Highway 395 on the South Truckee Meadows proper. This area is also a groundwater discharge area. Large-scale residential, and commercial and industrial development of this area is occurring such that the wetlands are being drained or condensed.

Flooding is a problem in the Plumas and Lakeside Dr. area south of McCarran in the Evans watershed. In the Dry Creek watershed flooding is a problem throughout much of its watercourse particularly east of US 395 and north of Longley Lane. Flooding on Thomas Creek occurs downstream of the Foothill road crossing in the Thomas Creek road and Holcomb Lane areas. Whites Creek flooding occurs near US 395, but recent work has lessened much of the problems. Major flood problems have occurred on Steamboat Creek at the Thomas and Whites confluences, but development work continues to alleviate these problem areas. Flood prone areas on Galena Creek occur on the alluvial fan and throughout its course in Pleasant valley.

Land use within these watersheds is diverse ranging from federally designated wilderness to areas of high-density commercial and industrial use. Galena, Whites, Thomas and Dry creeks flow through rural, single family residential developments, and golf courses (ArrowCreek, Montruex, Wolf Run) upon their middle reaches. Thomas and Dry also flow through small ranch lands upon the lower-mid reaches. These ranch lands are mostly used to raise livestock that impact the creeks. Upon reaching US 395 the creeks (excluding Galena, Browns, and Bailey) flow through commercial and industrial properties. The most intense industrial properties are on Dry Creek east of US 395. Near the confluences with Steamboat Creek, Dry, Thomas and Whites flow again through agricultural, residential and golf course properties (Hidden Valley and Rosewood Lakes).

Table 4 shows that the overall water quality is very good with suspended sediment loads, nitrogen, and bacterial counts relatively low. The constituents in this table show relatively low and stable values for Galena Creek. Whites Creek TDS concentration was also found to be relatively stable with very low values. This indicates that urban development near these creeks is not having much effect during this low flow period.

Table 4
General water chemistry

creek/reach	TDS Mg/l	TSS mg/l	TP mg/l	NO3 mg/l	TKN mg/l	Fecal coli count	Fecal strep count	coli/strep Ratio
Galena								
upper	87	4	0.02	0.1	0.33	51	>60	<0.85
mid	134	5	0.04	1	0.21	14	22	0.64
lower	99	3	0.09	0	0.26	34	22	1.5
Whites								
Upper*	55	2	0.03	0	0.1	10	NA	NA
mid	64	2	0.02	0.7	0.18	29	>60	0.5
lower	62	<1	0.02	0	0.26	50	80	0.62
Thomas								
upper	96	2	0.06	0.1	0.19	8	34	0.24
mid	133	62	0.12	0.4	0.62	20	110	0.18
lower	172	21	0.1	0.1	0.68	50	130	0.4

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Coli= coliform (fecal coliform is feces derived bacteria)
Strep=streptococci (fecal bacteria)
* sampled Oct 2000
Coli/Strep ratio is feces origin indicator where >1 is human source

As surface water flows downstream in Thomas Creek, TDS levels increase. This may be the results of livestock activities in the mid reaches and groundwater influx at the lower reaches. The suspended sediment load increased significantly from the upper to mid section and decreased at the confluence with Steamboat Creek (lower reach). The lower sediment load at the confluence is probably due to the substantial decrease in the streamflow velocity such that some of the suspended load settled to the creek bed. Bacterial levels increased downstream, but the coliform ratio remained relatively stable.

During a four-hour moderate rainstorm in January, 2002, water samples were taken at South Virginia street on Evans and Thomas creeks. The creeks were sampled for total hydrocarbon products, total suspended solids, total dissolved solids, nitrogen and phosphate. Dilute levels of oil were found in both Evans (0.64 mg/l) and Thomas (0.71 mg/l) creeks. Although the suspended sediment load in both of these creeks was visibly noticeable and of concern, the lab results showed that the TSS levels rose only slightly from the measurements taken earlier in the year.

Conclusions

The most obvious problem for these creeks is erosion and sedimentation. This is due to development encroaching upon or alteration of the creeks and stormwater discharges to the creeks. Table 5 lists the ratings for the three reaches on each creek, based upon the assessments.

Table 5
Stream Health Ratings

Creek	mid-reach		lower-reach
	upper	lower	
Evans	good	critical*	critical*
Dry	good	critical*	critical to sensitive*
Thomas	sensitive*	sensitive*	sensitive to critical
south fork Whites	sensitive*	sensitive*	sensitive*
north fork Whites	sensitive*	critical*	sensitive*
Galena	good	good	sensitive
Jones	sensitive*	critical*	none
Browns	good	good	good

East of Lakeside Drive ranching activities have degraded Evans, Dry and Thomas creeks. The alteration of these streams by man and livestock cause an increase in erosion, increased sediment load and degradation of water quality. Encroachment by residential development on Jones and Whites creeks on the lower mid-reaches have created excessive erosion, head cutting, steep banks and therefore increased sediment loads as well as a loss in flood protection. East of US 395, the streams Dry, Evans, Thomas, and Whites have, for the most part, been altered for flood control. As a result these creeks no longer function properly as streams. However, they do function well as flood control works. It is possible to restore these creeks to serve both purposes. Restoration efforts can be successful for many of the reaches listed critical and or sensitive and are marked with an asterisk (*).

Recommendations

The results of these stream assessments will be used to help develop watershed management programs. The following recommendations are made as a starting point in determining what components are necessary for the management plan. The recommendations are made based upon maintaining or improving the functionality of each stream.

1. A more detailed erosion and sediment source survey should be made for each creek. This will help identify areas where improvements to water quality and sediment transport can be made. The surveys can be conducted at a very low cost. The cost of making improvements is unknown and could be expensive.

2. Conduct water quality monitoring in association with the stormwater management program. This would include sediment loading sources, construction site erosion, urban runoff (oil and other petroleum based products), and golf course management of chemicals.

3. Increase construction site erosion control through enforcement and education in association with the stormwater quality program. Currently erosion control measures at construction sites near streams and drainages are not always effective.

4. Improve on a water quality databases of different reaches of each creek. To date there is little or no information on water quality for several of these creeks. This type of program would be effective in periodically assessing the condition of the watershed. The sampling should be conducted during wet and dry conditions. This could be done two or three times a year for three years followed by periodic sampling.

5. Each creek should be analyzed for restoration potential, if needed. Reporting of this should include project description, feasibility, limitations and first approximation cost estimates. This type of work can be as simple as re-vegetating the creek with native plants, fencing reaches for livestock control, or allowing the creek access to a natural flood plain. It could also be expensive such as redesigning and constructing culverts at major road crossings.

6. A public education program on the Stream Ordinance is strongly recommended for unincorporated area residents. This may also include a survey of individual lots and communication with these owners.

7. The City of Sparks and the City of Reno should develop a Stream Ordinance policy and actively engage in a public education program. This is to help restrict development's encroachment upon creeks and the North Truckee Drain. It could also be used to bring these water features to the public's attention and thereby increase public support for access, enhancement and/or restoration.

8. A review of the City of Sparks stormwater discharge program to the drain and its effectiveness should be undertaken. The review should address stormwater effects on erosion and sediment transport to the Truckee River. The surveys can be conducted at a very low cost. The cost of making improvements is unknown and could be expensive.

9. The City of Sparks and Washoe County should explore recreational development of the drain throughout its course in Spanish Springs. This could entail the same type of design the City of Sparks has done for the drain south of Shadow Lane. The design might actually increase the drain width, develop room for more flood plain, and increase native vegetation. This would provide wildlife habitat and result in a water feature that increases the quality of life to the City of Sparks community.

10. A White Top Eradication program is strongly recommended for the flood plain area of the South Truckee Meadows, generally east of US 395, Chalk Creek and the North Truckee Drain. Programs for eradication are available. Because this invasive plant is so wide spread, total eradication would be relatively expensive. Program elements would be:
    - mow in early spring
    - treat with appropriate herbicide such as 2,4,D
    - repeat 2 times a year for two to three years
    - revegetate with desirable plants

11. Restoration efforts on Jumbo Creek should be undertaken to eliminate erosion, restore the creek to its natural state and to create better flood protection.

12. Ranching operations are potential sources of nutrient (nitrogen and phosphate) loading to the Truckee River, particularly for Thomas, Evans and Sunrise Creeks. Proper land management practices should be used to alleviate this problem.

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CHAPTER 1
INTRODUCTION

Watershed Protection Programs help to safeguard community water supplies, both surface and ground water. The watershed approach is a coordinating effort of environmental management that focuses on public and private sector efforts to maintain or improve water quality of resources within geographic areas. This report addresses the following tributaries to the Truckee River:

- **North Carson, Verdi, Peavine** (Hunter, Alum, Tower, Sunrise, Dog, Bull Ranch, Unnamed, Chalk, Peavine, and Evans),
- **The North Truckee Drain,**
- **Washoe Valley** (Winters, Davis, Ophir, Franktown, Muskgrove, Lewers, McEwen, and Jumbo)
- **South Truckee Meadows** (Evans, Dry, Thomas, Whites, Galena, Jones, Browns, and Bailey)

There is a regional concern that water quality degradation detracts from our quality of life and impairs our drinking water quality. The objective of this program is to determine the current "health" of these streams through water quality assessment. Based upon this assessment, goals will be made for water quality improvement at various interagency and public meetings. The goals and how to attaint them will be written into the watershed management plans that are published, accepted by local authorities and disseminated to the public. The final phase is to implement these programs. The Regional Water Planning Commission contracted three agencies for the assessment and development of watershed protection programs: the Washoe County Department of Water Resources, the Washoe Storey Conservation District and the University of Nevada Cooperative Extension.

Study Areas and Organization of Report

Figure 1.1 shows the study area tributaries and watershed sub-basins. The primary focus of this study was directed at perennial creeks and their watersheds that are tributary to the Truckee River. Some ephemeral creek watersheds were addressed as well, particularly those on Peavine Mountain. The University of Nevada, under contract with the State of Nevada Health Protection Services, is currently assessing the main stem of the Truckee River. The final report on this "Surface Water Assessment Program" is forthcoming. Steamboat Creek is addressed by the Steamboat Creek Restoration Master Plan, published by the Washoe Storey Conservation District and is currently being implemented (WSCD, 2000).

<u>Organization of report</u>

A chapter of this report is devoted to each of the four sub-basin watersheds. Each chapter includes a physical description of the watershed, land use practices, available water chemistry, stream channel assessment and the identification and "rating" of problem areas. A brief overview of chapter contents follows.

The physical descriptions of each watershed are characterized in terms of drainage area, geology, soils, topographic slope, annual precipitation, estimates of average annual streamflow, general wetland and flood plain delineation, and vegetative cover. Some of these descriptions are illustrated in a Geographic Information System (GIS) format. The GIS mapping is current through 1990 such that conditions may have changed, particularly with respect to wetlands and areas of potential flooding. Groundwater recharge areas are not currently mapped, but work has been done to identify these types of areas (Kennedy/Jenks, Inc. 2001).

Land use activities that are contributing to or have the potential to contribute to water quality degradation are identified and plotted in a GIS format. These activities are mostly centered near development with respect to erosion, stormwater runoff, landfill, septic tanks, and toxic spill potential along stream corridors.

All available water quality data were collected for this assessment. Additional chemical and biological water quality samples were made to fill in any data gaps. However, due to the timing of the sampling program in late fall, some streams were dry and not sampled. A future sampling program of greater intensity and duration is proposed.

Stream assessments were conducted using the format adapted from the US Bureau of Land Management (BLM, 1998). One to several reaches of each stream were assessed for their "functionality" as described in the following section. The streams within the mountain block were assumed to be properly functioning and were not assessed. Each chapter gives a summary of each assessment and the full assessments are included in the Appendix.

The conclusion for each chapter contains discussions of the results of the assessment that includes invasive biota, stormwater and erosion, a stream health rating, and recommendations. The recommendations from each chapter are grouped and discussed in the last chapter. The stream health rating is discussed also in the following section.

Stream Assessment Procedures

During the months of January and February extensive field surveys of the streams were conducted. These surveys made assessments of the "functionality" of these streams. A properly functioning stream, as described by the US Bureau of Land Management (1988), can:

- dissipate stream energy associated with high water flow, thereby reducing erosion and improving water quality;
- filter sediment, capture bedload, and aid floodplain development;
- improve flow-water retention and ground water recharge;
- develop root masses that stabilize streambanks against cutting action;
- develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding and other uses; and
- support greater biodivesity.

Stream Health Ratings are based upon the BLM manual "Riparian Area Management, A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas" (BLM, 1998). Streams are rated as "Properly Functioning", "Functioning at Risk", and "Non-

Functional" based upon loss of habitat, excessive erosion and water quality degradation, development encroachment, and invasive plant species (Tall Whitetop). Impacted stream zones deemed "Critical" for this report reflects where the stream is no longer functioning properly. This is "critical" in the sense that water quality is degraded, riparian habitat is lost and in some cases flood protection is reduced. The "quality of life" for residents and the general public is also reduced. "Sensitive" sections refer to a "Properly Functioning Stream at Risk" whereby the stream could easily be rendered "Critical". A sensitive rating means that while the creek is acting in a natural form, alteration of the creek or development encroachment can degrade the creek to a non-functional state. These areas are located in urbanized settings and are shown in Figure 2.9. "Good" areas obviously are Properly Functioning Streams and are found throughout most of these drainages.

General Discussion on Water Quality and Sampling Procedures
Grab samples were taken using standard methods. The general chemistry analyses were conducted at the Nevada State Health Lab. The samples were analyzed for general minerals, total suspended solids, total kjeldahl nitrogen, total phosphate, fecal coliform, fecal streptococci, field pH, conductivity, dissolved oxygen (the meter proved unreliable) and temperature. An exception to this suite occurred with the sampling of three streams in Washoe Valley due to a miscommunication. Within each chapter certain constituents are tabled and discussed. The full water chemistry results are in the Appendix.

Total dissolved solids (TDS) is a compilation of the dissolved constituents within the water such as calcium, sodium, and bicarbonate. As an example, the Truckee River, near Verdi, has a TDS concentration in the range of 80 - 120 mg/l. The North Truckee Drain or Steamboat Creek have more variable TDS ranges of 300 - 600 mg/l. Total suspended solids (TSS) is a measure of the amount of sediment the streams are carrying. Total phosphate (TP) is a measure of both dissolved phosphate and organic phosphate. Nitrate and Total Kjeldahl Nitrogen (NO_3 and TKN) measure the dissolved and organic nitrogen (suspended in the water) respectively. Indicators of animal and human feces waste are measured by the concentration of fecal bacteria as fecal coliform and fecal streptococci. The fecal ratio is an indicator of whether or not the bacteria is human (>2) or animal (<1) derived where ratios between 1 and 2 are difficult to assess.

Stormwater Management
Stormwater management is an integral component of watershed protection. It is expected that the results of this assessment will be incorporated with stormwater management programs. The Cities of Reno and Sparks and Washoe County formed the "Truckee Meadows Interlocal Stormwater Committee", charged with the EPA mandated stormwater pollution control programs. This committee has just recently completed the "Truckee Meadows Regional Stormwater Quality Management Program" (KJC, 2002) in compliance with the Phase II National Pollution Discharge Elimination System (NPDES), that requires a reduction in polluted discharge to our regions streams and rivers. A monitoring program will construct dedicated monitoring sites of which two are located in residential areas, two in industrial areas, two in commercial areas and one in an area being developed. Within the South Truckee Meadows area, one residential monitoring site is proposed for the ArrowCreek subdivision on Thomas creek. An industrial site is also being proposed on Dry Creek for industrial monitoring. Additional

monitoring sites may be implemented as part of the Watershed Management Plan for this area. The committee's proposed sampling parameters are shown in Table 1.

Table 1
Stormwater sampling parameters

Nutrients and Non-Metals	Bacteria	Physical Parameters	Metals	Organics
Total Nitrogen	Fecal Coliform	Total dissolved solids	Copper	Oil and grease
Nitrite as N		Total suspended solids	Chromium	Dissolved organic carbon
Nitrate as N		Electrical conductivity	Lead	Total organic carbon
Ammonia as N		Temperature	Mercury	
Total Phosphate		PH	Nickel	
Ortho Phosphate		Dissolved oxygen	Zinc	
Sulfate		Turbidity		
Chloride				

General Description of the Geology and Hydrology

Geologic structure of region

The Truckee Meadows lies within the transition of two major tectonic regimes, the Sierra Nevada Batholith and the Basin and Range Extensional Province. The Sierra Nevada Batholith is a mountain chain of granodiorite that has tectonically intruded up into the earth's crust. The Basin and Range extension, or stretching of the earth's crust, formed major fault structures that have created north-south oriented mountain blocks and valley fill structure throughout Nevada. The Truckee Meadows lies within a transition zone between these two regimes with the Carson Range of the Sierra Nevada Batholith on the west and the Virginia Range of the Basin and Range on the east (see Figure 1.2). The Sierra Nevada Batholith appears to extend eastward to Pyramid Lake and Yerington.

The Virginia Range lithology within the study area is primarily composed of volcanic rocks underlain by granodiorite (Sierra Nevada Batholith) and overlain, in some areas, by consolidated or unconsolidated sediments. The volcanic activity of this area was pervasive over the last 20 million years, but last occurred approximately 700,000 years ago. Many inactive volcanic domes and cones still exist in the Truckee Meadows.

The Sierra Nevada Batholith extends from Mexico to Susanville, California. The Sierra Nevada rocks were formed beneath the earth's crust at least 60 million years ago, but have only recently intruded the surface of the earth in the last 2-3 million years. Much of the rock overlying the granodiorite has eroded off although exposures of this rock can still be found. The Carson Range is part of the Sierra Nevada Batholith. The northern portion of this range, north of Galena Creek, is still overlain with volcanic andesitic and basaltic rock. Along the flanks of this range, 2-3 million-year-old sedimentary rocks of the Truckee Formation can also be found.

The fault structure that has developed from these two geologic regimes has created the modern day topography. Most fault structures are oriented north-south, but some evidence exists for east-west oriented faults also. Faulting is important to recognize because watershed drainages tend to follow fault structures.

The Truckee Meadows sediments are the products of erosion from the volcanic, granodiorite, and earlier metamorphic or sedimentary rocks. These sediments have formed the soils of today whose characteristics are important in terms of permeability and erosive potential. The sediments derived from granodiorite are usually coarse sands and gravels, are very permeable and tend not to erode easily because of the larger sediment size. Sediments derived from volcanic andesite are not very permeable and erode easily because andesite generally weathers to clay and silt. Therefore, where volcanic rocks predominate in the upper watersheds, volcanic soils dominate the lower watershed. The same process is true of upper watersheds composed of granitic rocks.

<u>Hydrologic cycle of the Truckee Meadows</u>

The hydrologic cycle shown in Figure 1.3 diagrams the water processes within our area. Precipitation upon the mountain ranges, largely as snow, provides the bulk of the runoff to our creeks that flow to the Truckee River. The amount of water in these creeks then, is largely determined from the amount of melt from the annual snow pack. Thunderstorm activity also provides infrequent runoff to our creeks as well as short-term flooding events. Groundwater also discharges into stream channels providing a "base flow" of water. Natural groundwater recharge mostly occurs from snowmelt processes within the mountain blocks, generally above 5,000 feet. Other recharge areas occur within flood irrigated areas, beneath irrigation ditches and canals, and mid watershed reaches during large precipitation events. Flooding events also provide recharge to the groundwater aquifers where soils are permeable and unsaturated. Wetlands are generally groundwater discharge areas and predominate in the lower portions of the valley where discharge occurs due to the two processes of transpiration (plant uptake) and evaporation.

Precipitation within the study area is variable ranging from seven inches in the valley floors to as much as 60 inches on the Carson Range. This is due to the "rain shadow" or orographic effect from the Carson Range. Most of the precipitation on the mountain blocks is in the form of snow which occurs from November through April. It is not uncommon for snow to lightly blanket the Truckee Meadows in May as well.

The Truckee River originates as outflow from Lake Tahoe to the west of the Truckee Meadows. It is also fed from Donner and Independence lakes, and Prosser, Boca and Stampede reservoirs, all located in California. It generally flows northerly through California and into Nevada at Verdi, four miles past the state line. The Truckee River then flows easterly through the Truckee Meadows to Wadsworth and then northerly to Pyramid Lake. Within the Truckee Meadows, the Truckee River is largely fed by Hunter Creek, Steamboat Creek and the North Truckee Drain. Other lesser creeks tributary to the Truckee River are derived from the north slope of the Carson Range, the Verdi Range and Peavine Mountain (see Figure 1.1), but most of the water that flows to the Truckee River within Nevada is generated from the Carson Range.

Within the N. Carson, Verdi and Peavine sub-basin, irrigation and water supply diversions are made from the Truckee River such that the flow in this river is significantly reduced. Some of these irrigation diversions make their way to Spanish Springs (Orr Ditch) and the South Truckee Meadows (Steamboat, Last Chance and Lake ditches). Other irrigation ditches serve localized areas of the Central Truckee Meadows.

Steamboat Creek emanates from Washoe Lake, 15 miles south of the Truckee River. Steamboat Creek flows northerly through Pleasant Valley, Steamboat Valley, the south Truckee Meadows and central Truckee Meadows along the base of the Virginia Range. During this course it is fed from five perennial streams that drain the Carson Range and one ephemeral stream from the Virginia Range. Historically, there was significant irrigation in the South Truckee Meadows from Truckee River diversions (Steamboat, Last Chance and Lake ditches). Runoff from these irrigated fields also contributed flows to Steamboat Creek and ultimately the Truckee River, but irrigation today has been significantly reduced. This has had the effect of drying up wetlands and reducing the "secondary" recharge to the groundwater aquifers in this area.

The North Truckee Drain was constructed to drain wetlands and to collect unused Orr Ditch water in Spanish Springs. This ditch carries flows south, through Sparks, and discharges to the Truckee River as the east-side of the Central Truckee Meadows, near Vista. This area is also where Steamboat Creek discharges to the Truckee River. The Truckee Meadows Water Reclamation Facility also discharges its effluent (currently 32 mgd) into Steamboat Creek at this confluence. The Truckee Meadows Water Reclamation Facility is rightly touted as a "state of the art" facility in terms of Quaternary wastewater treatment. The effluent is probably the most highly treated and cleanest effluent in the United States. However, water quality in the Truckee River is significantly affected by the natural discharges of Steamboat Creek and the North Truckee Drain.

Wetlands generally occur on the valley floors of the Truckee Meadows. Wetlands are areas where groundwater and streams converge. They are areas where floodwater can be dissipated. Wetlands provide extensive riparian and wildlife habitat. They also provide a means of filtering water of nutrients (nitrogen and phosphorous) through plant uptake and provide an area for the deposition of sediment from streams. Today, many Truckee Meadow wetland areas have been altered or dried for development that has occurred in the last 120 years. Remaining wetlands are provided for in Spanish Springs along the North Truckee Drain, the South Truckee Meadows east of US 395, and along Steamboat Creek generally from the confluence with Whites Creek to the confluence with the Truckee River.

Only two diversions are made from the Truckee River for drinking water supply. The first is made near Verdi (Highland Ditch) and treated five miles downstream at the Chalk Bluff Water Treatment Facility at the west-end of Reno. The second and lesser diversion is made near the I-80 and US 395 Interchange for the Glendale Treatment Plant.

The hydrology of each of the four sub-basins is described in each chapter in more detail.

Effects of streambed alteration

A properly functioning stream will usually attenuate and assimilate moderate to high flows because it can dissipate the high energy of these waters that would otherwise erode the stream banks. Rural and suburban development often alter streams by straightening the channel, removing native vegetation, eliminating flood plains and/or routing storm flows into the channels through culverts and thereby increasing the energy of the flows. As a result, the "altered" stream channel becomes incised during moderate to high flows because it cannot dissipate the energy of these higher flows. Storm water is particularly destructive because concentrated flows at culverts erode stream banks in this immediate vicinity. And because the stream channel is forced to convey more water that it was naturally formed from, hence more erosive force.

The end result of these alterations to streams, either deliberate or unintentional, is to render the stream dysfunctional. This results in water quality degradation and a change in the hydrologic cycle as well.

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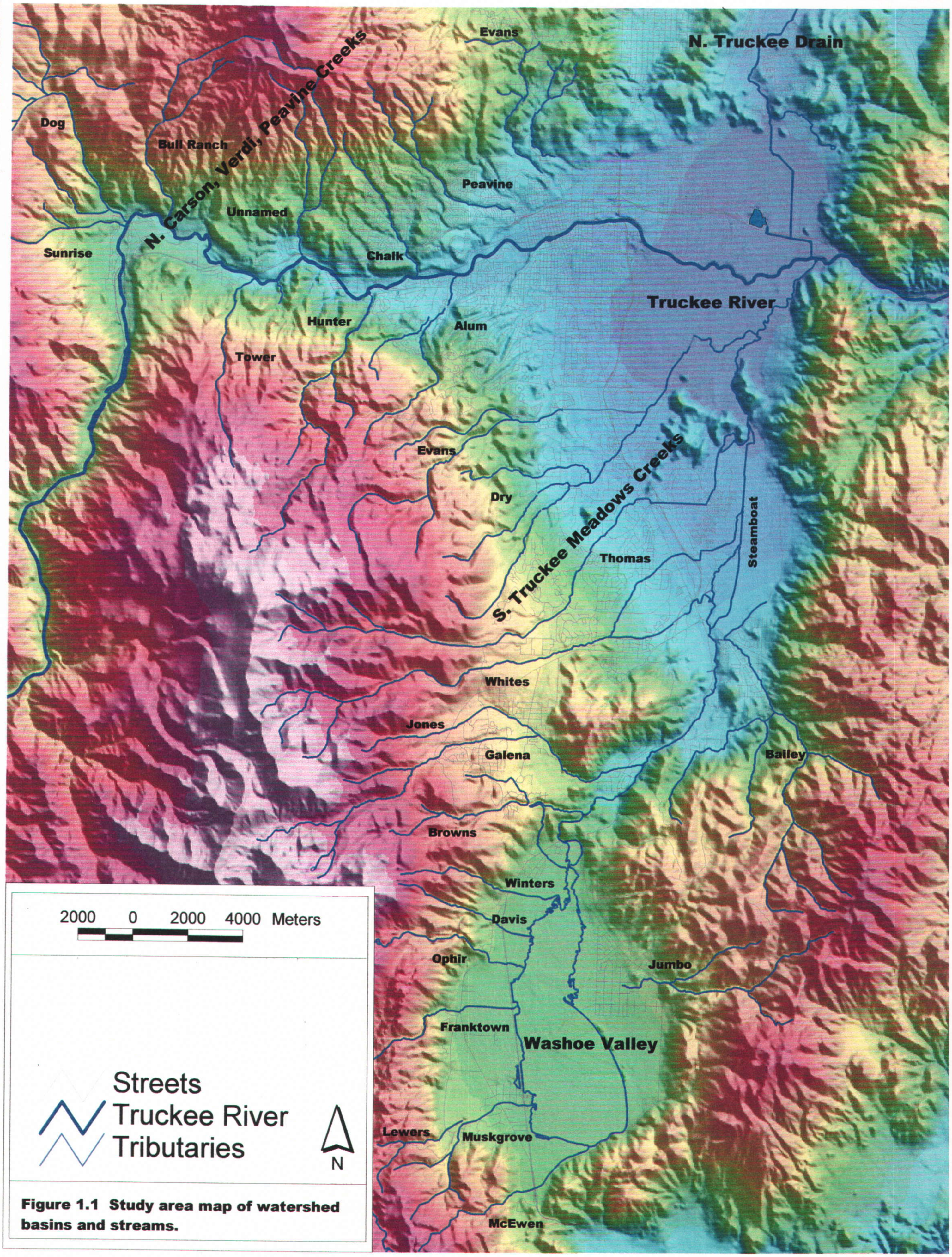


Figure 1.1 Study area map of watershed basins and streams.

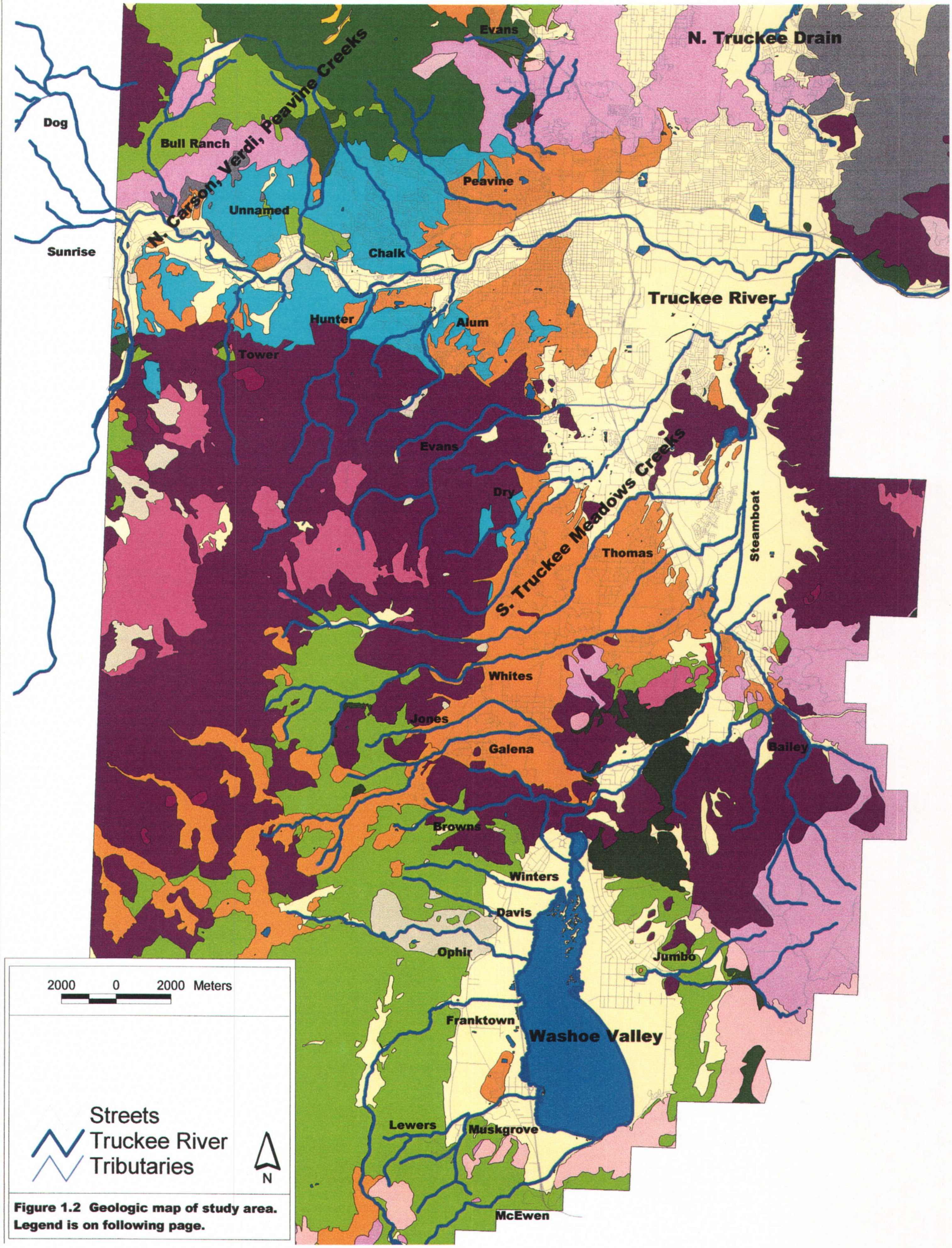
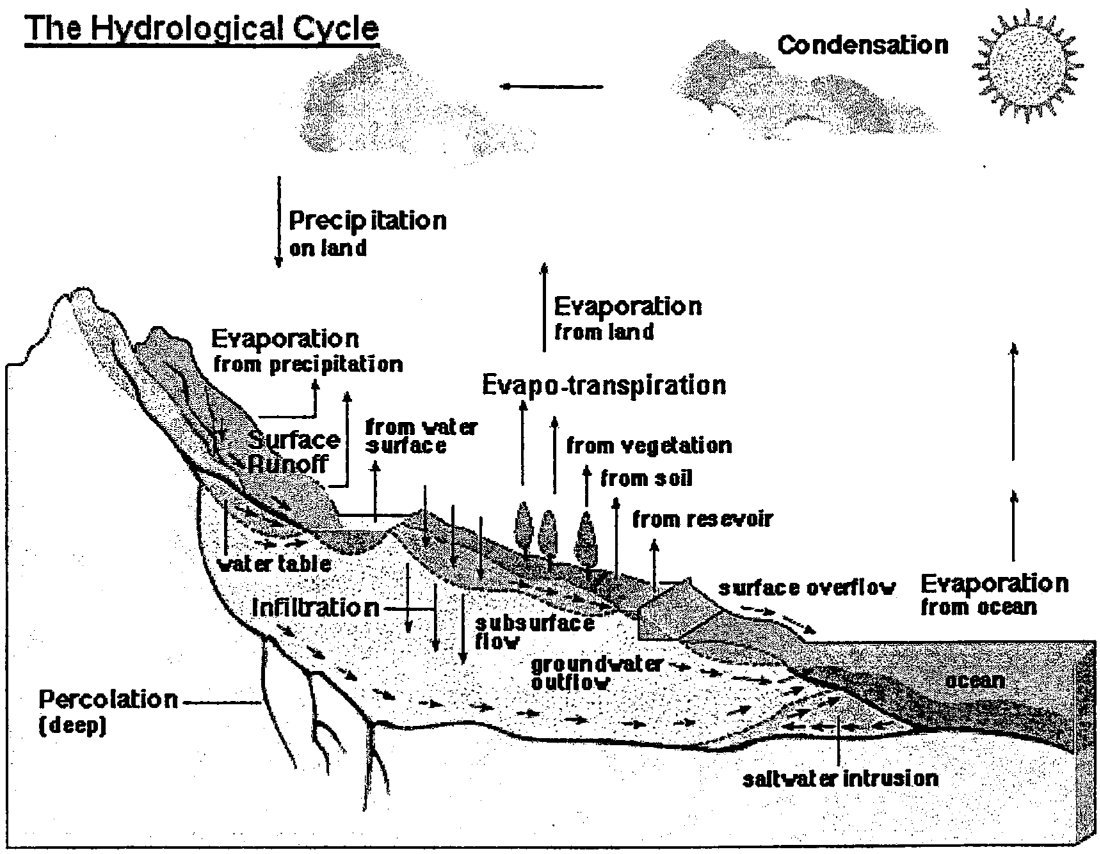


Figure 1.2 Geologic map of study area. Legend is on following page.

Lithology

- Qsl (young alluvial deposits)
- Qls (land slide deposits)
- Qal (stream deposits)
- Ql (lake deposits)
- Qg (glacial deposits)
- Qs (volcanic sinter)
- Qtg (older alluvium)
- Qba (basalt/andesite)
- Qtb (basalt)
- QTr (volcanic rhyolite domes)
- Tir (volcanic rhyolite plugs)
- Tab (volcanic basalt)
- Tst (Truckee Fm, old consolidated sediments)
- Tba (volcanic basalt)
- Tk (Kate Peak volcanics)
- Tki (Kate Peak intrusive volcanics)
- Tgd (granitic stocks)
- Ta (Alta Fm., andesitic volcanics)
- Th (Hartford Fm., rhyolite)
- Kgd (Sierra Nevada batholith, granodiorite)
- mvs (Peavine Sq., metamorphic)
- mv (Peavine Sq., metavolcanics)
- ms (Peavine Sq., metamorphic sediments)
- water

General units are taken from Bonham, Harold F. and Papke, Keith G. Geology and Mineral Deposits of Washoe and Storey Counties. 1969, Plate 1, scale 1:125,000. Other mapping from various Nevada Bureau of Mines and Geology reports (Washoe County, 1994).



The hydrological cycle is the continuous movement of water between the earth and the atmosphere. Water evaporates from water and land surfaces and transpires from living cells. This vapour circulates through the atmosphere, condensing to form clouds and precipitating as rain or snow. When water hits the earth's surface it either runs into streams and ends up in oceans or lakes, or seeps into the soil. The water that seeps into the soil is then either absorbed by the roots of vegetation, or it sinks into the groundwater reservoir.

Figure 1.3. The Hydrological Cycle.

Figure used with consent from Water Policy International Ltd and Water Web Management Ltd. Please see www.thewaterpage.com for more information on Water Science for Schools.

CHAPTER 2
NORTHERN CARSON-PEAVINE-VERDI CREEKS
Hunter, Alum, Peavine, Chalk, Dog, Sunrise, Bull Ranch, Evans

Physical Descriptions
These creeks flow directly to the Truckee River and drain the northern Carson Range (Hunter and Alum), Dog Valley (Dog) and the Verdi Range (Sunrise), or the southern flanks of Peavine Mountain (Bull Ranch, Peavine, Chalk, Evans) as seen in Figure 2.1. Most of these creeks are ephemeral with the exception of Dog Creek and Hunter Creek. The creeks are fed from snowmelt in their respective ranges and from groundwater base flow. Their drainages are orientated north or south towards the Truckee River. While these creeks are mostly ephemeral, their drainages can easily generate large flood flows in excess of 100 cfs or even 1,000 cfs (USGS, 1998).

<u>Creek Narratives</u>
Sunrise Creek drains a portion of the Verdi Range and flows easterly to the Truckee in the Verdi area, immediately upstream of the confluence with Dog Creek. This ephemeral creek has been used for irrigation purposes since the mid-1800's. The irrigation occurs on the relatively flat "bench land" between the steep Verdi Range and the Truckee River, where it is diverted to a reservoir. It may have also been diverted to the Coldron Ditch that irrigated lands north of the Truckee River.

The Dog Creek drainage is primarily in Dog Valley of California where most of the stream flow is generated. This creek drains the east slope of the Bald Mountain range and the west slope of Peavine Mountain, primarily on Forest Service land. The creek flows southeast from Dog Valley through a steep-walled, volcanic canyon and then flows for one mile to the Truckee River in Verdi. Only one-half of the watercourse is in Nevada. Dog Creek had been used for irrigation purposes in the past, but currently is not. Very large flood flows can be generated from Dog Valley as witnessed in January 1997 where the USGS estimated a peak flood flow of 2,500 cfs. The stream channel has largely been unaltered by the previous irrigation practices.

Bull Ranch Creek is ephemeral and drains the southwest slope of Peavine Mountain. It too is used for irrigation on lands served by the Coldron Ditch. However, once the creek leaves the steep slope of Peavine Mountain, its natural course to the Truckee River is less than 1,000 feet. Bull Ranch Creek was not investigated in this watershed assessment program because of its relatively small flow and that its watershed is largely undeveloped.

Several drainages on the south slopes of Peavine Mountain are evident and support other ephemeral streams. Most of these drainages have become affected by erosion and storm drainage where the mid-portions of their watersheds have been developed for residential subdivisions. Chalk Creek, so named because it discharges to the Truckee River at Chalk Bluff, was historically an ephemeral stream. Lately it has become perennial due to the residential development upon its mid-reach sections. Residential irrigation, sewage and water main leakance has created a substantial base flow to this creek. It is worth mentioning because of its recent increased base flow rate (greater than one cfs) and its resultant poor water quality (see chemistry section) even though it has a relatively small watershed. Hundreds of homes in "Northwest Reno" support recharge to the water table through lawn irrigation practices. As more residential development of the southern flanks of Peavine Mountain occurs, the other ephemeral drainages will also become perennial.

Peavine and Evans creeks drain the southeastern flanks of Peavine and were once used for irrigation on lands that are now residentially developed and intensely urbanized. They too are ephemeral, but pose significant flood threats to the City of Reno. Flood control works have been constructed on Peavine Creek and consideration is now being given to a flood control project on Evans Creek. The flows from Peavine are retained in these flood control basins and drainage downstream of these basins is rare. Flows from Evans Creek pass beneath McCarran Blvd and flow through Washoe County's San Rafael Park to Sierra Street. These ephemeral flows are then captured in a storm culvert that discharges into the Truckee River.

Three creeks drain the northern slope of the Carson Range; Tower, Hunter and Alum creeks. Tower is the western most and is ephemeral. It takes its name from the radio facility tower located at 8,200 feet in the upper reaches. The creek flows north to the Truckee River, flowing through the Belli Ranch area where it is used for irrigation of these lands.

Hunter Creek is the largest, perennial tributary to the Truckee River within this basin study area. Within the Carson Range the drainage has created steep-walled canyons down to an elevation of 5,000 feet. The relatively steep-walled drainage continues another mile from this point to the Truckee River through residential subdivisions. This creek water is used for municipal water supply purposes. Until recently, a diversion of the waters was at the 5,000 feet elevation where commingled water from Steamboat Ditch were treated at the Hunter Creek Reservoir. Currently, this water treatment plant is decommissioned. Hunter Creek water now flows to the Truckee River and is diverted downstream at Chalk Bluff or the Glendale treatment plant.

Alum Creek also drains the northern Carson Range although from a much smaller drainage area, between the Hunter and Evans drainages. This drainage, like Hunter, generates much of the runoff from a steep-walled and mountainous area, mostly in forested lands. The creek flows out onto its mid-reaches at 4,900 feet where it continues to flow through a small canyon to its natural flood plain (lower reach) near Plumas St. and McCarran Blvd. This lower reach continues only one mile to the Truckee River in a highly urbanized residential setting. The waters were and currently are used for irrigation purposes on the lower flood plain area.

Geologic and Hydraulic descriptions

Figure 1.2 shows the geology of the greater study area including these watershed areas. The upper drainages of Alum, Hunter and Tower creeks are primarily composed of volcanic andesite. In some areas, mainly the Alum and Hunter creeks, the andesite has been hydrothermally altered or "bleached". The hydrothermal alteration results in the release of sulfates, among other minerals, that is found in the water chemistry, particularly in Alum Creek. In the lower reaches these three creeks flow through the Truckee Formation composed of fine to coarse grained sediments of Miocene to Pliocene age (3-12 m.y.a.). At or near the confluence with the Truckee River, the surface sediments are floodplain deposits.

The Sunrise and Dog creek geology is not shown on Figure 1.2, but is comprised of Mesozoic metamorphic rocks, Cretaceous granodiorite and andesitic volcanics. On the mid to lower reaches of the Sunrise drainage the creek flows across sediments comprised of volcanic clay that is easily erodable. Dog Creek, on its lower reach, flows within a flood plain composed of its flood deposits. Bull Ranch Creek's upper reaches drain Cretaceous granodiorite with some areas of volcanic andesite and basalt. This creek flows across a short reach of sediments at the confluence with the Truckee River.

Chalk and Peavine creeks drain Mesozoic metavolcanics in the upper reaches and the Truckee Formation and recent alluvial deposits in the mid-reaches. Chalk Creek continues to flow through the Truckee Formation until it reaches Fourth Street, then through recent alluvial deposits at its confluence with the Truckee River. Peavine Creek effectively terminates at the flood control basin near Clayton Jr. High School in Recent alluvial and flood deposits. Evans Creek drains volcanic basalt in the upper reaches and older sediments in the mid-reaches. This creek also abruptly terminates at Manzanita Lake on the University of Nevada campus.

Figure 2.2 shows the classified hydric soils for the study area, meaning their potential to adsorb precipitation. Soils with a high to very high classification will have a high runoff capability whereas soils rated low will have a low potential to generate runoff (high rate of infiltration) from precipitation. One could view Figure 2.2 as a map of low-permeability soils, which can be seen throughout the Chalk, Peavine and Evans watersheds, and the mid to lower watersheds of Bull Ranch, Unnamed, Tower, Alum and Hunter creeks. This is the result of outcropping rocks or the clayey nature of sediments derived from volcanics. Figure 2.3 is a map showing percent slopes of these watersheds. Washoe County has determined that the slopes in red are unsuitable areas for development. These areas will also generate substantial runoff to creeks during high intensity precipitation events. Precipitation within these drainages ranges from 56 inches at the crest of the Carson Range to 8 inches on the south and basal flank of Peavine (Klieforth, 1983). Table 2.1 lists the physical description statistics for these creeks.

Table 2.1
Physical description statistics

Watershed	Drainage area (sq mi)	Average range in streamflow (cfs)	Range in precipitation (in)	Range in elevations (ft)
Bull Ranch	5.8	0-3*	16-36	4,820-8,260
Dog	26.1	1-20	16-45*	4,840-8,100
Sunrise	4.4	0-1	16-40*	4,840-7,600
Tower	3.7	0-2*	16-50	4,700-7,650
Hunter	11.7	5-20	12-56	4,600-7,900
Alum	4.9	0-5	10-40	4,560-7,400
Chalk	4.6	0-2*	8-14	4,595-6,000
Peavine	2.4	0-3	8-16	4,760-6600
Evans	3.8	0-2	10-12	4,480-5,580

*Estimates as there are little or no measured records.

Figure 2.4 is a map of the 100-year flood zones as determined from the US Federal Emergency Management Agency (FEMA). These areas are susceptible to flooding during most high intensity, long duration precipitation events and not just during 100-year rainstorms. While flooding obviously occurs within the active creek channels, floods overflowing their banks create problems for development built within floodplains, which these maps help illustrate. Flooding does not appear to be a problem other than areas adjacent to the Truckee River and the creeks.

Figure 2.5 outlines wetland areas as mapped by Washoe County, the US Army Corps of Engineers, the Federal Emergency Management Agency, the Nevada Department of Wildlife and the Desert Research Institute (Washoe County, 1999). These wetlands are based upon vegetation, hydric soils (soils frequently saturated) mapping, playas, floodways, and of course observations. Within the Carson-Peavine-Verdi Tributaries study area few areas are mapped as wetlands. Large-scale residential development of the Peavine and lower Alum Creek area has occurred such that small wetlands have been drained over the last forty years. Much of the other wetland areas occur within the upper and undeveloped watersheds are probably not mapped because of their small size.

Figure 2.6 is a map of the types of vegetation mapped during the late 1980s. The upper watersheds are mapped as coniferous and brushland with Peavine being mapped almost exclusively as brushland. Within the mid reaches of the watersheds the vegetative type is brushland dominated with sage and bitterbrush. On the lower reaches urban development dominates the landscape. If this map were updated, the urban development would replace much of the mid reaches on Peavine Mountain as seen where subdivision roads are located. Also, more development is occurring throughout the mid reaches of the unnamed drainage on Peavine Mountain.

Land Use

Land use within these watersheds is diverse, ranging from national forest to areas of high-density residential, commercial and industrial use. The City of Reno and Washoe County share the lower watersheds as depicted on Figure 2.7. Development is primarily residential. Residential development, west of the City of Reno, is located in Verdi, Mogul and the Belli Ranch areas. The western and southern watersheds within this sub-basin are largely unaffected by development. However, on the southern slopes of Peavine and the Carson Range, high density development occurs throughout the mid and lower watersheds of Alum, Chalk, Peavine, Evans, and the Unnamed drainage above Mogul.

Sanitary Survey

A sanitary survey was conducted to specifically locate and map the following:

- Septic tanks within the watersheds,
- landfills,
- hazardous waste/chemical generators,
- above/below ground storage tanks,
- herbicide, fertilizer and pesticide application areas (golf courses),
- industrial sites, and
- road salt storage sites (NDOT and Washoe County).

Figure 2.8 shows the results of this survey. Since data for the Truckee River are excluded in this assessment (see Introduction for this discussion), no known hazardous materials are found within 150 feet of the creeks. Indeed, almost all development within these watersheds is residential. This figure does show the locations of all septic tanks. These are located, if at all, at the very base of these watersheds. Water chemistry taken on Dog and Alum creeks does not yield evidence for effluent contamination. Minor algae growth was noted in Dog Creek during the stream surveys.

Stream Chemistry

There is little water chemistry data for any of these creeks other than Hunter Creek. During the autumn of 2001, water chemistry samples were taken at the confluences with the Truckee River for the creeks Hunter, Alum, Chalk and Dog (Table 5.2). These data represents low flow conditions. Because of the limited size of the data set, more aggressive surveys should be undertaken to better sample normal flow and storm runoff for fully quantifying urbanization effects upon the creeks. Results for all the sampling can be found in the appendix.

General chemistry

Table 2.2 lists select water quality constituents for the creeks sampled. The listed constituents represent water quality that is influenced by natural conditions, erosion, human waste (septic tanks), and livestock waste. Overall the water quality is diverse. While Dog and Hunter creeks show good quality water, Alum, and in particular Chalk, show very high total dissolved solids (TDS). The Alum water is high in sulfate (420 mg/l), probably derived from the hydrothermally altered volcanics, and calcium (100 mg/l). Chalk water has an alarmingly high level of TDS. The main constituents are sulfate (1800 mg/l), calcium and manganese (360 and 240 mg/l respectively), sodium (236 mg/l) and bicarbonate (344 mg/l). Suspended sediment loads are mostly very low. Nitrogen and bacterial counts are relatively low, exceptions being the bacterial count for Alum and the nitrate count for Chalk.

Table 2.2
General water chemistry

creek/reach	TDS	TSS	TP	NO3	TKN	Fecal coli	Fecal strep	coli/strep Ratio
	mg/l	mg/l	mg/l	Mg/l	mg/l	count	count	
Dog	172	3	0.03	0.0*	0.2	<1	11	<0.1
Hunter	116	5	0.05	0	0.15	2	20	0.1
Alum	740	16	0.11	0	0.58	30	350	0.08
Chalk	3,080	<1	0.26	3.0	0.35	<10	50	<0.2

TDS= total dissolved solids (inorganic chemistry)
TSS= total suspended solids (sediment)
TP = total phosphate (organic phosphate)
TKN=total Kjeldahl nitrogen (organic nitrogen)
Coli= coliform (fecal coliform is feces derived bacteria)
Strep=streptococci (fecal bacteria)
* Below detection

Stream Surveys: North Carson Watersheds

Tower Creek

A brief survey was made of Tower Creek. This creek flows through largely undeveloped property in the Belli Ranch area. Natural erosion is occurring upstream of this development. Development impacts surveyed were minimal. However, the creek could become impaired through future development and residential activities.

Hunter Creek

Hunter Creek is located southwest of Reno, almost entirely in the Toiyabe National Forest. The headwaters are fed by springs and snow melt high up near the peaks of the Carson Range. The Creek flows through mostly undisturbed terrain and converges with the Truckee River near the Mayberry Pedestrian Bridge.

The stream channel is in very good condition. Dirt roads, trails and irrigation canal crossings do not affect the channel stability. Vegetation is recovering nicely following a recent burn through the riparian corridor. The healthy vegetation provides very good habitat for wildlife such as deer, coyotes, small mammals and birds. The stream flow is very clear and water quality appears to be good. The stream should be protected for its value as a source of clean water, wildlife habitat and open space.

Alum Creek

Alum Creek is a seasonal stream that flows when it receives water from springs or from snow melt and storm events. The headwaters are in the steep canyons of the Toiyabe National Forest, about three miles south of the Caughlin Ranch Subdivision. The creek terminates in the Truckee River, near the intersection of Mayberry Drive and McCarran Boulevard in west Reno.

The upper reaches are relatively undisturbed by human activities. The steep canyons are not well suited for roads or development. However, dirt roads exist on the ridges above the creek and are a source of sediment from very erodable soils. A maintenance plan for Hunter Lake Road, and other roads in the area, would reduce sediment in Alum Creek. The plan should include proper road drainage and should attempt to reduce off-road travel.

The middle reaches of Alum Creek Flow through open space within a low-density residential setting. The vegetation is groomed turf sod with little or no woody riparian vegetation adjacent to the stream channel. Riparian vegetation should be re-established along the creek to replace the existing sod. This would prevent fertilizers and other lawn care chemicals from reaching the stream. It would also provide valuable wildlife habitat. The majority of the reaches are relatively stable, however, some minor bank erosion was observed.

Upstream of the Caughlin Parkway crossing, stormwater runoff from the Seasons Subdivision is contributing significant sediment to the channel. A recent storm event appears to have resulted in approximately 200 to 300 yards of sediment deposited in the creek. The source of the storm water should be controlled and the gully should be armored to prevent further erosion. Polluted runoff from construction activities is entering the creek at storm drain outfalls below the Seasons

Subdivision. This should be controlled by implementing erosion control Best Management Practices at the construction sites, as required by Reno City Ordinances.

The lower reach of Alum Creek Flows through open space within a medium density residential setting. There is little riparian vegetation along the creek. Riparian vegetation should be re-established to replace the sod. This would improve water quality, prevent erosion and provide much better wildlife habitat. Near the confluence of Alum Creek and the Truckee River, very good riparian vegetation was observed. The vegetation included rushes, sedges, willows, and other woody vegetation, that would be appropriate along the rest of the lower and middle reaches. Within the subdivision at the confluence with the Truckee River, native vegetation has been replaced with sod. As above, this sod should be replaced with appropriate vegetation in order to prevent water quality contamination from fertilizers.

Stream Surveys: Verdi Watersheds

Dog Creek

Dog Creek flows from the north, toward Verdi, where it enters the Truckee River. Vegetation is healthy and the riparian zone provides very good habitat for wildlife. Water in the creek flows clear, however, healthy algae were observed. This may be an indicator of under-treated septic reaching the stream. The upper reach of Dog Creek is in proper functioning condition and the lower reach is functional-at risk. It is considered at risk due to the very straight alignment of the channel along the edge of the valley. Homes and roads, perched on the ridge above the creek, are threatened by soil erosion and slope instability along the upper reach. High flows will continue to carve away at the toe of the slopes, increasing the risk of damage to structures. In some cases, it may be necessary to armor the slopes to prevent erosion and sediment movement.

Sunrise Creek

Sunrise creek watershed is located northwest of Verdi. Development in the headwaters is low density residential and development is occurring along the middle reaches. The stream is relatively undisturbed, with the exception of some encroachment from roads. Vegetation along the channel is vigorous and healthy, and provides good wildlife habitat. Water quality appears good along all areas observed. The stream is in proper functioning condition. Development within the channel floodplain should be avoided and road crossings should preserve riparian vegetation. Stormwater runoff should not transport sediment to the creek.

A lama ranching operation discharges irrigation water, storm water and ephemeral stream flows to natural drainages that enter the Truckee River. Over-grazing has removed pasture and meadow grasses, leaving much of the ranch area in bare soil that is subject to erosion. Sheet flow and standing water is conveyed off-site in unprotected ditches that erode and are a source of sediment. Untreated animal waste is a source of pollution. Water leaving the site is very milky in color and sediment and silt is deposited in the channel downstream of the ranch. Head cut erosion was observed in many of the channels that flow from the ranch. High flows have the potential to cause significant erosion and may cause environmental and property damage. The lack of vegetation limits the suitability of the channels for wildlife habitat.

Clean stream flows entering the site should be conveyed through the ranch in stable channels that are protected from livestock trampling and animal wastes. Runoff from the sites should be detained in treatment basins before discharge to the Truckee River. Livestock should be kept out of ditches and live streams. Bare soils should be revegetated and livestock should be limited to the carrying capacity of the range.

Stream Surveys: Peavine Watersheds

Peavine Mountain is located northwest of Reno, east of Verdi and west of Stead. Five predominant streams flow from the south slopes to the Truckee River. From west to east, the streams are Bull Ranch Creek, Unnamed stream (Mogul), Chalk Creek/Rainbow Creek, Peavine Creek, and Evans Creek. Middle reaches are developing into residential and commercial subdivisions. Development is rapid and a new subdivision is under construction west of Northgate Golf Course that will include over two thousand new homes. Outside of developments, streams are typically in good condition. Conditions vary within subdivisions. Some steams are very impacted by encroachment and questionable construction practices, while other areas have been nicely preserved as parks and open space.

In the upper reaches and along streams set aside for open space, vegetation is healthy and relatively undisturbed by human activities. In other areas, riparian vegetation was removed and streams were channelized by development. Peavine streams and springs are a source of water and habitat for wildlife, such as deer, coyotes, small mammals, birds and reptiles. Streams that are not disturbed by development are typically stable and able to convey flood flows without damage to the environment or property. Water quality is impacted by sediment from construction activities, naturally occurring salts and lawn care chemicals. Improperly functioning sewer lines may also contribute to water pollution. Algae were observed in most of the streams.

<u>Bull Ranch Creek</u>

The stream flows from the west slopes of Peavine Mountain to the Truckee River near East Verdi, it is relatively undisturbed by human activities. Water quality appears good and vegetation along the channel provides suitable habitat for wildlife. Channel geometry is good and not affected by encroachment from development.

<u>Unnamed Creek (Mogul)</u>

The unnamed stream is located west of the Northgate Golf course and converges with the Truckee River near Mogul. The upper reaches usually flow well into the summer, while the lower reaches dry up in early spring. The riparian vegetation along the stream provides very good wildlife habitat. The stream has its origins in springs and is recharged by snowmelt and rain. The undisturbed upper reaches are in excellent condition, while the lower reach has recently been severely impacted by encroachment from new development.

Currently a 2,000 home development is under construction on the mid to lower reach. A sewer pipeline, that will service the development, is under construction along the stream channel in the steep canyon north of Mogul. The sewer line is constructed in the floodplain adjacent to the flow line of the creek. A survey of the stream channel showed encroachment upon the channel and significant sediment placed in the creek from the construction. Because there is not a buffer zone maintained between the creek and sewer line, the encroachment will be a source of sediment to the creek. Additionally, the development of the storm drain system will increase the natural flow during storm events thereby increasing the risk of erosion and sediment transport to the Truckee River.

Chalk Creek/Rainbow Creek

The stream is located on the south slope of Peavine Mountain and flows toward the developments near McQueen High School. The watershed is roughly between Robb Drive and McCarran Boulevard. The stream converges with the Truckee River about one mile west of McCarran Boulevard. The stream usually flows year round and is fed by springs, rain, snow melt and runoff from development. The riparian vegetation along the stream provides very good wildlife habitat for deer, coyotes, small mammals, reptiles and birds. The upper reaches are undisturbed and enter the developed areas in good condition. In the lower reaches, near Mae Anne Avenue, the stream is within a park setting with a multi use trails and interpretive signs. The natural vegetation and channel geometry is preserved and the stream is in good condition.

The mid-reaches have been developed with moderate density subdivisions. South of Mae Anne Drive, the channel function is good along these reaches. No excessive down cutting or unusual erosion was observed. Natural sinuosity erodes slopes in some areas, however, this is a natural process that does not appear to overload the system with sediment. Tests indicate that dissolved solids and nutrients affect water quality. Some of the dissolved solids are the result of salts leaching out of the soil and some may be from improperly functioning sewer lines and over applications of lawn care chemicals. Sediment does not appear to influence the system. Vegetation is good and includes Salix and Black willows, cottonwood trees, and typical native brush. Some rushes and sedges are growing along the channel. Tall whitetop weeds threaten native vegetation. A management plan should be developed that controls weeds and encourages the existing riparian vegetation. Overall, the stream is in good condition in the reach is an excellent site for the open space and multi use trails. Flood flows do not threaten homes or damage the environment.

South of the Freeway, flows in the creek appear to be limited by culverts and detention basins. It appears that out of bank flows have not occurred for some time. This has limited the natural lateral movement of the stream. It appears that riparian vegetation in the floodplain is being replaced by upland species such as sage, bitterbrush, and rabbit brush. Tall whitetop, Scotch thistle and other weeds are beginning to out-compete colonies of excellent native grasses, rushes and sedges along the creek. A management plan should be developed that controls weeds, and encourages the existing riparian vegetation. Overall, the stream is in good condition in the reach and would be a good site for open space and multi use trails.

Peavine Creek

Peavine Creek flows from the seven thousand-foot level on Peavine mountain towards Reno just east of McQueen High School. South of McCarran Boulevard, the steam flows parallel to Kings Row. The creek appears to be ephemeral and flows in response to intense storm events and snow melt. Two large detention basins prevent most sediment from reaching the Truckee River and control the risk of flooding. The stream flows through residential and commercial developments created in the 1980s and 1990s. Vegetation is appropriate for the setting and provides habitat for wildlife along most of the reach. Vegetation includes stands of willows, rushes, sedges and trees.

Evans Creek

Evans Creek is located north of Rancho San Rafael Park in North Reno. It flows from the southeast slopes of Peavine Mountains in a relatively undisturbed setting north of McCarran Boulevard. South of McCarran Boulevard, it enters the park and a one-acre reservoir, before flowing to Manzanita Lake at the University of Nevada. The stream leaves Manzanita lake and enters the Ore Ditch on the University property. The upper reaches are used as open space and trails. Water quality is good in the upper reaches above McCarran Boulevard. In the park, there is a risk of nutrients entering the creek from ranching and sod maintenance. Vegetation and channel geometry are good along most of the reach and the stream provides good wildlife habitat. In the past, the channel has been a source of flooding at the University of Nevada. A proposed flood control project would provide detention in the canyon north of McCarran Boulevard.

Conclusions and Recommendations

Invasive biota

Only two watersheds harbor invasive plant species. These are Chalk Creek where Tall Whitetop and Scotch Thistle are found and an unnamed drainage near Sunrise Creek where Scotch Thistle is found. Both Tall White Top and Scotch Thistle are problems because they out-compete native plants, do not provide useful habitat or forage, and are difficult to eradicate.

Stormwater and erosion

During the field inspections and stream assessments note was made of areas where moderate to significant erosion was occurring. Particular note is made of the following areas as shown on Figure 2.9. Construction site sediment is being discharged to Alum Creek during storm events along Caughlin Parkway. Construction of the sewer line above Mogul in the "unnamed" drainage is built in the channel flood plain placing significant sediment in the channel. This will be carried to the Truckee River during moderate storm events. Erosion of a small drainage channel in Verdi along Hill Lane will jeopardize this road and will discharge animal waste and sediment into the Truckee River as well. Other construction sites within the Chalk Creek drainage are also discharging sediment into the drainage that will eventually be carried to the Truckee River.

Stream health rating

The most obvious problem for these creeks is erosion and sedimentation. This is due to development encroaching upon or alteration of the creeks and stormwater discharges to the creeks. Table 2.4 lists the ratings for each creek, based upon the assessments. As noted above, residential development and construction activities are impacting these watersheds. However, most of the degrading activities are located in active construction areas such that the effects are generally temporary problems. An exception is the sewer line above Mogul. Reclamation efforts will alter the stream channel and if not effective, will cause sediment to be transported to the Truckee River. Restoration efforts can be successful for many of the reaches listed critical and or sensitive and are marked with an asterisk (*).

Table 2.3
Stream Health Ratings

Creek	reach	
	mid	lower
Tower	good	sensitive
Hunter	good	good
Alum	sensitive	sensitive*
Dog	good	sensitive
Sunrise	good	critical*
Bull Ranch	good	good
Unnamed	good	sensitive
Chalk	good	sensitive
Peavine	good	none
Evans	good	none

Stream Ordinance

In 2000, the Washoe County Development Code, Article 418, Significant Hydrologic Resources was enacted. The purpose of this article was to regulate development activities and protect perennial streams. A "critical stream zone buffer area" was set to within 30 feet of the stream thalweg and a "sensitive stream zone buffer area" set to within 150 feet of the stream thalweg. This ordinance is only in effect outside the City of Reno limits. Generally, the stream surveys were conducted within the City of Reno and with the exception of the Mogul drainage, buffer zones are being respected.

Recommendations

The results of these stream assessments will be used to help develop watershed management programs. The following recommendations are made as a starting point in determining what components are necessary for the management plan. The recommendations are made based upon maintaining or improving the functionality of each stream.

1. A more detailed erosion and sediment source survey should be made for each creek. This will help identify areas where improvements to water quality and sediment transport can be made. The surveys can be conducted at a very low cost. The cost of making improvements is unknown and could be expensive.

2. A public education program on the Stream Ordinance is strongly recommended. These measures would help to reduce flood potentials, invasive plants, and improve water quality that discharges to the Truckee River. This may also include a survey of individual lots and communication with these owners.

3. A White Top Eradication program is recommended for the Chalk Creek. Programs for eradication are available. Because this invasive plant is somewhat contained, total eradication would be relatively inexpensive.

4. Increase construction site erosion control through enforcement and education. Currently erosion control measures at construction sites near streams and drainages are not always effective.

5. Improve on general water quality analysis and databases of different reaches of each creek. To date there is little or no information on water quality for several of these creeks. This type of program would be effective in periodically assessing the condition of the watershed. The sampling should be conducted during wet and dry conditions. This could be done two or three times a year for three years followed by periodic sampling.

6. The lama ranching operation in Verdi is a potential source for nutrient (nitrogen and phosphate) loading to the Truckee River. Proper land management practices could alleviate this potential.

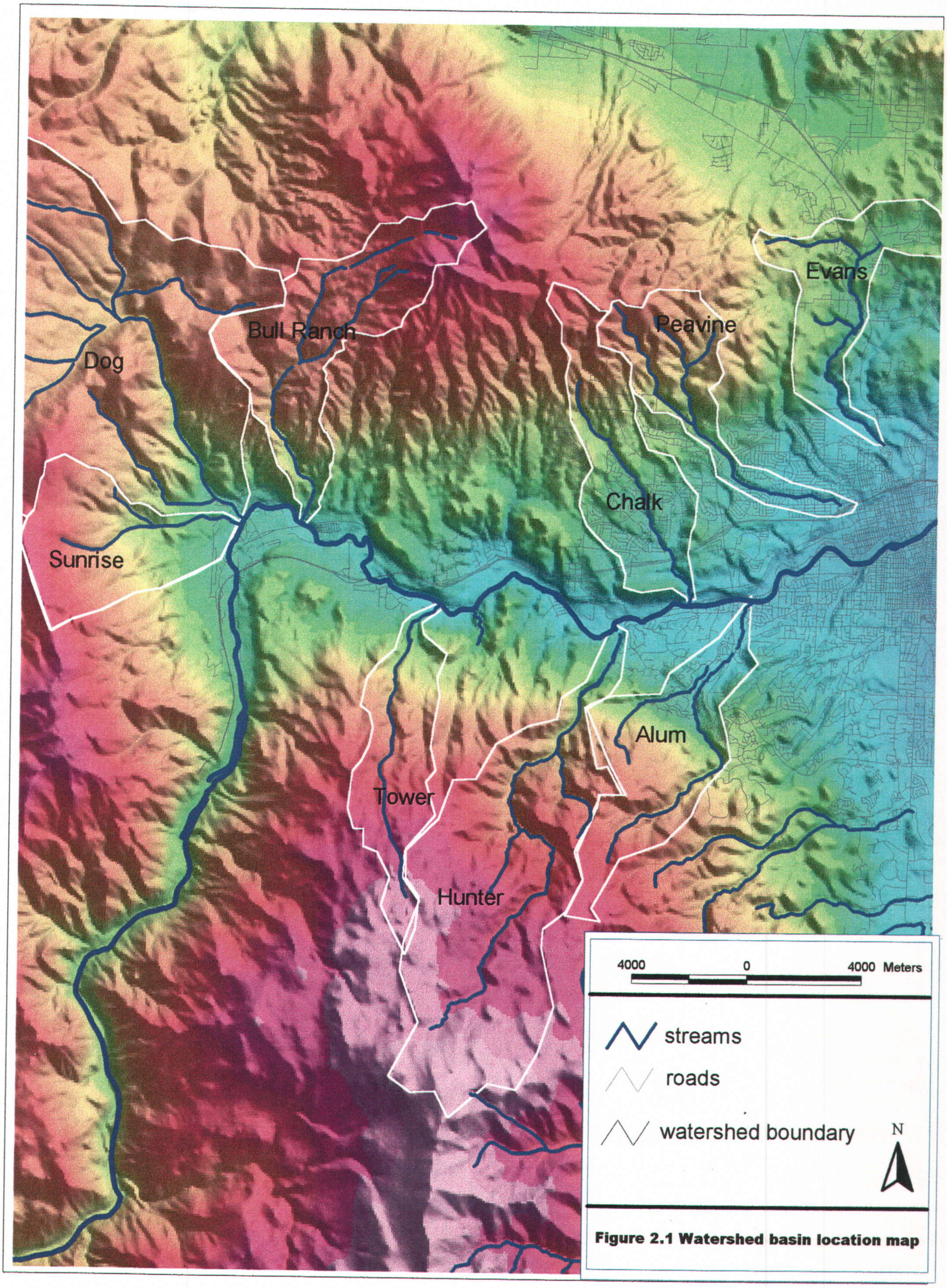


Figure 2.1 Watershed basin location map

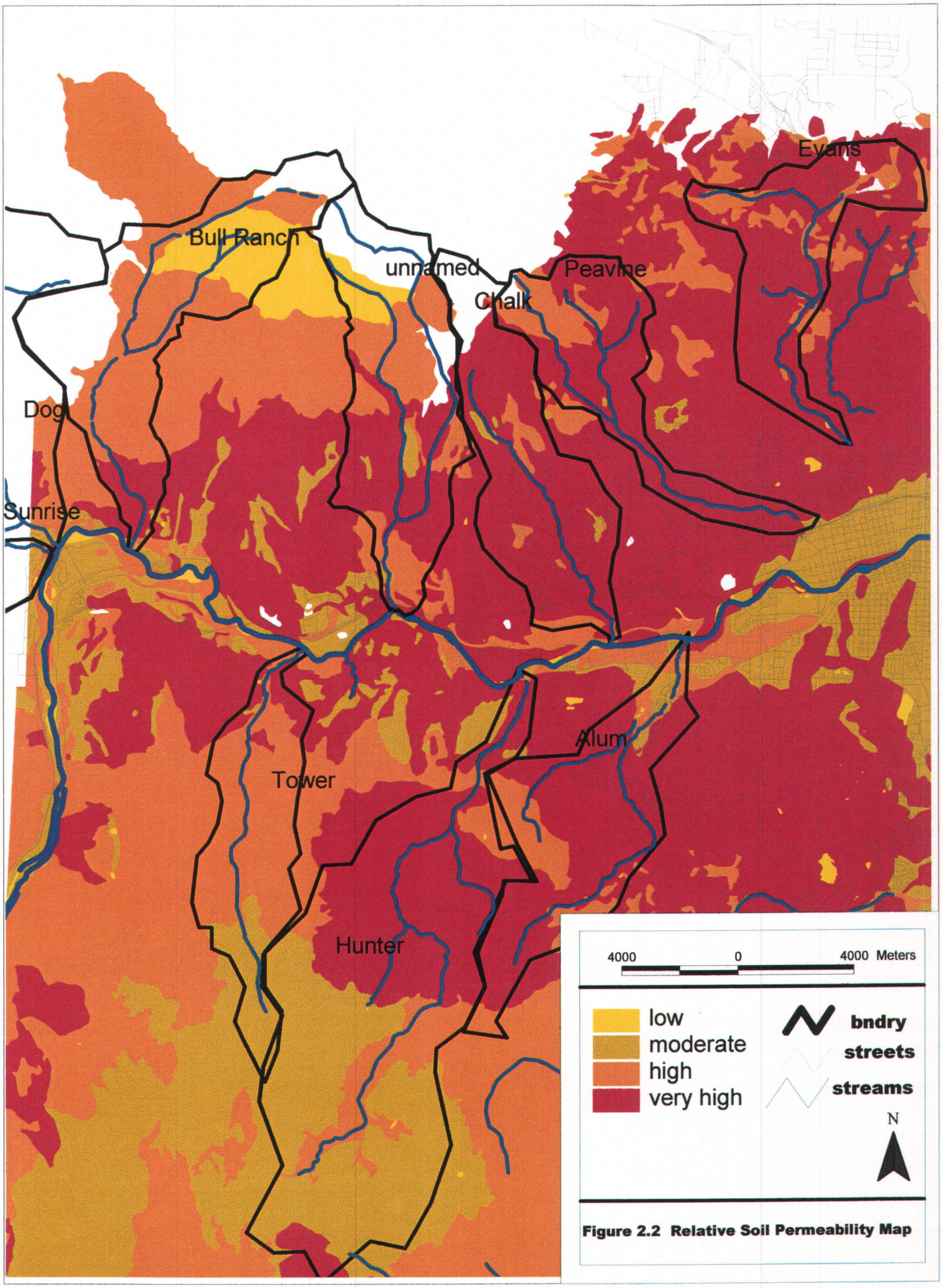


Figure 2.2 Relative Soil Permeability Map

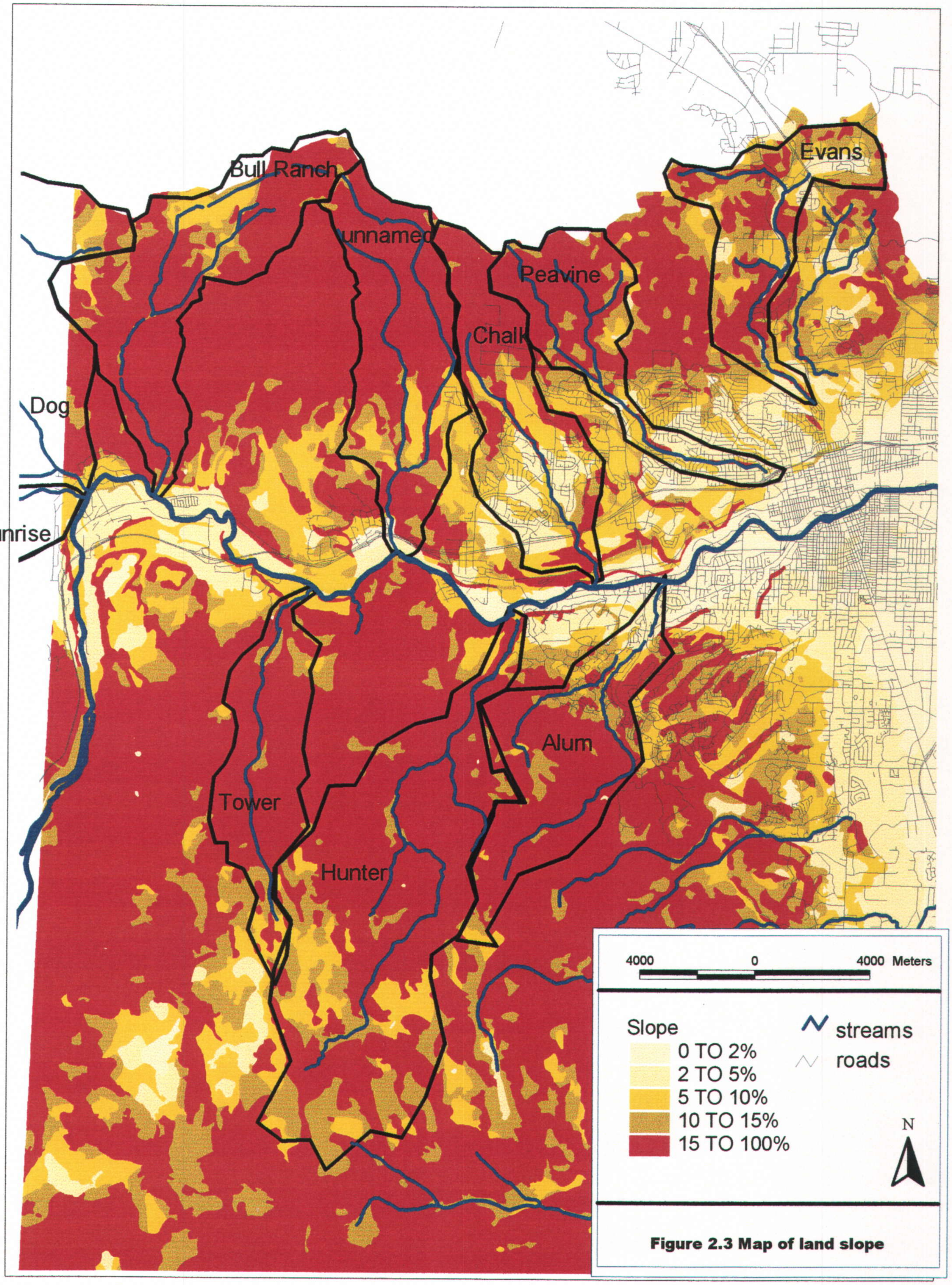


Figure 2.3 Map of land slope

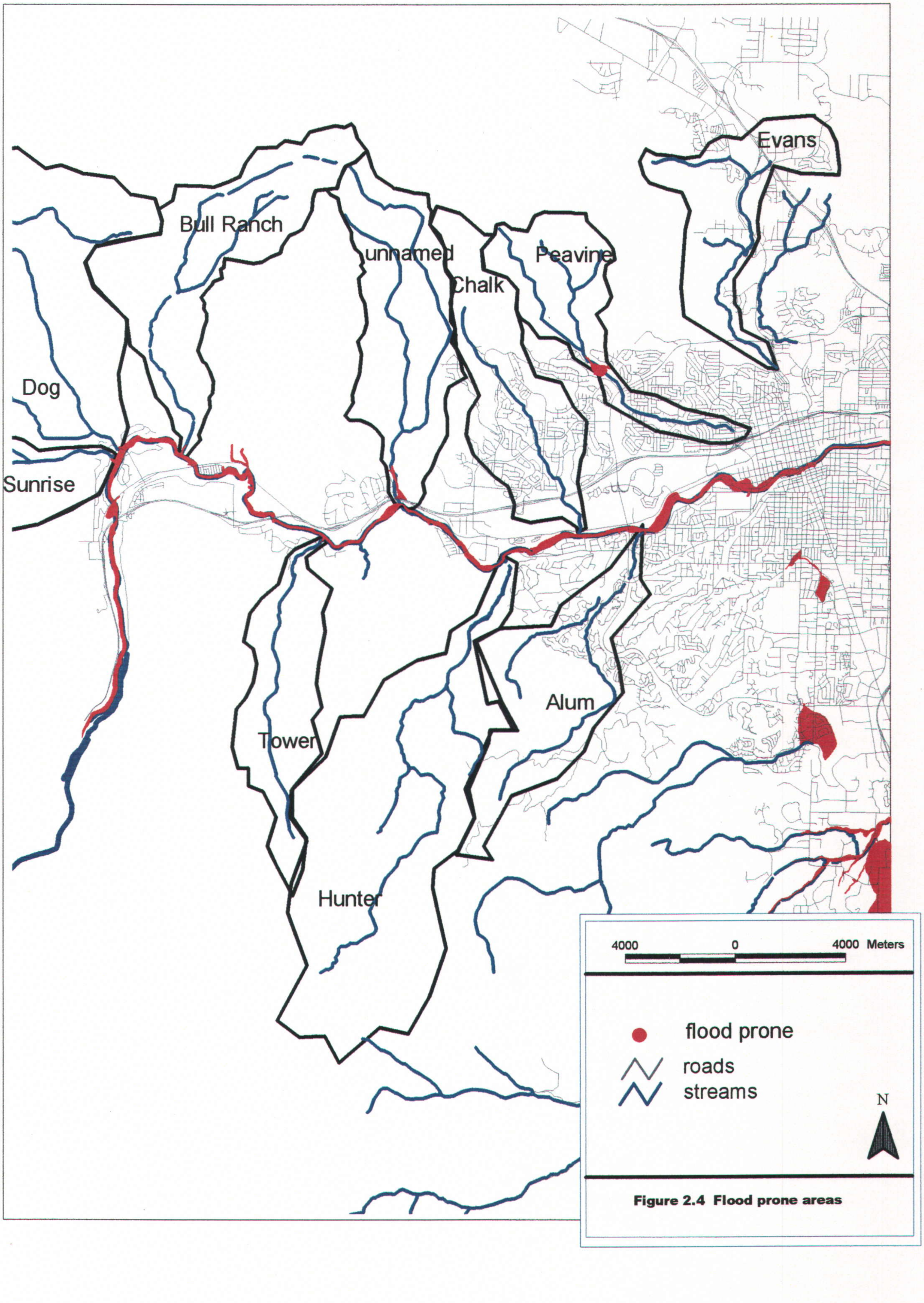


Figure 2.4 Flood prone areas

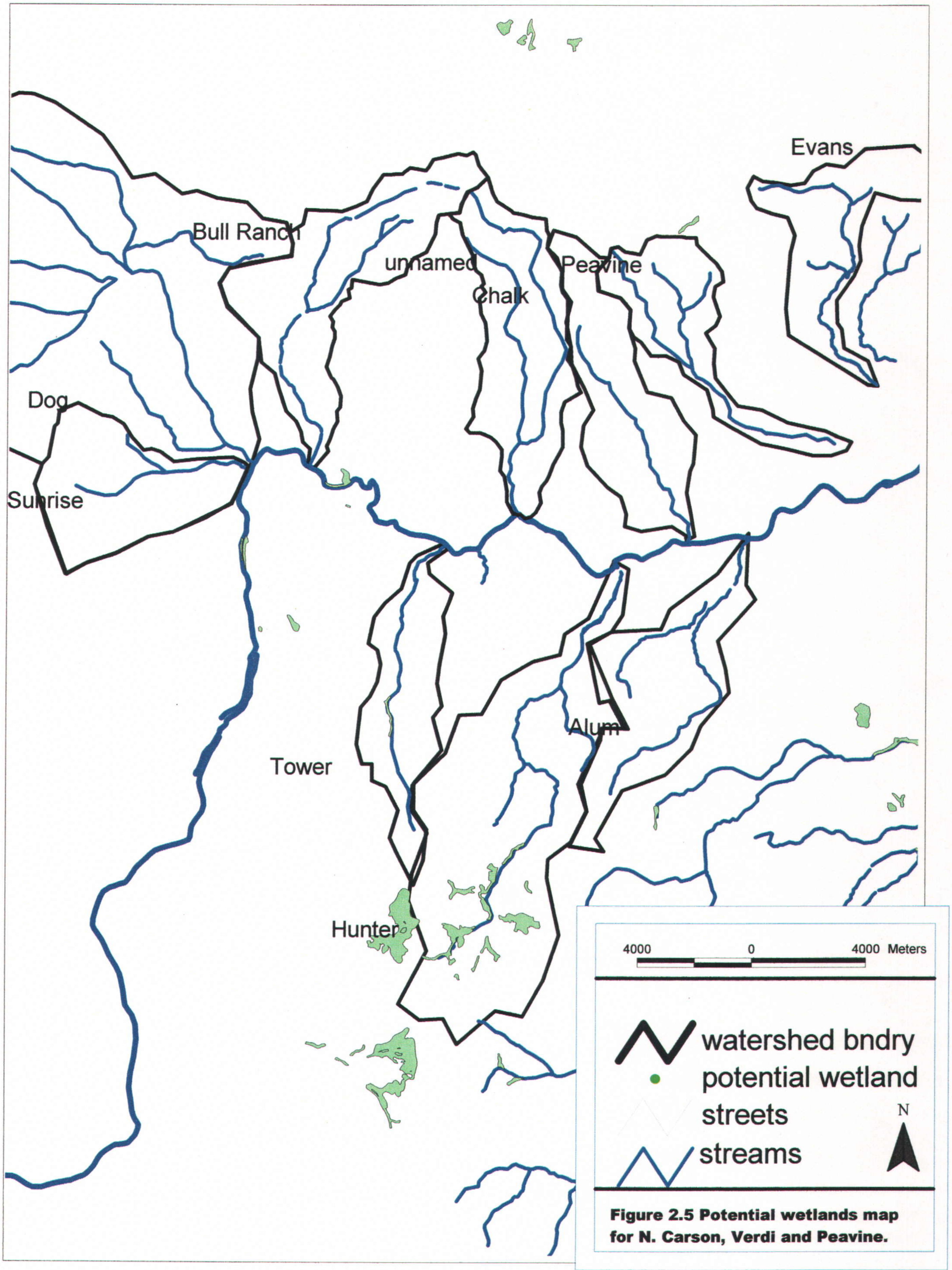


Figure 2.5 Potential wetlands map for N. Carson, Verdi and Peavine.

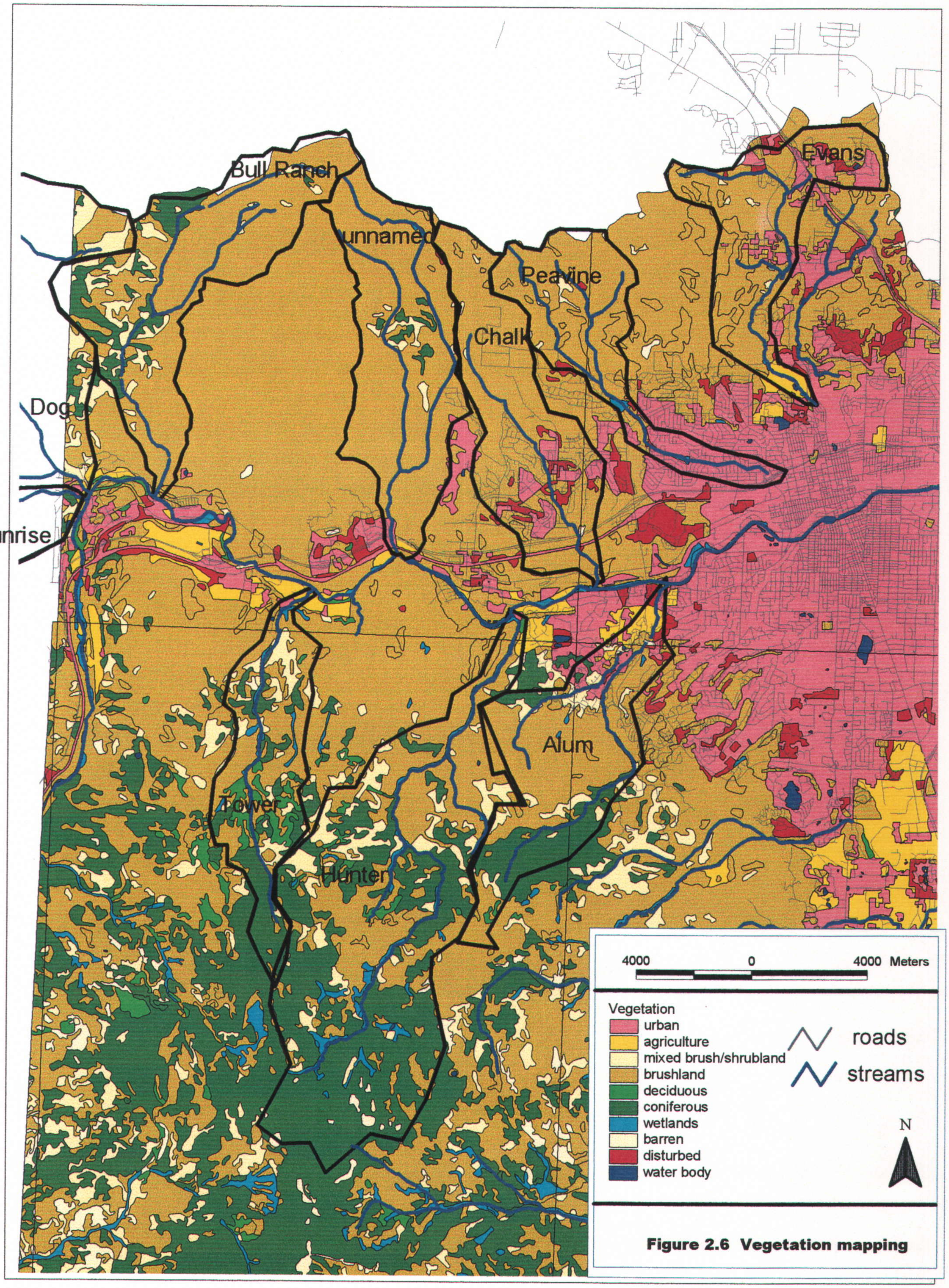


Figure 2.6 Vegetation mapping

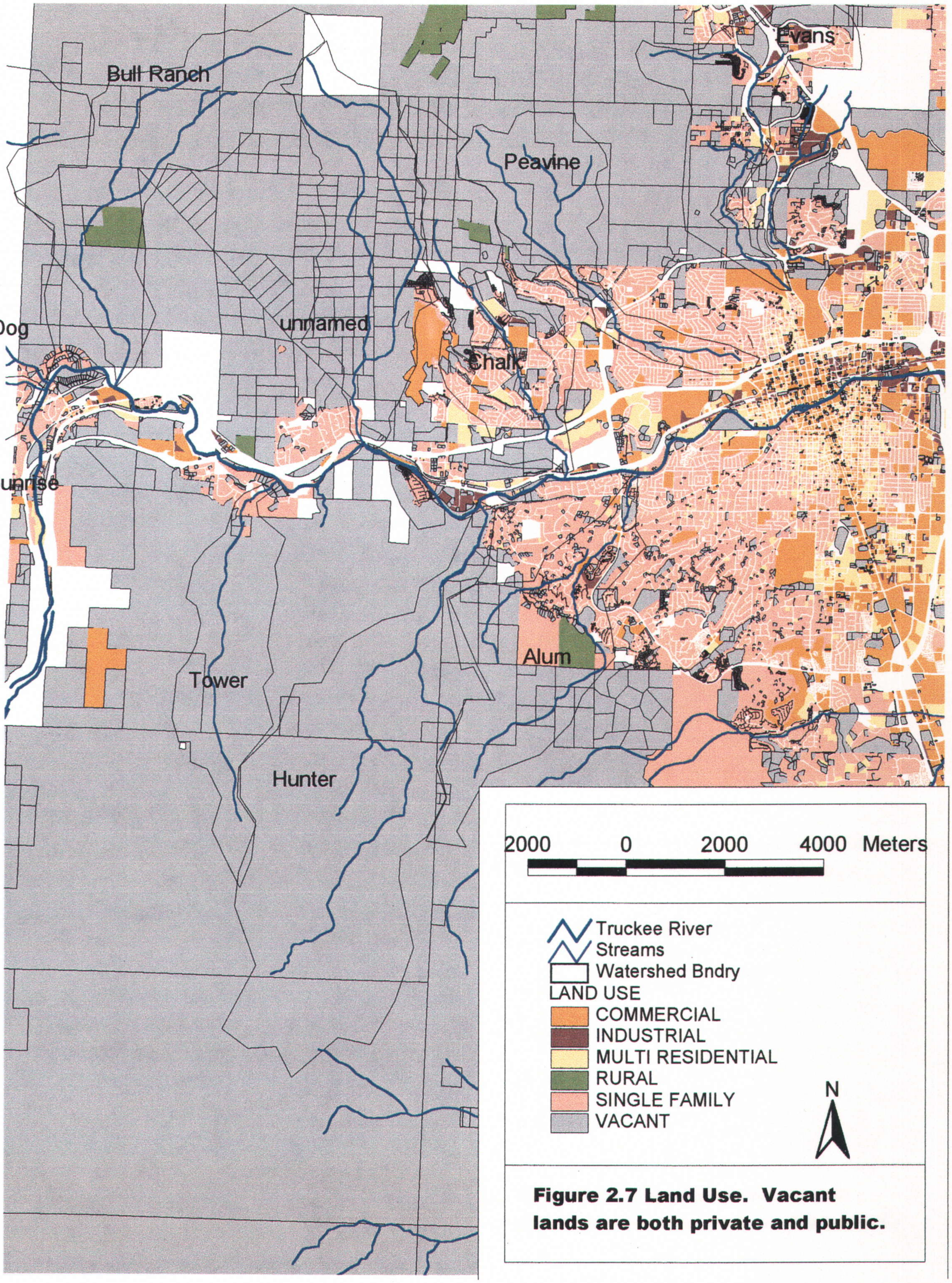


Figure 2.7 Land Use. Vacant lands are both private and public.

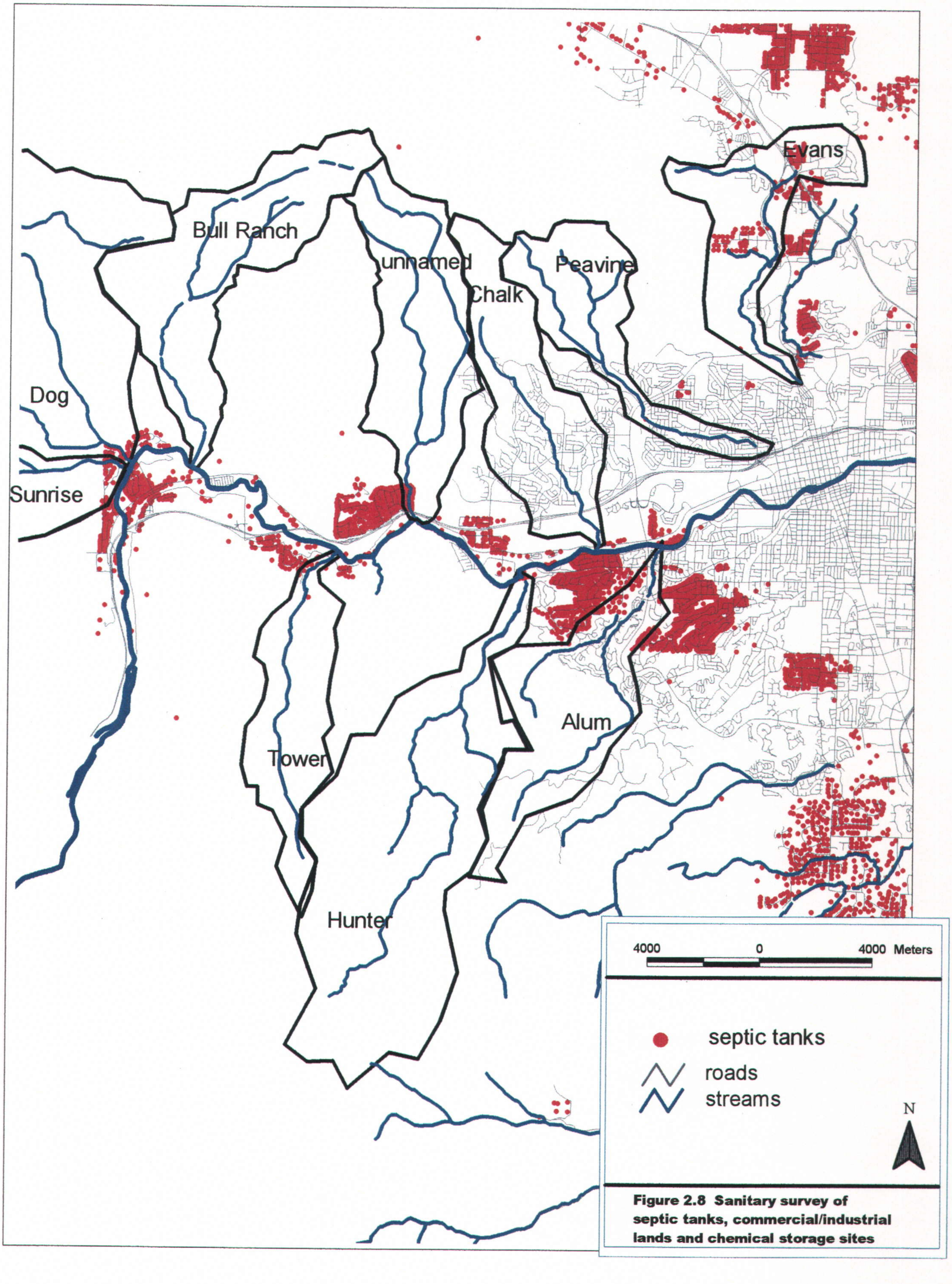


Figure 2.8 Sanitary survey of septic tanks, commercial/industrial lands and chemical storage sites

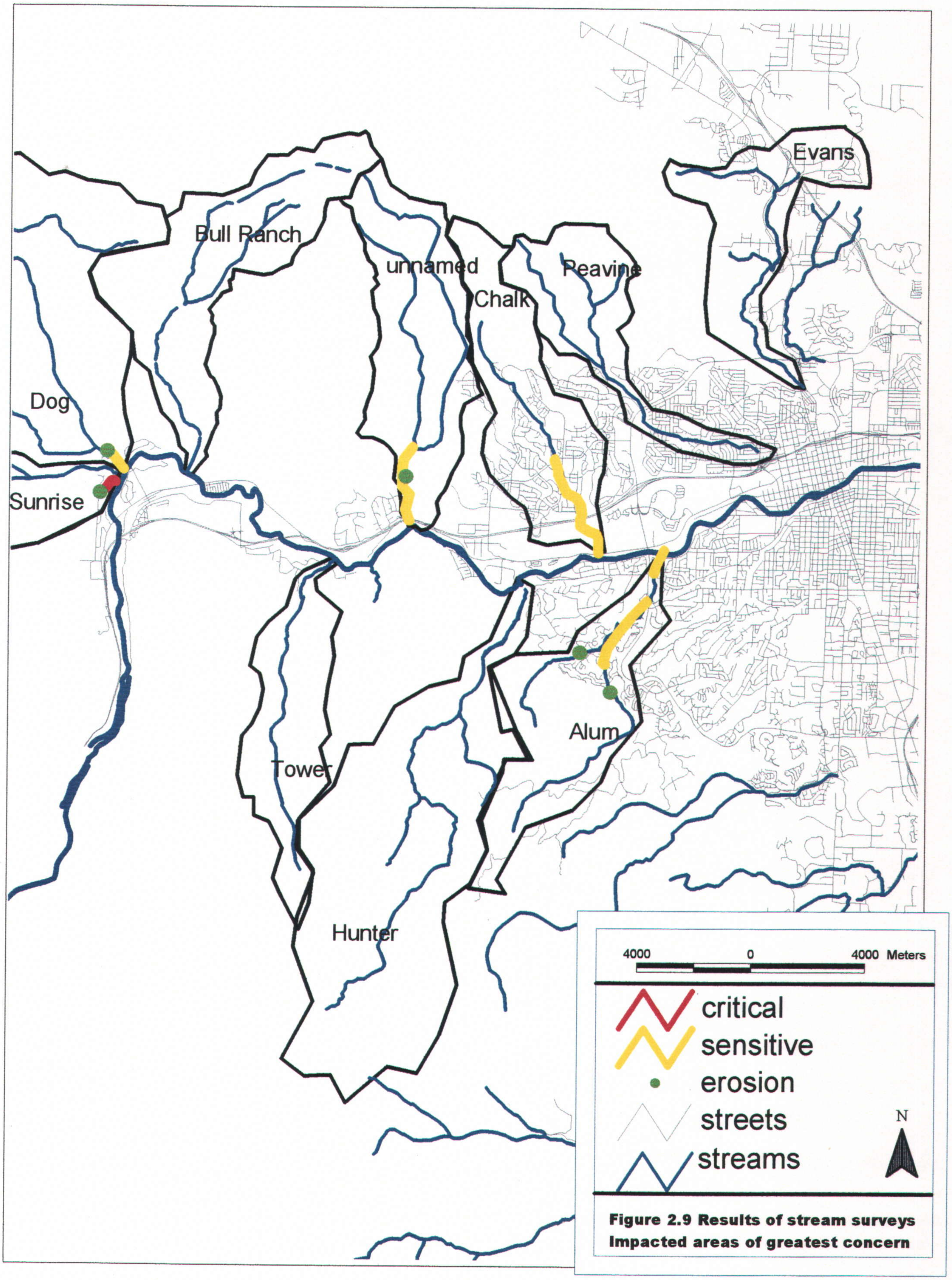


Figure 2.9 Results of stream surveys Impacted areas of greatest concern

CHAPTER 3
NORTH TRUCKEE DRAIN

Physical Descriptions

There are no perennial streams in this watershed. Truckee River water was imported into Spanish Springs through the Orr Ditch beginning in 1878. Tail water from flood irrigation and springs were collected through the North Truckee Drain and exported back to the Truckee River. This drain is perennial. However, as residential development replaces irrigated lands, the need for the drain may diminish over the next twenty to thirty years.

Creek Narrative

This drain originates where the Orr Ditch ends as seen in Figure 3.1, the east central area of Spanish Springs. The drain flows nine miles south to the Truckee River. In the northern portion of the drain, City of Sparks residential and golf course development have surrounded and incorporated this water feature into their landscaping. The drain continues southward through undeveloped land where residential development is planned. In this area the drain flows through a recently constructed flood water detention dam. At the southern boundary of Spanish Springs the drain flows through agricultural lands, north of Shadow Lane. The drain then flows through residential and commercial property, before flowing parallel to Sparks Boulevard. The City of Sparks has developed the drain in this section for open space and recreation while the drain still serves storm drain functions. South of Interstate 80, the drain flows through industrial properties. At Kleppe Lane, discharge from the Sparks Marina flows into the drain channel. The Sparks Marina is a groundwater fed lake that has formed from in an open pit once used for mining gravel. The drain then flows to and discharges to Truckee River south of the Alamo Truck Stop and Greg Lane.

Geologic and hydraulic descriptions

Figure 1.2 shows the geology of the study area within the North Truckee Drain area. The drain flows through Quaternary fine-grained basin fill sediments derived from volcanic rocks (Lousetown Formation). The drain continues to flow through fine-grained deposits of Truckee Meadows alluvium.

Figure 3.2 shows the classified hydric soils for the study area, meaning their potential to adsorb or repel precipitation. Soils with a high to very high classification will have a high runoff capability whereas soils rated low will have a low potential to generate runoff (high rate of infiltration) from precipitation. One could view Figure 3.2 as a map of low-permeability soils, which dominate the watershed. This is the result of outcropping rocks or the clayey nature of sediments derived from volcanics. Figure 3.3 is a map showing percent slope of this watershed. Washoe County has determined that the slopes in red are unsuitable areas for development. These areas will also generate substantial runoff during high intensity precipitation events. Precipitation within this drainage ranges from 14 inches at the crest of the Virginia Range to 7 inches on the valley floors (Klieforth, et. al., 1983). Table 3.1 lists the physical description statistics for these creeks.

Table 3.1
Physical description statistics

Watershed	Drainage area (sq mi)	Average range in streamflow (cfs)	Range in precipitation (in)	Range in elevations (ft)
North Truckee Drain	76.7	1 - 5	7-14	4,380-7,400

Figure 3.4 maps the 100-year flood zones as determined from the US Federal Emergency Management Agency (FEMA). These areas are susceptible to flooding during most high intensity, long duration precipitation events and not just during 100-year storms. The map indicates that natural flooding occurs throughout most of the North Truckee Drain area within Spanish Springs and the lower lands near the Truckee River. Washoe County and the City of Sparks are currently working on flood management programs to help solve this problem (Parsons, 2002; Kennedy Jenks Consultants, 2000).

Figure 3.5 outlines potential wetland areas as mapped by Washoe County, the US Army Corps of Engineers, the Federal Emergency Management Agency, the Nevada Department of Wildlife and the Desert Research Institute (Washoe County, 1999). These wetlands are based upon vegetation, hydric soils (soils frequently saturated) mapping, playas, floodways, and of course observations. Obviously the greatest concentration of wetlands are within the "headwaters" of the drain, the reason the drain was constructed in the first place. These encompass the northern half of the drain's length within Spanish Springs proper. As seen on this figure, wetlands mapped in areas with extensive roads have recently been further drained. As development increases within this area, the wetland area will decrease in area currently shown on this figure.

Figure 3.6 maps vegetation as surveyed during the late 1980s. The land in the northern half of the drain area is a mixture between agricultural lands and brushland. If this map were updated, the urban development would replace much of this land including wetlands shown on this map where roads are mapped. The southern portion of the drain is mapped urban where disturbed areas are now urban.

Land Use

Figure 3.7 shows land use zoning as described by the Regional Planning Commission. The entire study area is within the City of Sparks. The northern portion of the study area is currently zoned for single family residences with the commercial properties as mostly golf courses. The southern portion of the drain is zoned single family residential with some commercial properties as is the central portion of the drain. The last 1.5 miles of the drain are zoned commercial and industrial.

Sanitary Survey

A sanitary survey was conducted to specifically locate and map the following:

- Septic tanks within the watersheds,
- landfills,
- hazardous waste/chemical generators,
- above/below ground storage tanks,
- herbicide, fertilizer and pesticide application areas (golf courses),
- industrial sites, and
- road salt storage sites (NDOT and Washoe County).

Figure 3.8 shows the results of this survey. Septic tank effluent, as groundwater, may flow to the drain in the northern portions of the study area given the density of septic tanks within the immediate area. Although not shown, the Red Hawk golf course is located within the northeastern portion of the drain, using it for a water feature. The first northern commercial property shown is a ranching operation. Downstream commercial properties are primarily retail stores. At the southern end of the drain, industrial and commercial sites are shown to border the drain. This includes aboveground and underground storage tanks as well as three Resource Conservation and Recovery Act (RCRA) sites. RCRA sites are those that store, use, or generate toxic chemicals and are required to adhere to local, state and federal storage and handling regulations.

Stream Chemistry

A substantial amount of water quality data exists due to the Truckee Meadows Water Reclamation Facility's Truckee River sampling program, beginning in 1985. This data is discussed below. For this current assessment, grab samples were taken at Shadow Lane, at the confluence with the Sparks Marina discharge and at the confluence with the Truckee River. Grab samples were taken using standard methods. The general chemistry analyses were conducted at the Nevada State Health Lab. The samples were analyzed for general minerals, total suspended solids, total kjeldahl nitrogen, total phosphate, fecal coliform, fecal streptococci, field pH, conductivity, dissolved oxygen (the meter proved unreliable) and temperature. Results for all the sampling can be found in the appendix.

<u>General chemistry</u>

Table 3.2 lists select water quality constituents for the North Truckee Drain as various locations. The listed constituents represent water quality that is influenced by natural conditions, erosion, human waste (septic tanks), and livestock waste.

As listed, the total dissolved solids concentration in the North Truckee Drain (728 mg/l) and the Marina discharge (496 mg/l) to the Drain are relatively high. The lower concentration in the Marina discharge dilutes the upstream concentration that eventually flows into the Truckee River. However, this concentration (532 mg/l) is much higher compared to the Truckee River, estimated at 100-150 mg/l. It is interesting that the concentration of total suspended solids at the Truckee River is much lower than sampled at Shadow Lane and of the Marina discharge. The suspended sediment concentration appears to be diluted or has settled onto the ditch bottom.

Table 3.2
General water chemistry

creek/reach	TDS	TSS	TP	NO3	TKN	Fecal coli	Fecal strep	coli/strep Ratio
	Mg/l	mg/l	mg/l	mg/l	mg/l	count	count	
N Truckee Drain								
Shadow Lane	728	52	0.18	1.8	1.15	na	800	na
Marina discharge	496	65	0.4	0.1	0.47	1100/100	90/100	12.2/1
@ Truckee	532	6	0.28	0.6	0.53	150/100	180/100	0.8/1

TDS= total dissolved solids (inorganic chemistry)
TSS= total suspended solids (sediment)
TP = total phosphate (organic phosphate)
TKN=total Kjeldahl nitrogen (organic nitrogen)
Coli= coliform (fecal coliform is feces derived bacteria)
Strep=streptococci (fecal bacteria)
/ = analyzed at two dilutions

Nitrogen does not appear to be a problem at the concentrations sampled. The fecal sampling shows high values at Shadow Lane and in the Marina discharge, but rather dilute at the Truckee River. The coliform to streptococci ratio is generally one, meaning that the source is a mixture of livestock and human. However, the Marina sample was analyzed at two different solutions (1:1 and 10:1) and the fecal coliform results were different by an order of magnitude. This may reflect the uncertainty in the analysis procedures. Noteworthy is that fact that during an inspection of the Drain at the confluence with the Truckee River a sediment plume discharging to the Truckee River from the Drain was obvious (see stream assessment dated February 6, 2002).

Water quality samples on the North Truckee Drain have been taken for many years. Samples taken by the Truckee Meadows Water Reclamation Facility began at least in 1985 and can be found on their web page (www.tmwrf.com). The appendices show graphs of some of the constituents sampled- electrical conductivity (as a surrogate of total dissolved solids), temperature, and flow. A trend line is included in the graphs to indicate any trends in the data. However, all trends shown have a poor correlation as shown on the graphs. This is because there is a large range in data values throughout the year and throughout the period of record.

Temperature shows a general downward trend from 14° Celsius to 12° Celsius and is probably insignificant. Electrical Conductivity shows an increase from approximately 470 to 650 micro siemens/cm. Using a temperature of 13° Celsius, the total dissolved solids concentration for these EC values is estimated at 300 to 420 mg/l ±50 mg/l. Looking at the graphs, some values of EC appear to exceed 800 mg/l of total dissolved solids. It also appears from this graph that the range in higher values is increasing with time since 1997. Flows in the drain appear to show a decline, especially in the last two to three years and may reflect recent drought conditions and/or a reduction in Orr ditch flows to the Spanish Springs Valley.

Stormwater Chemistry

On Jan 16, 2002 water from the North Truckee Drain was sampled above the confluence with the North Truckee Drain during a moderate rainstorm. The sample was analyzed for total hydrocarbons (oil = 71 mg/l), total suspended solids (232 mg/l), total dissolved solids(312 mg/l), total phosphates (0.36 mg/l), nitrate (0.9 mg/l), and kjeldahl nitrogen (1.6 mg/l). While there is not a November 2001 sample at this location to compare to, it is instructive to compare these concentrations to the Shadow Lane concentrations listed in Table 3.2. The TDS is one half that found at Shadow Lane as is the nitrate concentration (although the nitrate is low in both samples). Total suspended solids is four times that found in the November 2001 sample which was sampled during dry and low flow conditions. Kjeldahl nitrogen and total phosphate are also elevated, but not significantly. These results show mostly the increase in total suspended solids and oil/grease found in the drain waters as a result of storm drain effects.

Drain Survey
The North Truckee Drain has its origins in springs and wetlands in the Spanish Springs Valley. The channel drains housing developments, ranches and undisturbed areas. The stream leaves Spanish Springs and flows parallel to Sparks Boulevard where it provides drainage for developments, roads and commercial property. It crosses Interstate 80 near Wild Waters and flows through commercial and industrial areas before entering the Truckee River. Just south of Interstate 80, the Sparks Marina drain converges with the North Truckee drain.

In Spanish Springs the channel exists in two forms, the existing channelized stream and segments that were improved to provide flood control and drainage for development. The existing stream was moved to the edge of the valley, probably to economize ranch management. Periodic dredging is required, and the channel lacks the geometry expected in a natural stream. Vegetation in the channel is good, and includes rushes, sedges, and salt grass. The channel is fair habitat for wildlife and, while there appears to be a high concentration of salts in the water, the water flows clear. A 200-300' wide 8' deep flood control channel replaces the existing channel in developing areas. The geometry of the new channel is appropriate, and is revegetating nicely.

Spanish Springs is developing very rapidly, and in many areas, development is encroaching on existing wetlands. In the future, this may affect water quality by reducing groundwater recharge and increasing total dissolved solids in the North Truckee Drain. At the south end of Spanish Springs, the North Truckee Drain flows through a ranch setting. The agricultural property is used to produce hay and cattle. Vegetation along the creek provides some wildlife habitat and is mostly pasture grasses with some riparian species at the edge of the creek. The stream is fenced to keep livestock out of the stream.

In Sparks, The North Truckee Drain enhances Sparks Boulevard by serving as open space with walking trails and landscaped areas. The channel has a very straight alignment with steep banks. Ground water and storm water drainage from urban areas has a negative impact on water quality. The water has a gray-green color and the visibility is about one foot. Vegetation along the channel is poor to fair. Willows, trees, rushes and sedges are doing well in some areas, while in other areas, favorable vegetation is out-competed by Tall Whitetop weeds. It appears that some woody vegetation is removed to improve flood characteristics. Vegetation along the channel provides some wildlife habitat. Restoration of the North Truckee Drain along Sparks Boulevard may include increasing the width of the floodplain and improving riparian vegetation. Weed abatement should be implemented soon to control Tall Whitetop and other noxious weeds.

South of Interstate 80, the channel has a very straight alignment through commercial and industrial properties. The banks of the channel are very steep and up to 15 feet high. In some areas, the channel banks are unstable and contribute sediment to the creek during flooding and high flows. Willows grow along the banks of the channel and provide some soil reinforcement and wildlife habitat. Water quality is bad. The water has a bad smell and is gray-green in color. Bubbles form in eddies and debris floats on the surface. Visibility is about eight inches. A sediment plume is clearly visible where the North Truckee Drain enters the Truckee River. The Sparks Marina Drain converges with the North Truckee Drain. The water quality in the Marina Drain appears to be worse than the North Truckee Drain.

Restoration may include reducing the steepness of the channel banks to prevent erosion and encouraging riparian vegetation. A water treatment facility should be considered to treat the flows in the North Truckee Drain. Water pollution sources should be investigated and pollution ordinances enforced.

Conclusions and Recommendations

Invasive biota

This watershed is relatively free of the invasive plant Tall Whitetop. It is found in the drain throughout the portion that parallels Sparks Boulevard. Tall White Top is a problem because it out-competes native plants, does not provide useful habitat or forage, and is difficult to eradicate. At the current density of Tall Whitetop in this drainage, it should be relatively easy to eradicate.

Stormwater and erosion

During the stream assessment it was noted that the most southern portion of the drain, south of Interstate 80, was being eroded. This is most likely due to lack of a flood plain and excessive flows during storm events. It will be difficult to control further erosion and a source of sediment to the Truckee River without reconfiguring this channel.

Stream Ordinance

In 2000, the Washoe County Development Code, Article 418, Significant Hydrologic Resources was enacted. The purpose of this article was to regulate development activities and protect perennial streams. A "critical stream zone buffer area" was set to within 30 feet of the stream thalweg and a "sensitive stream zone buffer area" set to within 150 feet of the stream thalweg. This ordinance is only in effect outside the City of Sparks limits. The stream survey for the North Truckee Drain was conducted within the City of Sparks and buffer zones are being somewhat respected. However, the most southern portion of the drain, south of Interstate 80, is at risk to future encroachment.

Stream Health Rating

Figure 3.9 illustrates the results of the drain assessment whereby most of the drain is rated sensitive. This rating is imposed because the drain is at risk from encroachment by present and future development. The drain is at risk from increased stormwater discharge that could result in erosion of the channel, loss of riparian vegetation (for better flood conveyance), and loss of flood plain within the channel. The most southern portion of the drain is rated as critical. This is due to the erosion of the stream banks, the proliferation of Tall Whitetop, sediment being transported to the Truckee River (Marina discharge?), at risk from various sources of pollution and lack of native vegetation.

Recommendations

The results of the drain assessments will be used to help develop watershed management program. The following recommendations are made as a starting point in determining what components are necessary for the management plan. The recommendations are made based upon maintaining or improving the functionality of the drain.

1. A review of the City of Sparks stormwater discharge program to the drain and its effectiveness should be undertaken. The review should address stormwater effects on erosion and sediment transport to the Truckee River. The surveys can be conducted at a very low cost. The cost of making improvements is unknown and could be expensive.

2. The City of Sparks should develop a Stream Ordinance policy and actively engage in a public education program. This is to help restrict development's encroachment upon the drain. It could also be used to bring the drains features to the public's attention and thereby increase public support for access and enhancement and/or restoration.

3. White Top Eradication is recommended for the lower section of the North Truckee Drain. Programs for eradication are available. Because this invasive plant is somewhat contained to the lower one mile of drain section, total eradication would be relatively inexpensive.

4. Increase construction site erosion control through enforcement and education. Currently erosion control measures at construction sites near streams and drainages are not always effective.

5. Improve on general water quality analysis and databases of different reaches of the drain. To date there is little information on water quality above Interstate 80. This type of program would be effective in periodically assessing the condition of the watershed. The sampling should be conducted during wet and dry conditions. This could be done two or three times a year for three years followed by periodic sampling.

6. The City of Sparks and Washoe County should explore recreational development of the drain throughout its course in Spanish Springs. This could entail the same type of design the City has done for the drain south of Shadow Lane. The design might actually increase the drain width to develop more flood plain and native vegetation. This would provide wildlife habitat and result in a water feature that increases the quality of life to the community.

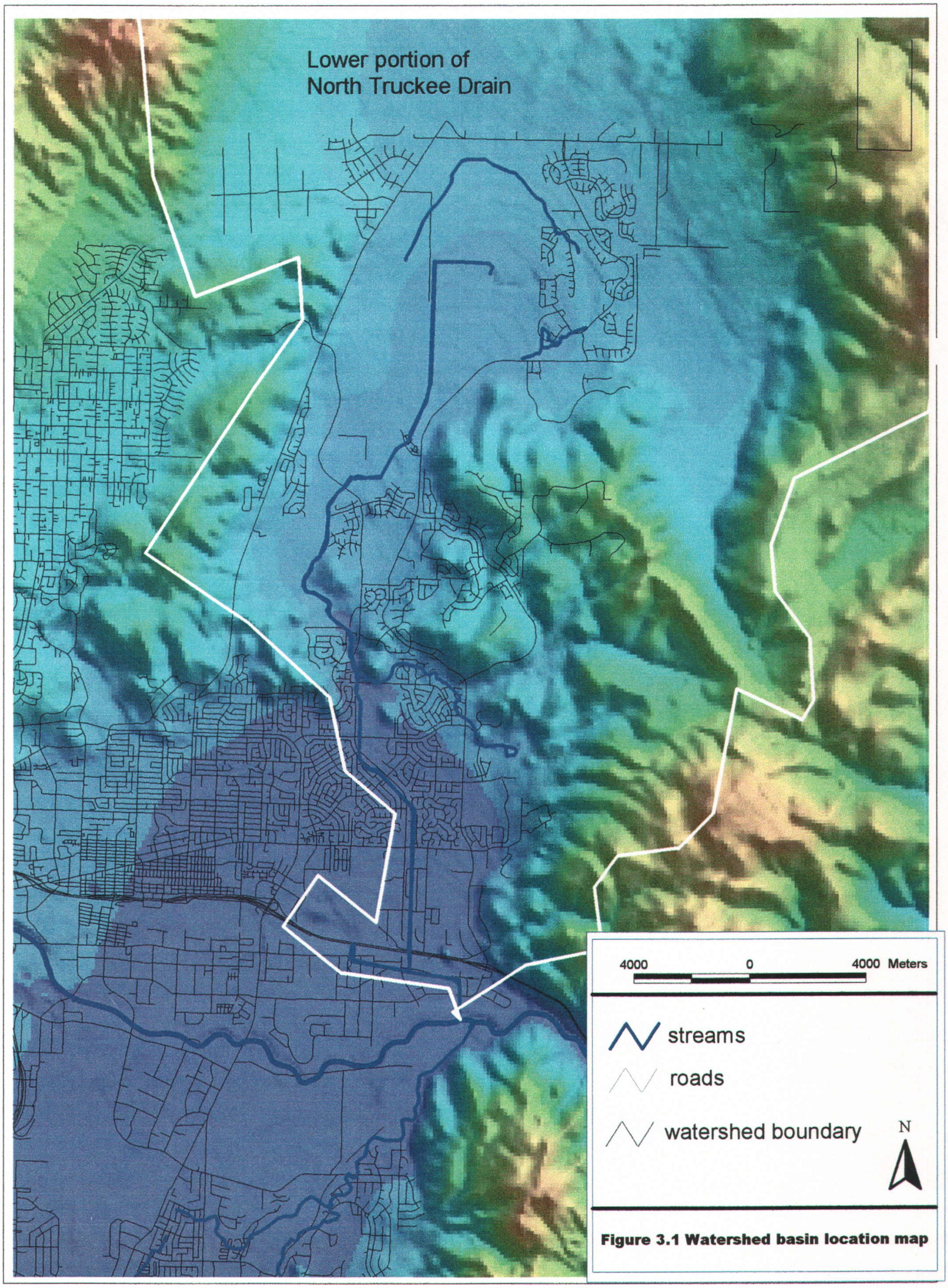


Figure 3.1 Watershed basin location map

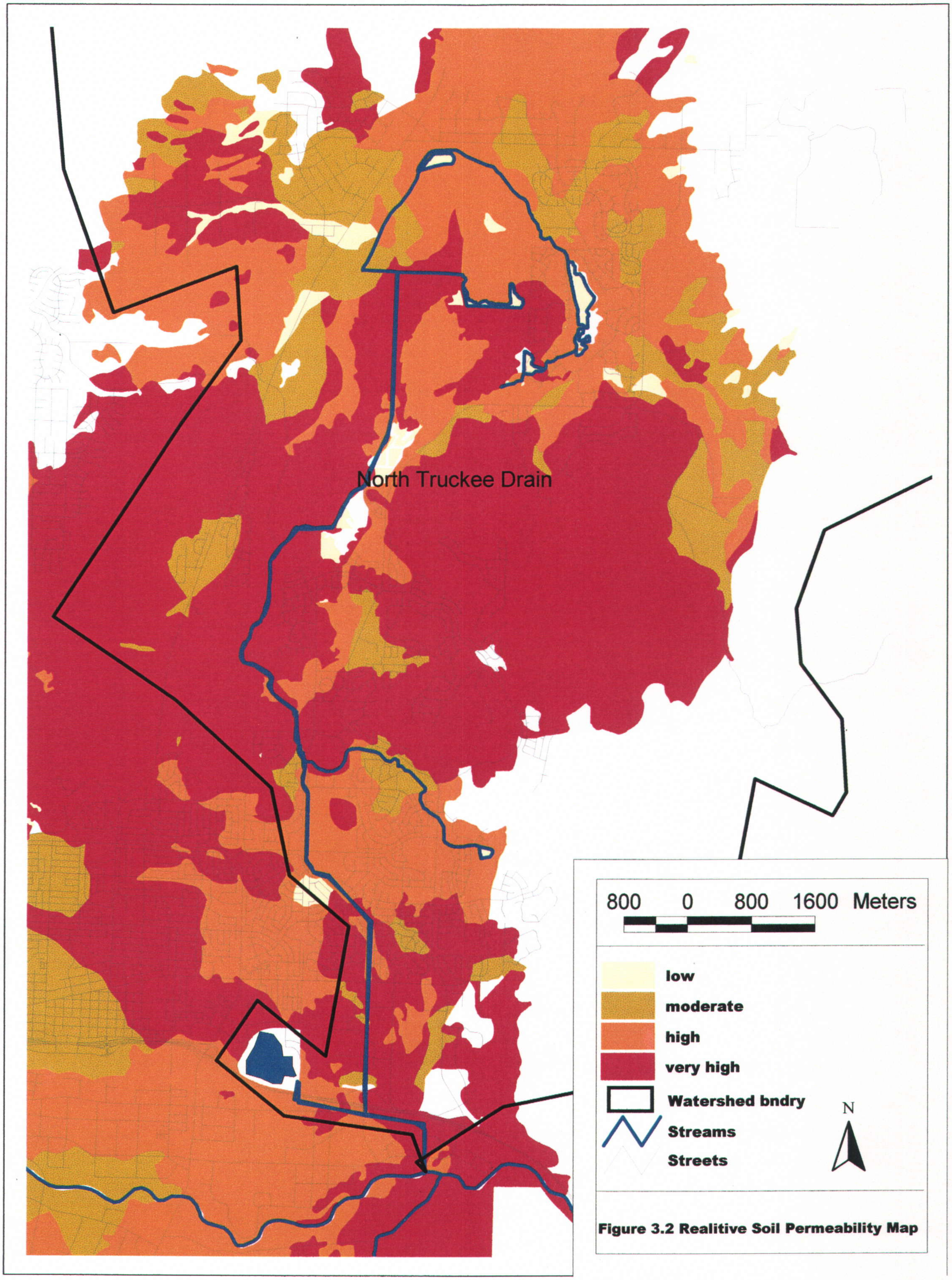


Figure 3.2 Realitive Soil Permeability Map

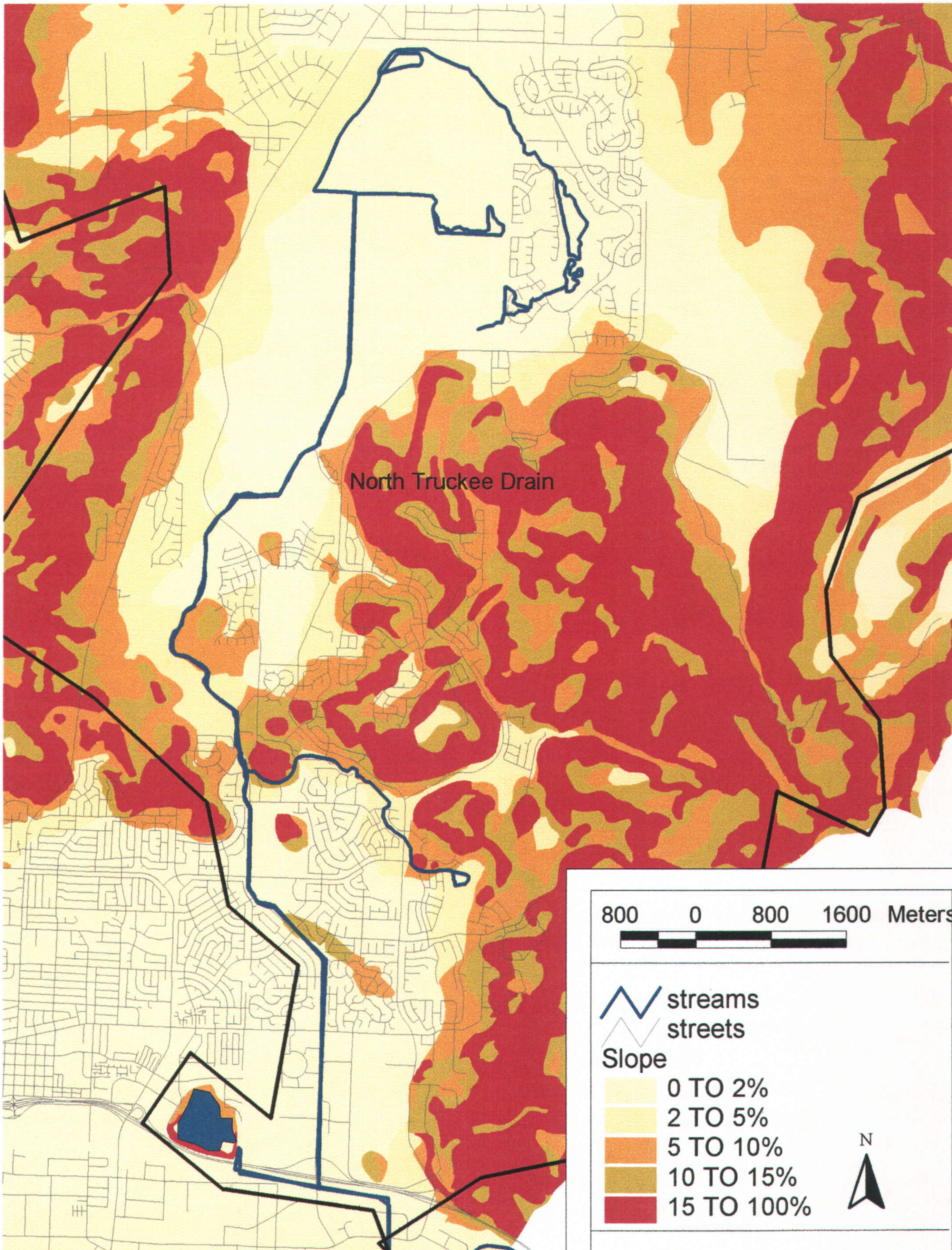


Figure 3.3 Map of land slope

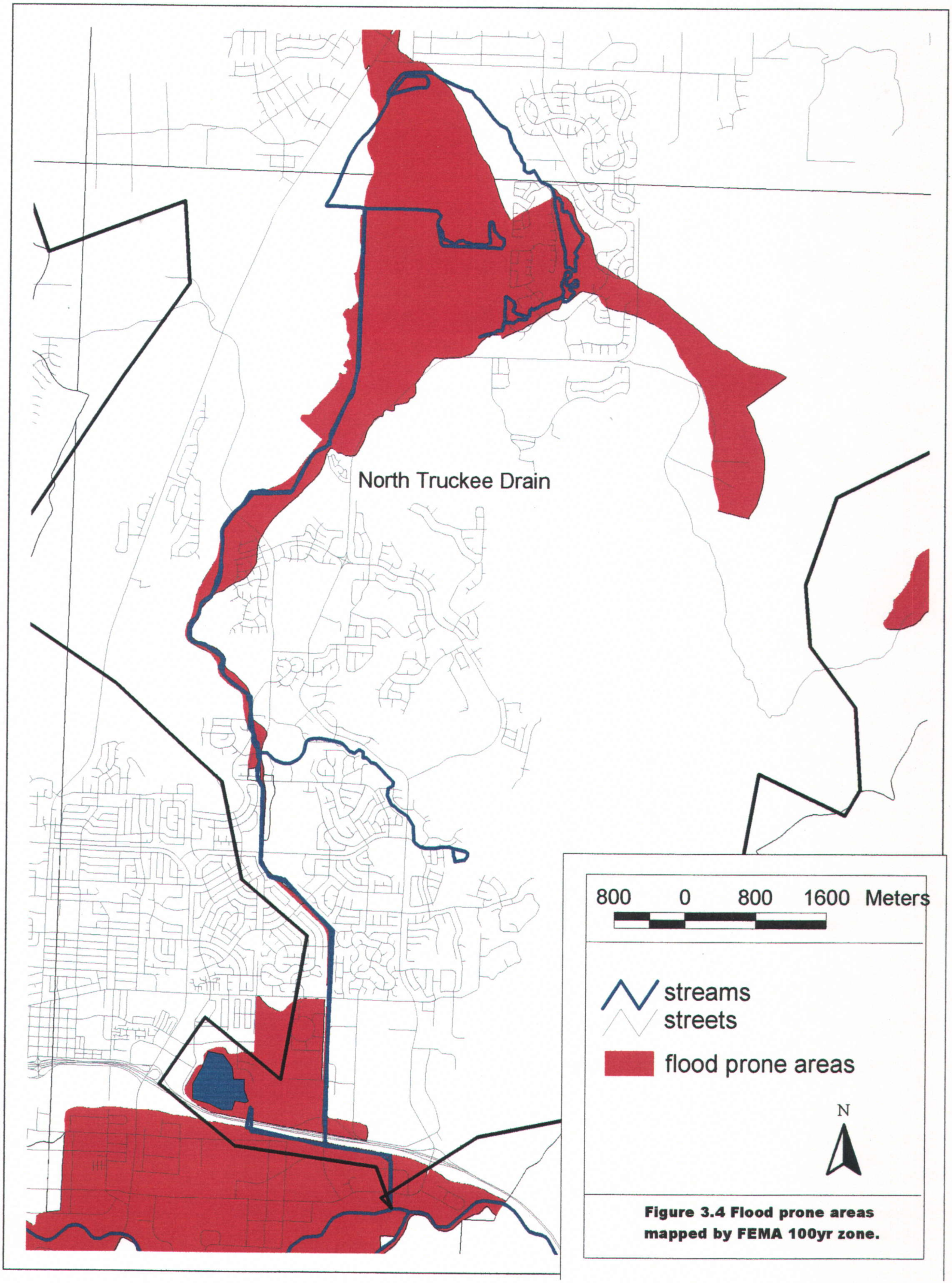


Figure 3.4 Flood prone areas mapped by FEMA 100yr zone.

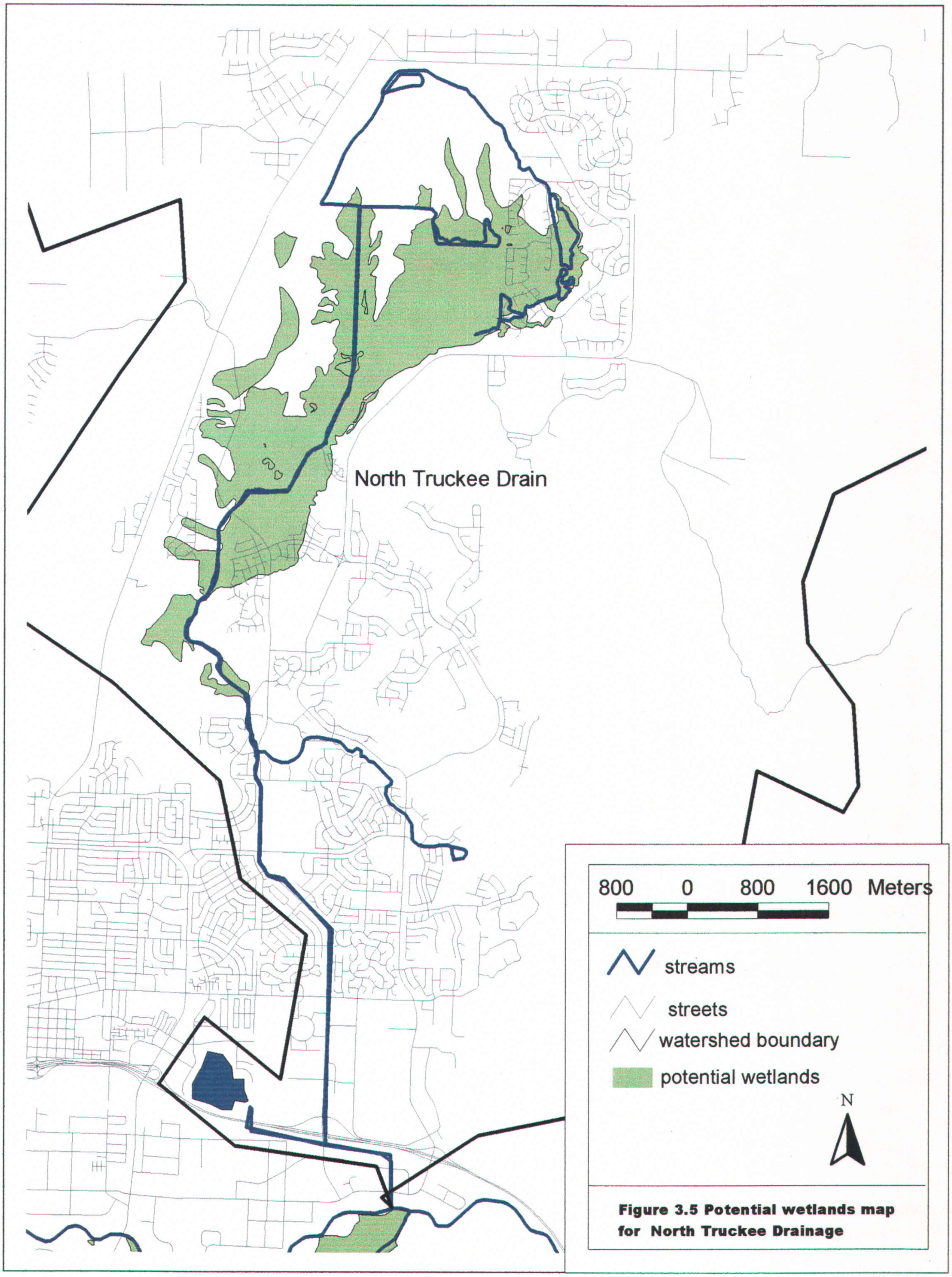


Figure 3.5 Potential wetlands map for North Truckee Drainage

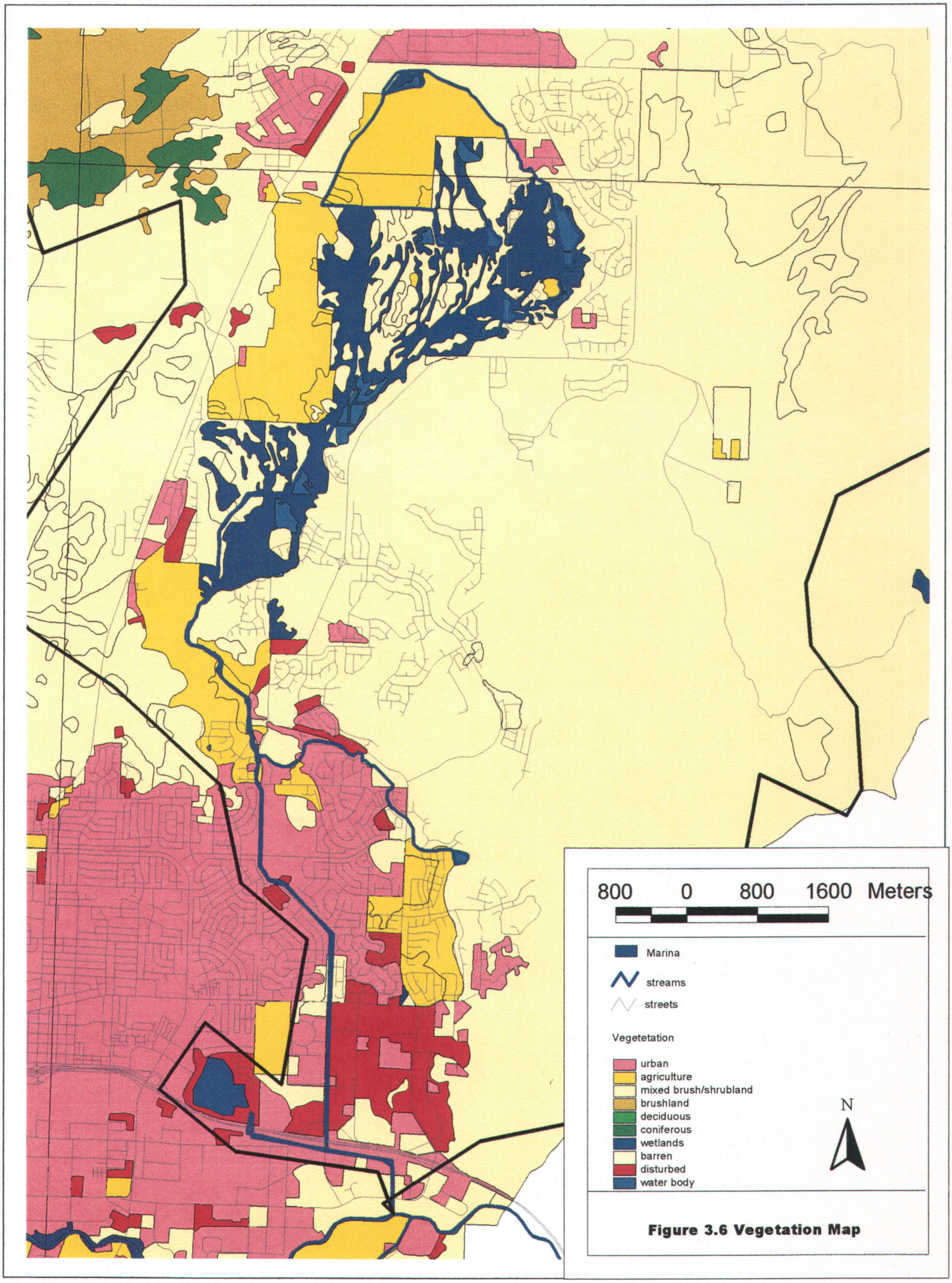


Figure 3.6 Vegetation Map

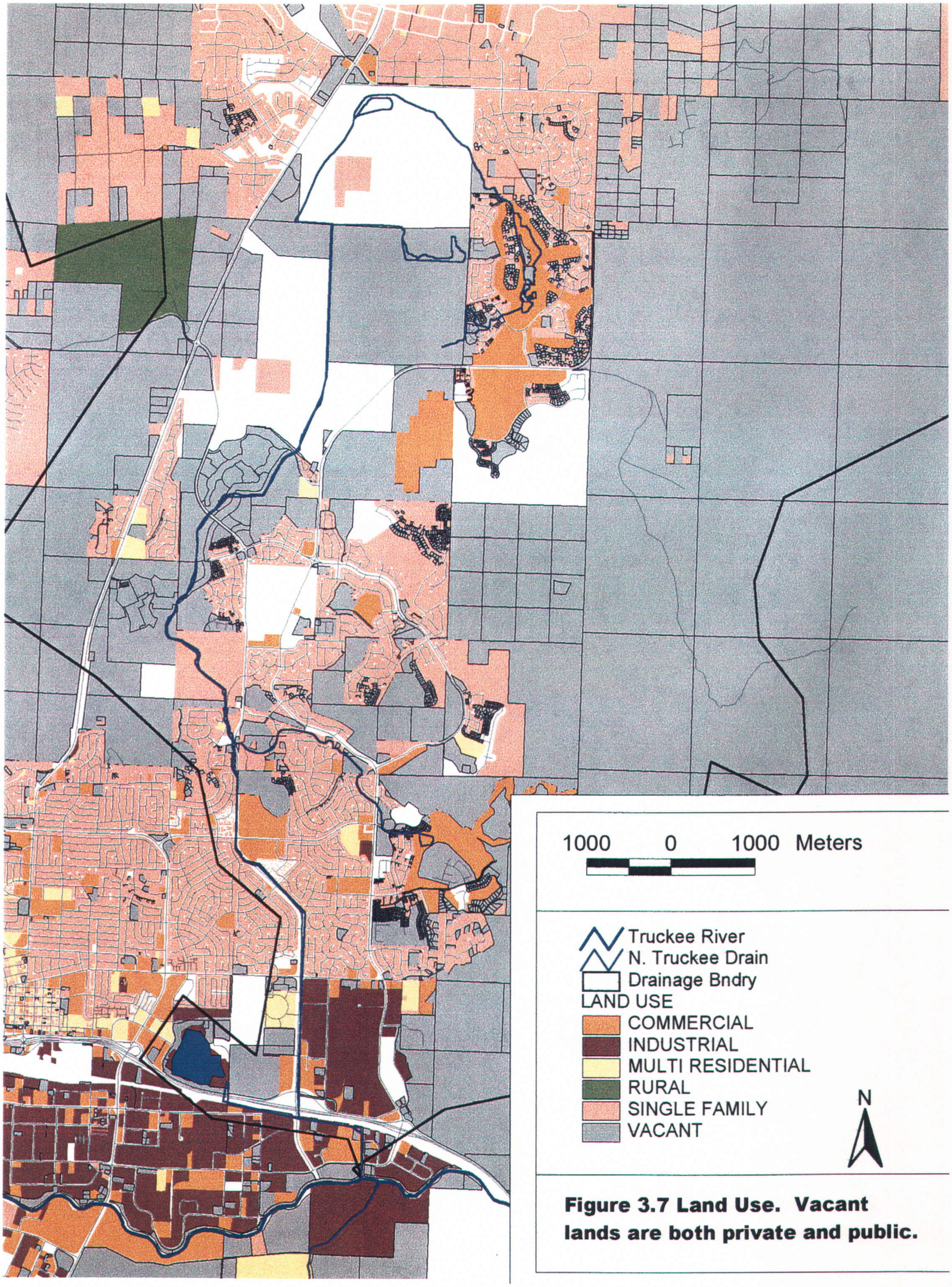


Figure 3.7 Land Use. Vacant lands are both private and public.

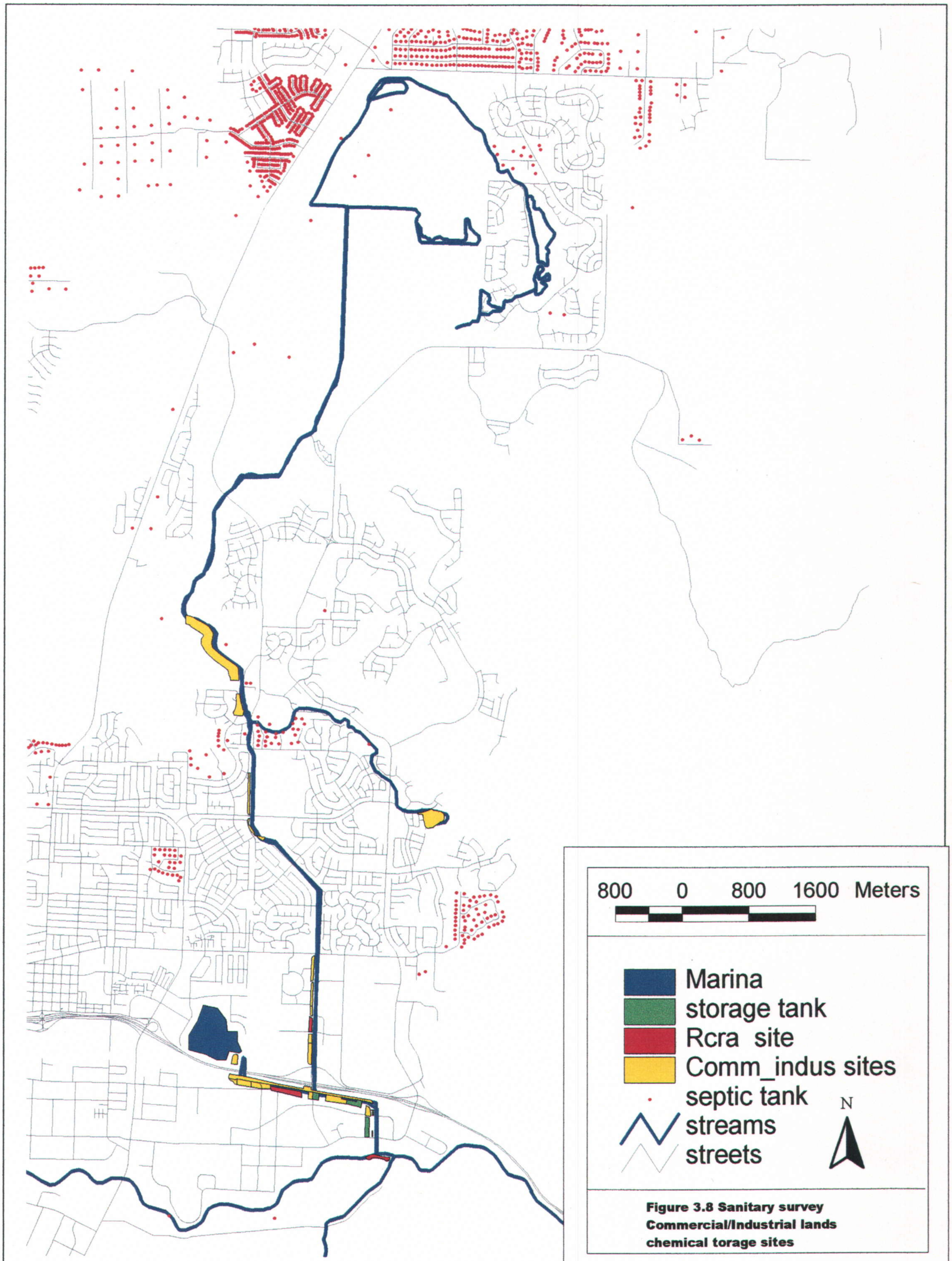


Figure 3.8 Sanitary survey Commercial/Industrial lands chemical torage sites

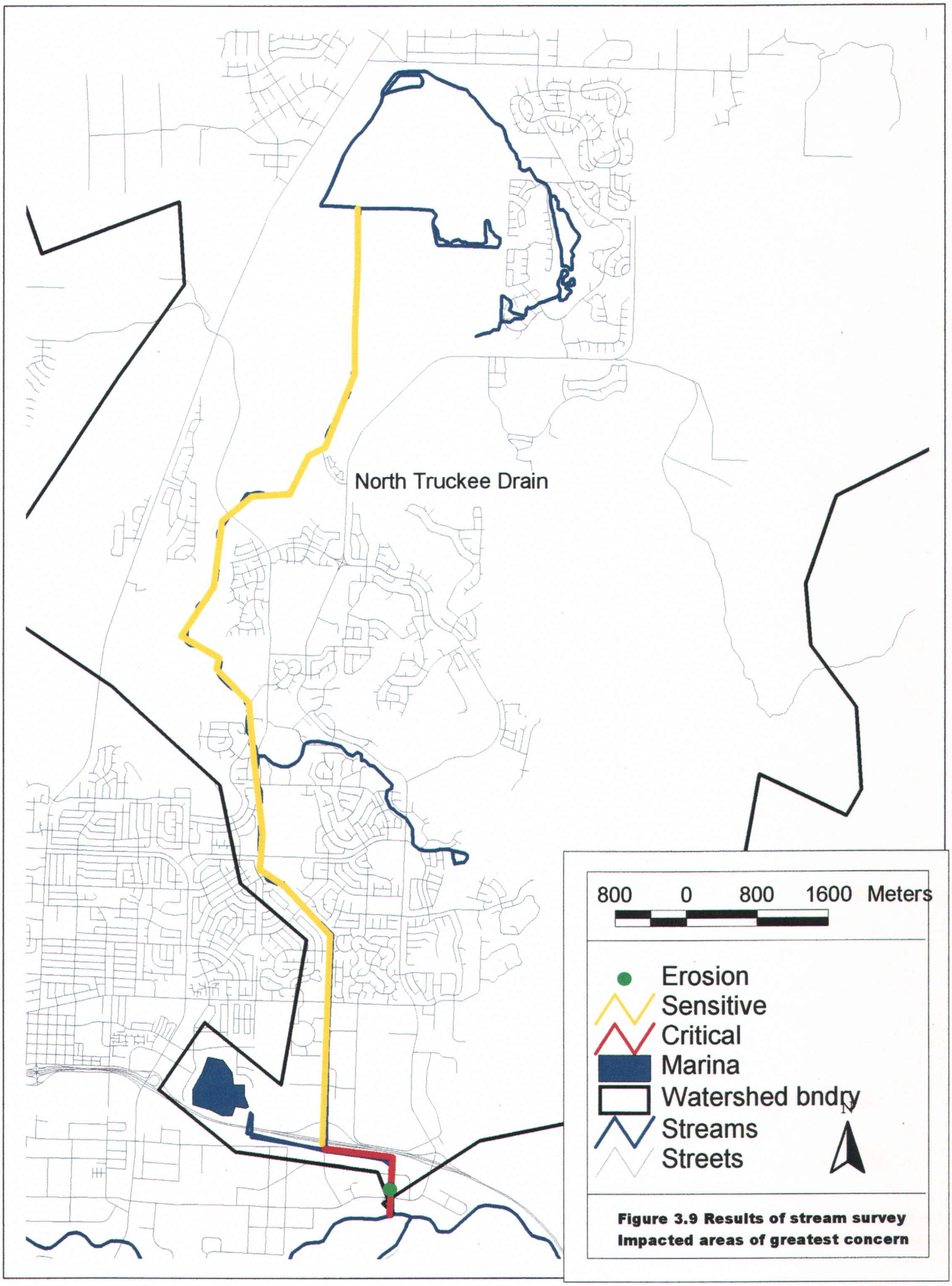


Figure 3.9 Results of stream survey Impacted areas of greatest concern

CHAPTER 4
WASHOE VALLEY
(Jumbo, Winters, Davis, Ophir, Franktown, Lewers, Muskgrove, McEwen Creeks)

Physical Descriptions
The perennial creeks of Washoe Valley flow from the Carson Range eastward and discharge into Washoe Lake. Jumbo Creek is ephemeral and originates in the Virginia Range, also flowing to Washoe Lake. Outwash from the creek drainages has formed alluvial fans where they emanate from the mountain block canyons. Below the alluvial fans, or where the fans coalesce to form a bajada, the creek waters often disperse into wetlands or infiltrate into the coarse, granitic soils. The western side of Washoe Valley historically was irrigated with these waters. Today, residential development and one golf course have only marginally changed the manner of use of these creeks.

<u>Creek Narratives</u>
Jumbo Creek has a relatively large drainage area, but stream flows are small and ephemeral due to the smaller amount of precipitation in the Virginia Range (Table 4.1). Two tributaries of the creek converge at a canyon mouth above New Washoe City, a residential development of approximately 1,000 homes. Below this the creek flows atop an alluvial fan and usually infiltrates into the granitic soils, never reaching Washoe Lake unless the flows are relatively large. The creek waters are not used by man, but are probably water righted.

Winters Creek is the most northern creek in western Washoe Valley, draining a portion of Slide Mountain's snowmelt. Its flow is normally ephemeral and relatively small. The creek drainage in the upper watershed is mostly in granodiorite before flowing across glacial outwash on the alluvial fan. Once it crosses US 395 the creek is used for irrigation purposes. During the winter months, it flows terminate at the most northern end of "Big" Washoe Lake. This creek is ungauged such that there are no records of its annual flow.

Davis Creek also drains a portion of Slide Mountain. It too flows down a steep slope of granodiorite before entering the Washoe County Davis Creek Park. A diversion of the creek is used to support a small pond within the park. The creek then flows upon its alluvial fan before infiltrating into the granitic soils used for pasture. Flows rarely get to Washoe Lake.

Ophir Creek is the second largest perennial creek in the valley. It drains the southern face of Slide Mountain and other portions of the Carson Range including the Tahoe Meadows west of the Mount Rose Highway summit. The Upper and Lower Price Lakes and Rock Lake feed Ophir Creek in the upper watershed. The upper watershed is an area of historical and extensive rock slides and debris flows off of Slide Mountain, the most recent occurring in May of 1983 that caused significant residential damage on the alluvial fan. Once Ophir Creek reaches the alluvial fan, it is diverted for irrigation purposes which otherwise flows to Washoe Lake.

Franktown Creek is the largest perennial creek in the valley. It drains a portion of the Carson Range and has its origin in Little Valley; an eight-mile, linear, north south oriented valley west of and parallel to Washoe Valley. The headwaters of this valley are at the south end of which

Hobart Creek originates and is tributary to Franktown. The Hobart Reservoir and waters from Marlette Lake (within the Tahoe Basin) were transported to Virginia City in the late 1800's via aqueduct and siphon, for water supply and are still currently used for these purposes. Once Franktown Creek emanates from the steep walled canyon into Washoe Valley it is diverted for irrigation of the pasture and hay croplands on the alluvial fan. During none irrigation periods, this creek is the largest supplier of water to Washoe Lake.

Lewers, Muskgrove, and McEwen Creeks are small creeks that drain the southwest portion of the valley (Big Canyon Creek is a tributary to Muskgrove Creek). The headwaters are on the east slope of the lee side of Little Valley (Franktown and Hobart drainage). These creeks are mostly ephemeral in low to normal years of precipitation. Historically they were used for irrigation, but largely dry up in the mid-late summer months. They have built small alluvial fans where their flows normally infiltrate when not used for irrigation.

Geologic and Hydraulic descriptions

The western portion of Washoe Valley is largely composed of Cretaceous age granodiorite of the Sierra Nevada (Figure 1.2). Significant debris flows are within the upper to mid portions of the Ophir Creek watershed. The valley floor is composed of alluvial fans from these creeks that coalesce to form a bajada. The lower portion of the western valley has a high groundwater table that supports Washoe Lake and appurtenant wetlands. The eastern side of Washoe Valley is comprised of pre-Cretaceous metasediments, Cretaceous granodiorite and Tertiary volcanics. Jumbo Creek has formed an alluvial fan as it emanates from the upper watershed canyon.

Table 4.1 shows the physical descriptions of each of these sub-watersheds. Soils within this watershed are largely of granitic origin and are medium to coarse grained and free of volcanic silts and clays. Figure 4.2 maps the relative soil permeability that reflects these types of soils showing moderate to very high permeability of infiltration of surface waters. Figure 4.3 maps slopes of 15% or less for this watershed. This map shows that almost all of the valley floor is from 0 to 5% in slope and immediately becomes greater than 15% above the valley floor boundary. This is a good indication of why the groundwater table is so shallow.

Table 4.1
Physical Description statistics

Watershed	Drainage area (sq mi)	Average range in streamflow (cfs)	Range in precipitation (in)	Range in elevations (ft)
Jumbo	7.4	0-3	10-24	5,030-7,410
Winters	2.3	0-2	12-52	5,030-9,700
Davis	2.0	0-2	14-52	5,030-9,700
Ophir	6.3	1-10	14-52	5,030-9,700
Franktown	15.4	1-15	15-56	5,030-9,050
Lewers	1.4	0-2	16-40	5,030-7,600
Muskgrove	3.0	0-2	16-40	5,030-8,000
McEwen	1.8	0-2	16-40	5,030-8,200

Figure 4.4 maps the flood prone areas of Washoe Valley showing that, exclusive of US Highway 395, there are few residential areas at risk to flood damage. The Bellevue area, southwest of the Lake, is however prone to flooding. Figure 4.5 outlines potential wetland areas of Washoe Valley as mapped by Washoe County, the US Army Corp of Engineers, the Federal Emergency Management Agency, the Nevada Department of Wildlife and the Desert Research Institute (Washoe County, 1999). Most of the potential wetland areas are east of Franktown Road and "Old" US 395 and most of the area between "Big" Washoe Lake and Little Washoe Lake. Figure 4.6 shows the vegetative mapping by Washoe County in the late 1980's. The upper watersheds of the west valley creeks are in forested and brush/shrub lands. Agriculture predominates east of Franktown Road and south of Washoe Lake. Today there are more agricultural lands than those mapped east of Lakeside Blvd and south of New Washoe City. Brushland dominates the eastern watersheds. On the valley floor, the lake and wetlands dominate the landscape.

Land Use

Figure 4.7 shows the land use for this watershed. Most of the land is under residential development, used for agriculture or is public land (US Bureau of Land Management and US Forest Service). There are very few lands used for retail purposes and one parcel for industrial purposes. The agricultural parcels are used mostly for pasture, hay crops or livestock.

Sanitary Survey

A sanitary survey was conducted to specifically locate and map the following:

- Septic systems,
- landfills,
- hazardous waste/chemical generators,
- above/below ground storage tanks,
- herbicide, fertilizer and pesticide application areas (golf courses),
- effluent reuse sites,
- industrial sites, and
- road salt storage sites (NDOT and Washoe County).

Figure 4.8 maps the results of the sanitary survey for Washoe Valley creeks. The survey concentrates on locating potential sources of contamination within 300 feet of the creeks. The map also locates all septic systems within the watershed because of their concentration potential effect on the watershed. As seen in this figure, septic systems represent the largest single source of potential pollution to the watershed. The largest concentration of septic systems are located on the eastside of Washoe Lake (New Washoe City) within the Jumbo Creek drainage. Other large concentrations are located in Washoe City (west of Little Washoe Lake) on the Galena/Browns diversion and west of Washoe Lake (Bellevue area) on the Muskgrove Creek drainage. The Lightening W Golf Course is located on Muskgrove Creek. There is potential for fertilizers, herbicides and pesticides to be washed into this creek.

Stream Chemistry

To date there has not been any chemistry located for these creeks. During May 2002, Franktown, Ophir and Muskgrove creeks were sampled for water chemistry. Table 4.2 shows results of some of the constituents sampled. Mistakenly, not all of the same constituents were sampled for as were with the other streams listed in this report.

Table 4.2
General water chemistry

creek/reach	TDS	Turbidity	NO3	Iron	Total coli	Fecal coli	E coli
	mg/l	NTU	mg/l	mg/l	count	count	count
Franktown	65	4.6	0	0.59	137	<10	<10
Ophir							
upper	61	2.2	0	0.26	53	<10	<10
lower	63	3.1	0	0.3	20	<10	<10
Muskgrove							
upper	80	4.0	0.1	0.59	178	<10	<10
lower	224	5.4	0	0.38	50	10	10

TDS= total dissolved solids (inorganic chemistry)
Turbidity= suspended solids (sediment)
NO3 = nitrate (oxidized nitrogen)
Coli= coliform (fecal coliform is feces derived bacteria, total includes other sources)
E Coli=Escherichia coliform (fecal bacteria)

Franktown Creek was sampled upstream of all development, but not downstream as all of the flow was diverted for irrigation, no return flow being found. The results show very clean water. During sampling, large masses of iron bacteria were noted in the stream. Ophir was sampled above and below development and also showed very clean water with little change in chemistry. Muskgrove was also sampled above and below development and showed significant changes in TDS and Fecal Coliform. This is probably a result of Muskgrove Creek flowing through irrigation and livestock fields.

Stream Surveys

<u>Jumbo Creek</u>

Jumbo Creek flows into Washoe Valley from the west slope of the Virginia Range. The headwaters are located in the steep canyons about three miles west of Virginia City and terminate in Washoe Lake. The stream is ephemeral and flows in the spring from snowmelt and following storm events. Jumbo Grade is a dirt mining road between Washoe Valley and Virginia City, and it roughly parallels Jumbo Creek. Land use in the lower and middle reach is low-density residential and small ranches. There appears to be an active aggregate pit in the middle reach. The upper reach is undeveloped and mostly used for outdoor recreation.

In the lower reach, Jumbo Creek is very straight along roads and through subdivisions. Some homes along the creek have been flooded and channel erosion has caused damage. The minimal vegetation along the creek does not provide good wildlife habitat. Water quality is impacted by individual septic systems, stormwater discharge from developments, and erosion. A stream restoration project was built downstream of East Lake Boulevard, to stabilize the creek and limit damage from flooding. The channel was reshaped, armored and grade control structures were installed. The restoration project is an example of treatments suitable for the lower reach of Jumbo Creek. Encroachment by roads and residential lots limit restoration options and will require creative political and structural solutions. Installing grade control structures and establishing riparian vegetation may reduce the risk of flood damage, prevent erosion and improve wildlife habitat.

Road encroachment and off-road vehicle use affect the middle and upper reach. Roads concentrate flows to the stream, change the channel alignment and impact vegetation along the creek. The channel has incised several feet and has unstable vertical banks. Since high flows no longer spread out across the floodplain, channel erosion is very rapid. Riparian vegetation is perched on the terrace above the channel, where roots have difficulty reaching the low water table. New vegetation cannot take hold along the eroding channel. Existing riparian vegetation is good wildlife habitat, but as the water table recedes, upland species such as Rabbitbrush and Sagebrush will replace the riparian plants. Restoration opportunities may include excavation to develop a new active floodplain. Grade control structures combined with bioengineering solutions, which use vegetation to stabilize the channel, may also be implemented. Successful re-vegetation should be the main goal of any restoration along the reach.

Ophir Creek

Ophir Creek flows into the north end of Washoe Lake from the east slopes of the Sierras, draining the west slope of Slide Mountain. Upon the mid-reach, Ophir Creek flows through a wetland meadow setting. The US 395 freeway divides the meadow, with the Sierras to the west and Washoe Lake to the east. The meadow is used for cattle grazing and is mostly vegetated with wetland grasses. West of the freeway the channel has fair sinuosity and high flows have access to the floodplain. East of the freeway, flows are channelized for irrigation and grazing where vegetation has been removed on the channel banks. This has resulted in bare soil and erosion. Livestock grazing on both sides of the freeway has removed riparian vegetation. The freeway box culvert serves as grade control and may limit channel incision. Flood flows pass without damaging property and only cause minor erosion since flows are able to spread across the meadow. The lack of riparian vegetation provides little wildlife cover.

Ophir Creek is adapting to the large sediment load discharged during the last Slide Mountain landslide in 1983. The channel flows through boulder and cobble debris, vegetation has been slow to emerge due to the lack of suitable soil. The existing vegetation is providing fair wildlife habitat. Flood flows are able to spread out across the floodplain without causing damage to property. Maintenance will be an ongoing issue as sediment is transported downstream. Culverts, diversions and ditches may become clogged. Water quality has not been degraded as sediment is mostly sand that does not become suspended in the creek.

Franktown Creek

Franktown Creek flows from the steep canyons of Slide Mountain just north of Bowers Mansion, through wetland meadows in Washoe Valley and into Washoe Lake. The land use is open space, low density residential and agricultural. Franktown Creek crosses under Franktown Road, old Highway 395, and US 395 Freeway.

The upper reach of Franktown Creek is in good condition and relatively undisturbed by human activities. Vegetation is healthy and provides very good habitat for wildlife. The rocky soil, dense vegetation, and access to the floodplain prevents high flows from causing erosion. Water quality appears good, however the color has a red tint. This may be from naturally occurring oxidized iron.

The lower reach of Franktown Creek flows through a low gradient meadow pasture. Undisturbed sections of stream have fair to good channel geometry, while other areas are channelized and used as irrigation ditches. Riparian vegetation is absent, probably due to livestock grazing. Existing vegetation is mostly wetland grass species, which extend from the meadow to the edge of the creek. Livestock trample the banks of the creek in some areas, resulting in bare soil and erosion. The channel is vertically stable due to culverts and road crossings that serve as grade control. The lack of riparian vegetation limits the stream's usefulness as wildlife habitat. Water quality appears good in the creek, however nutrients from animal waste may be entering the stream. Reducing the impact from livestock would improve riparian vegetation, reduce sediment in the creek and improve wildlife habitat. This could be accomplished by fencing the riparian zone along the creek to control grazing.

Muskgrove Creek

The upper reach of Muskgrove Creek flows from the east slopes of the Sierras and enters the south end of Washoe Valley in a low-density, urban setting. The middle reach flows through the Lightening W Golf Course, low-density residential developments and small ranches before entering the South end of Washoe Lake.

The upper reach of Muskgrove Creek is in good condition. The creek is relatively undisturbed and water quality is very good. Vegetation is healthy and provides habitat for wildlife. There are a few homes near the creek, but they do not appear to affect the stream. A portion of the middle reach is diverted through a golf course. The banks of the creek are vegetated with sod that does not provide very good wildlife habitat. The lack of a riparian buffer zone along the creek also increases the potential for fertilizers and other chemicals to enter the creek. Downstream from the golf course, the Old Highway 395 road swale concentrates irrigation and storm flows from pastures, and channels them to the creek. This is a significant source of pollution. Stabilizing the road swale, revegetating channels, establishing riparian buffer zones and fencing livestock from the creeks would benefit water quality.

East of the Old Highway 395, The creek is channelized and has a very straight alignment through small ranches and a housing development. It is entrenched about five feet and the banks are near vertical. Homes, ranch structures and fences encroach on the stream. Water quality appears good, however the incised channel may be affected by adjacent septic leach fields and animal waste. During high flows, bank erosion contributes sediment to the creek. Flooding is controlled by periodically dredging the channel. This prevents healthy riparian vegetation from re-establishing and inhibits the natural rejuvenation process of the channel morphology. Willows, perched at the top of the channel banks appear healthy and provide habitat for wildlife. Restoration would be challenging, along the lower reach, due to the close proximity of structures to the stream and the numerous property owners. A properly designed channel would improve wildlife habitat reduce sediment and improve flooding characteristics in the area. This would involve excavating a wide channel with a lowered floodplain, developing a meandering low flow channel and re-establishing riparian vegetation.

Winters, Davis, Lewers and McEwen Creeks

These creeks were not assessed because it was assumed that their condition would be similar to the larger creeks of Franktown and Ophir. Lewers is tributary to Muskgrove just east of Franktown Road.

Conclusions and Recommendations

Invasive biota

Invasive plants, such as Tall Whitetop, were not noted during the stream surveys.

Stormwater and erosion

The upper and middle reaches of Jumbo Creek, upstream of East Lake Blvd, suffer from erosion. This is especially true where a dirt road parallels the creek causing sheet flow into the creek during runoff events. The incision of the creek has created unstable and easily eroded banks without vegetation. Restoration efforts should be undertaken to eliminate this erosion and to create better flood protection.

Muskgrove Creek below the Lightening W Golf Course suffers from erosion because of residential encroachment, a straightened alignment and periodic dredging of the channel. Restoration efforts should also be undertaken to eliminate this problem.

Stream Health Rating

The most obvious problem for these creeks is erosion. This is due to development encroaching upon or alteration of the creeks and stormwater discharges to the creeks, particularly along the upper and middle reaches of Jumbo Creek. Jumbo is considered "non-functional" as a stream. Ophir Creek, east of US Highway 395 suffers from alteration of the stream channel and livestock trampling the creek bed and the elimination of vegetation. Muskgrove Creek is rated sensitive through the Lightening W Golf Course due to the removal of native vegetation for sod. It becomes Critical below Old US 395 due to residential encroachment and erosion.

Stream Ordinance

In 2000, the Washoe County Development Code, Article 418, Significant Hydrologic Resources was enacted. The purpose of this article was to regulate development activities and protect perennial streams. A "critical stream zone buffer area" was set to within 30 feet of the stream thalweg and a "sensitive stream zone buffer area" set to within 150 feet of the stream thalweg.

Most of these streams are not affected by residential encroachment. Farming and irrigation activities have altered the creek channels over the past 140 years. It is unlikely that these practices will change in the near future. Within residential areas, particularly Muskgrove Creek, encroachment could be held in check by this ordinance as long as residents are aware of the ordinance and its purpose.

Recommendations

1. A public education program on the Stream Ordinance is strongly recommended. This may also include a survey of individual lots and communication with these owners particularly for Muskgrove Creek.

2. Improve on general water quality analysis and databases of different reaches of each creek. To date there is little or no information on water quality for these creeks. This type of program would be effective in periodically assessing the condition of the watershed. The sampling should be conducted during wet and dry conditions. This could be done two or three times a year for three years followed by periodic sampling.

3. Restoration efforts on Jumbo Creek should be undertaken to eliminate erosion, restore the creek to its natural state and to create better flood protection.

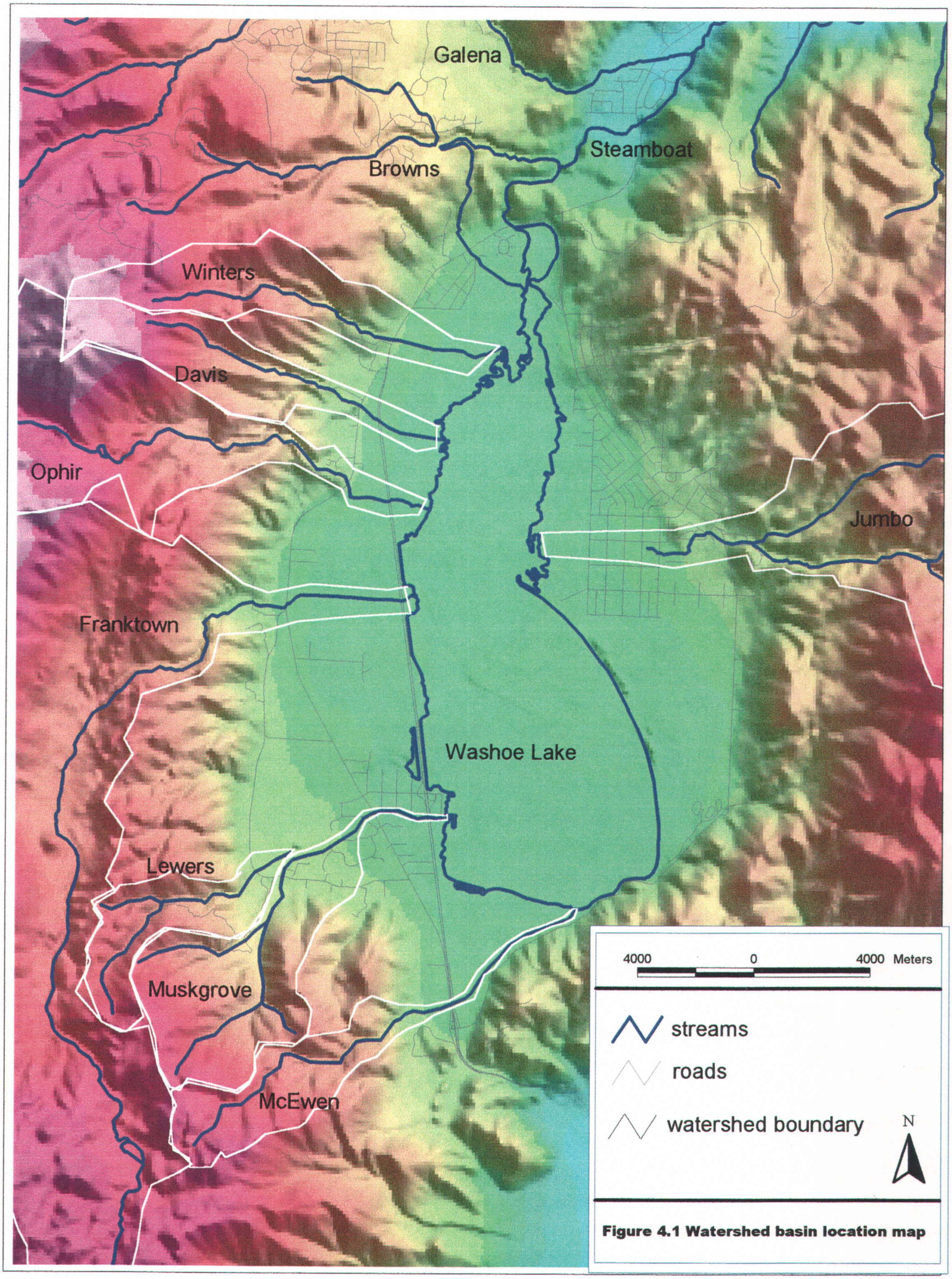


Figure 4.1 Watershed basin location map

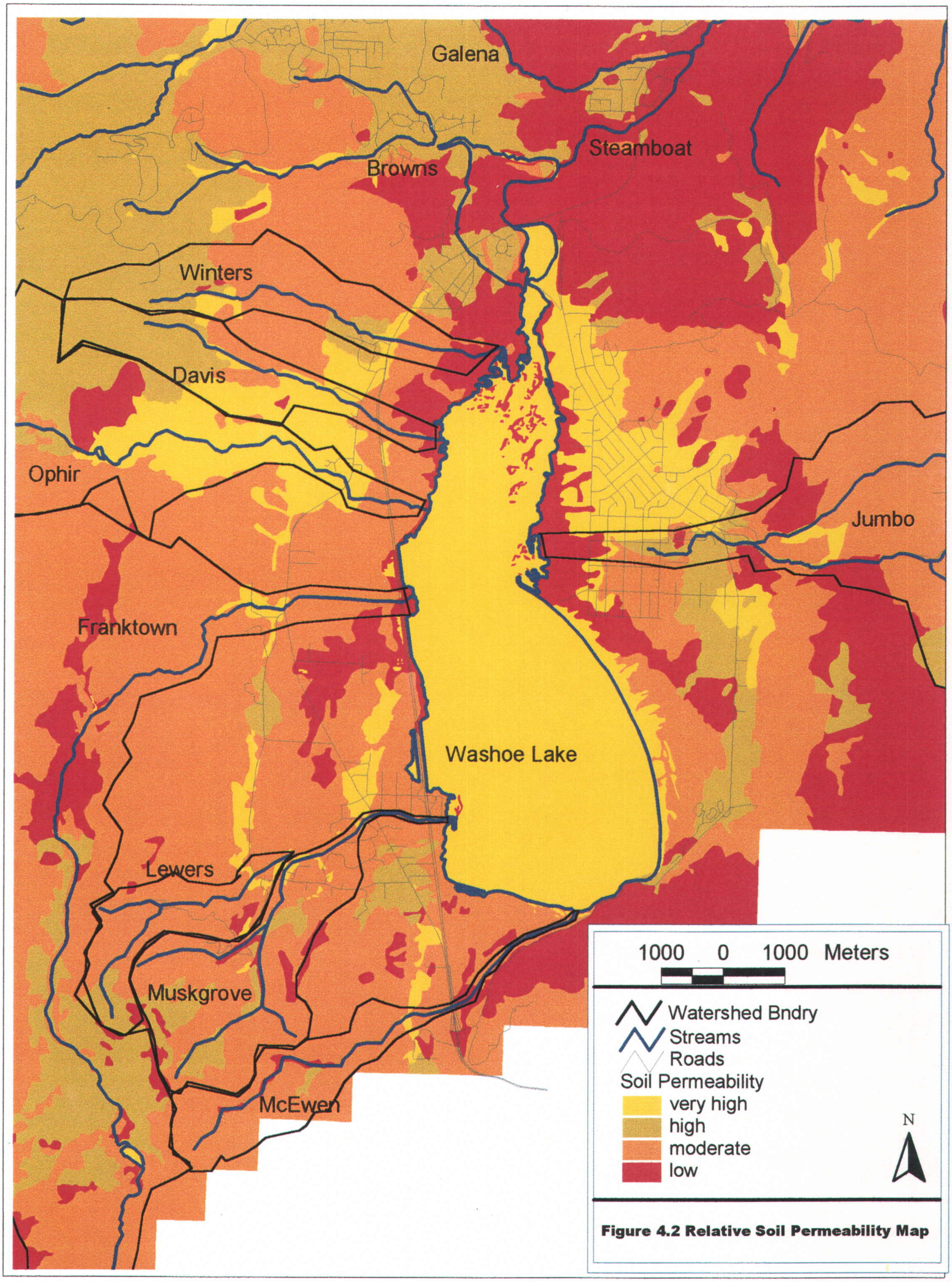


Figure 4.2 Relative Soil Permeability Map

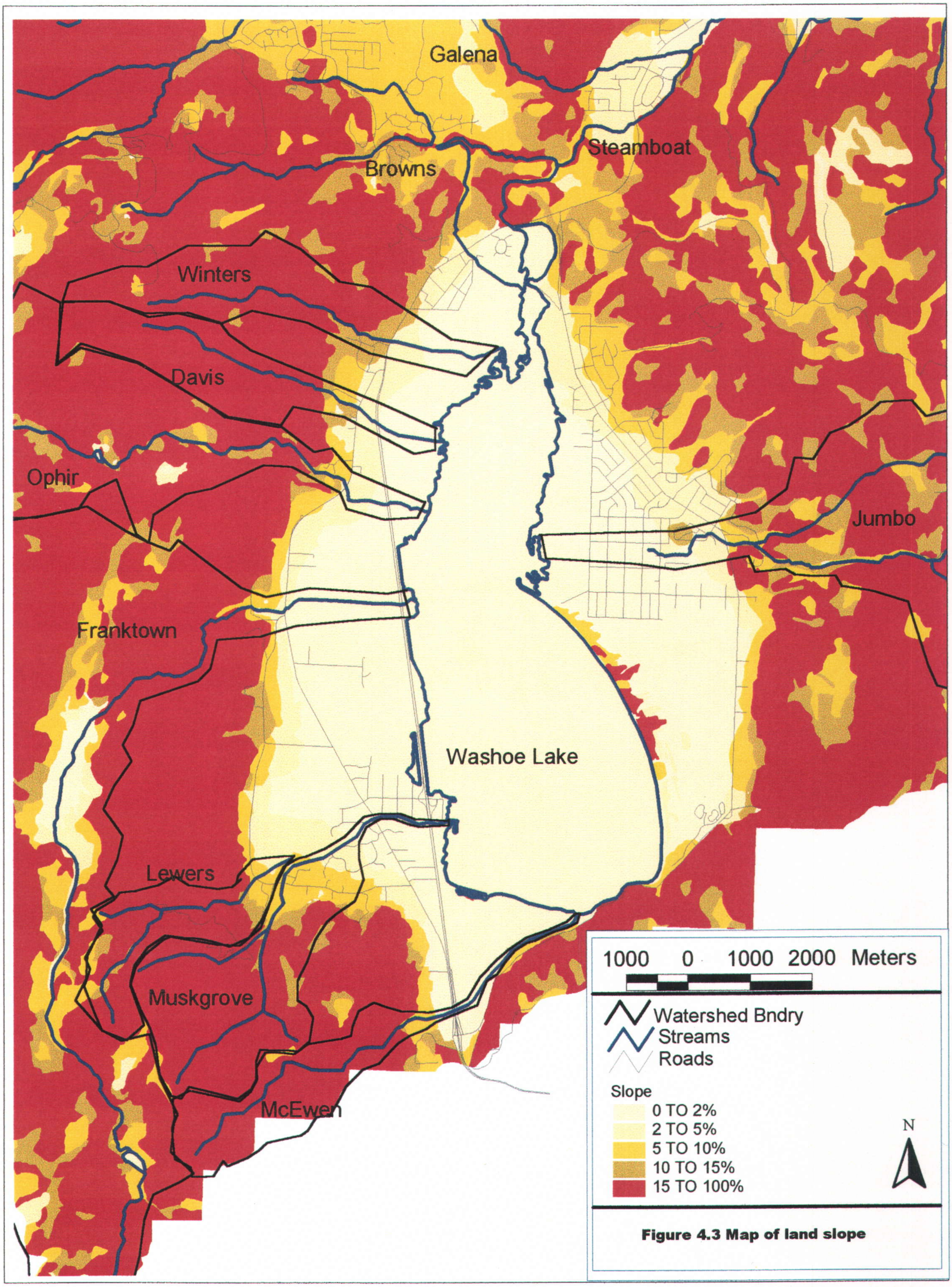


Figure 4.3 Map of land slope

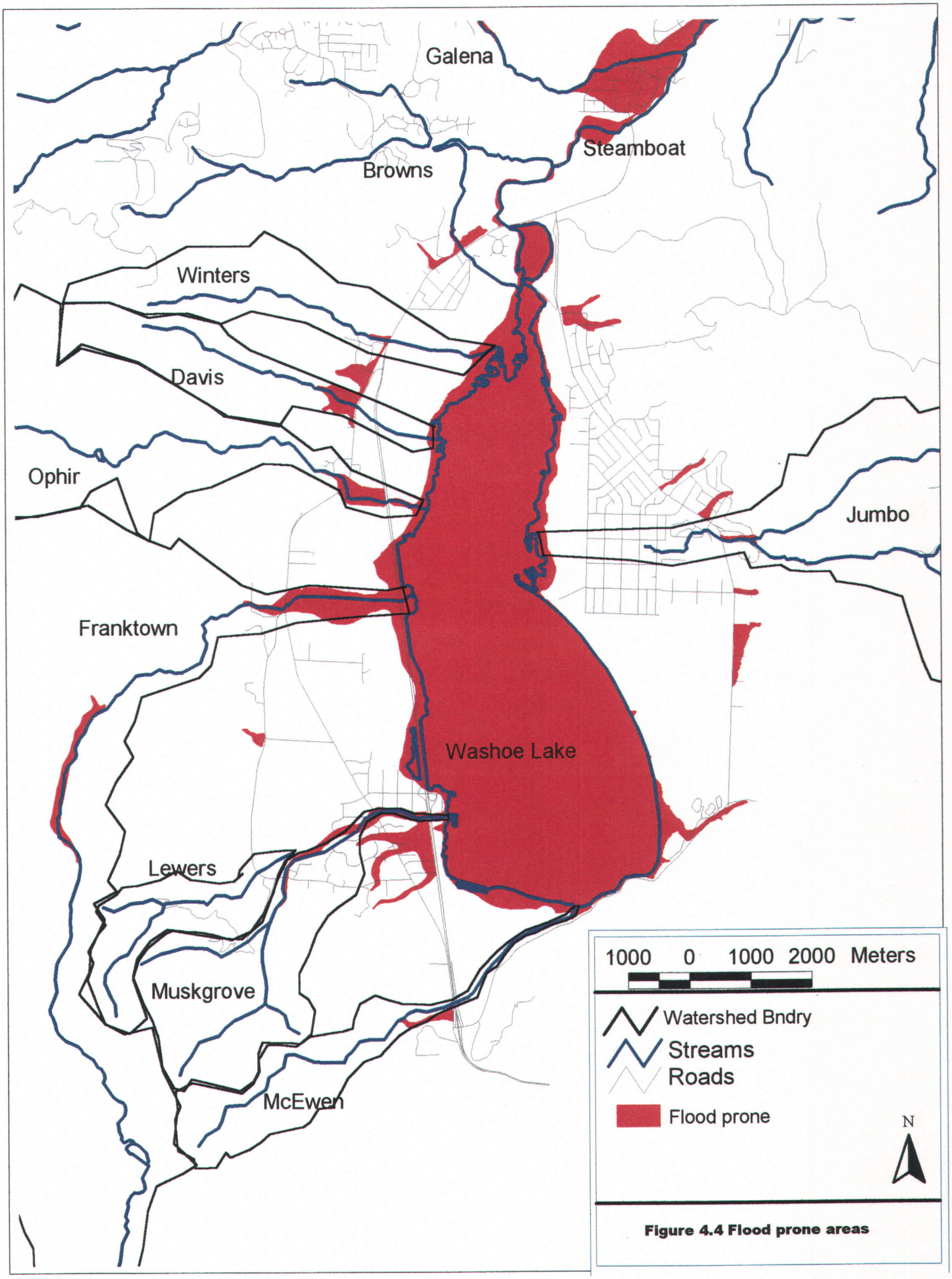


Figure 4.4 Flood prone areas

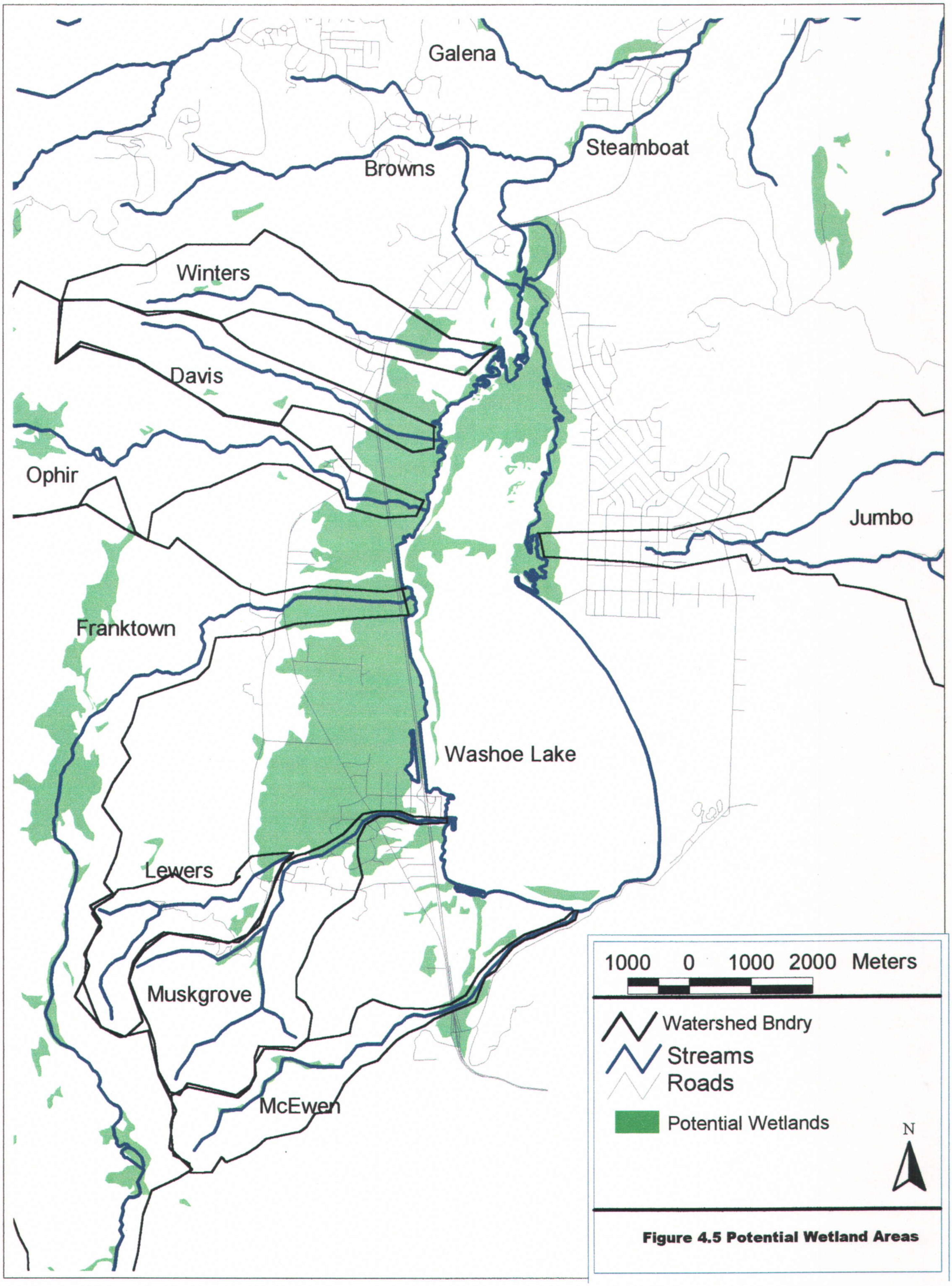


Figure 4.5 Potential Wetland Areas

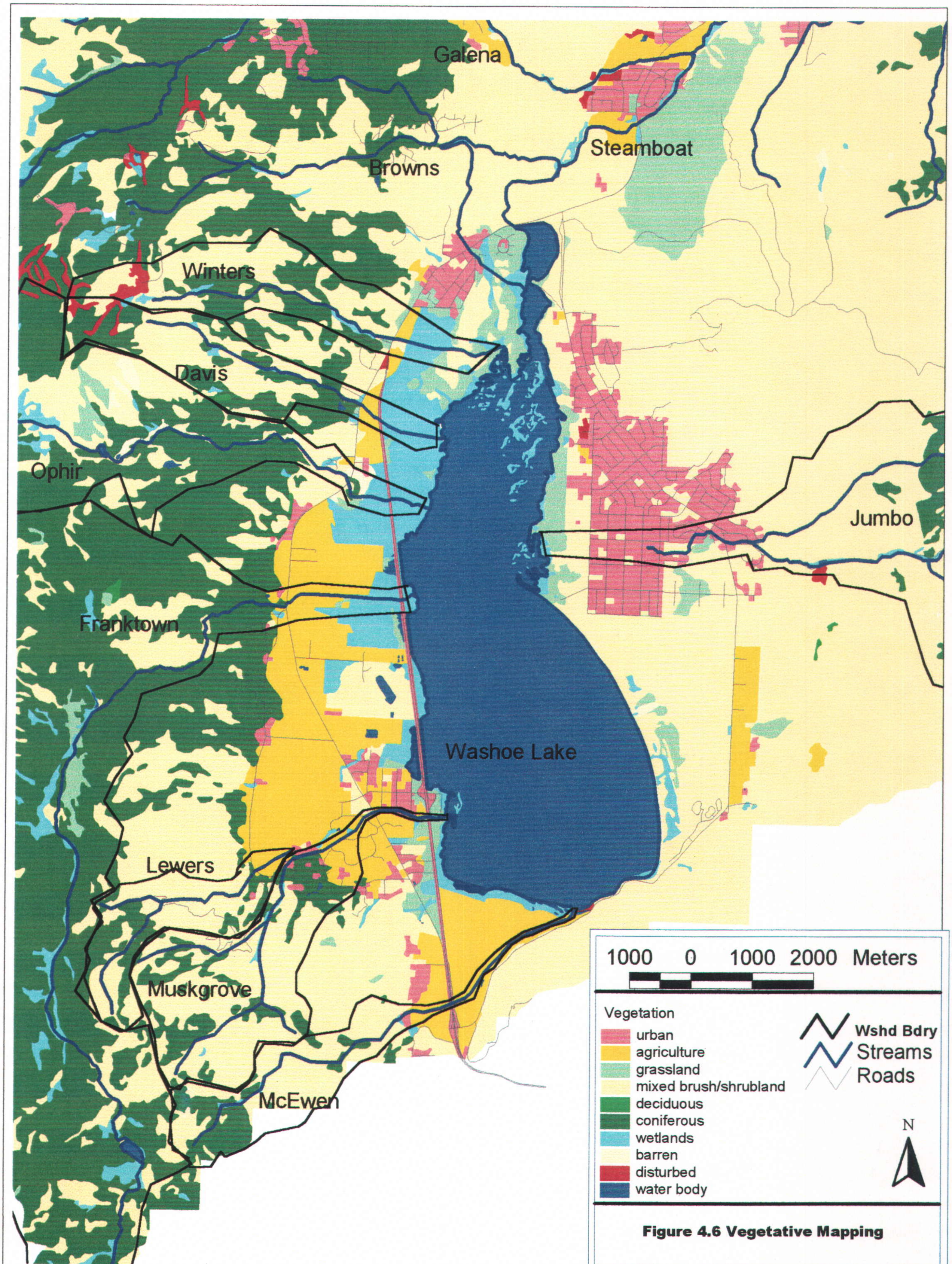


Figure 4.6 Vegetative Mapping

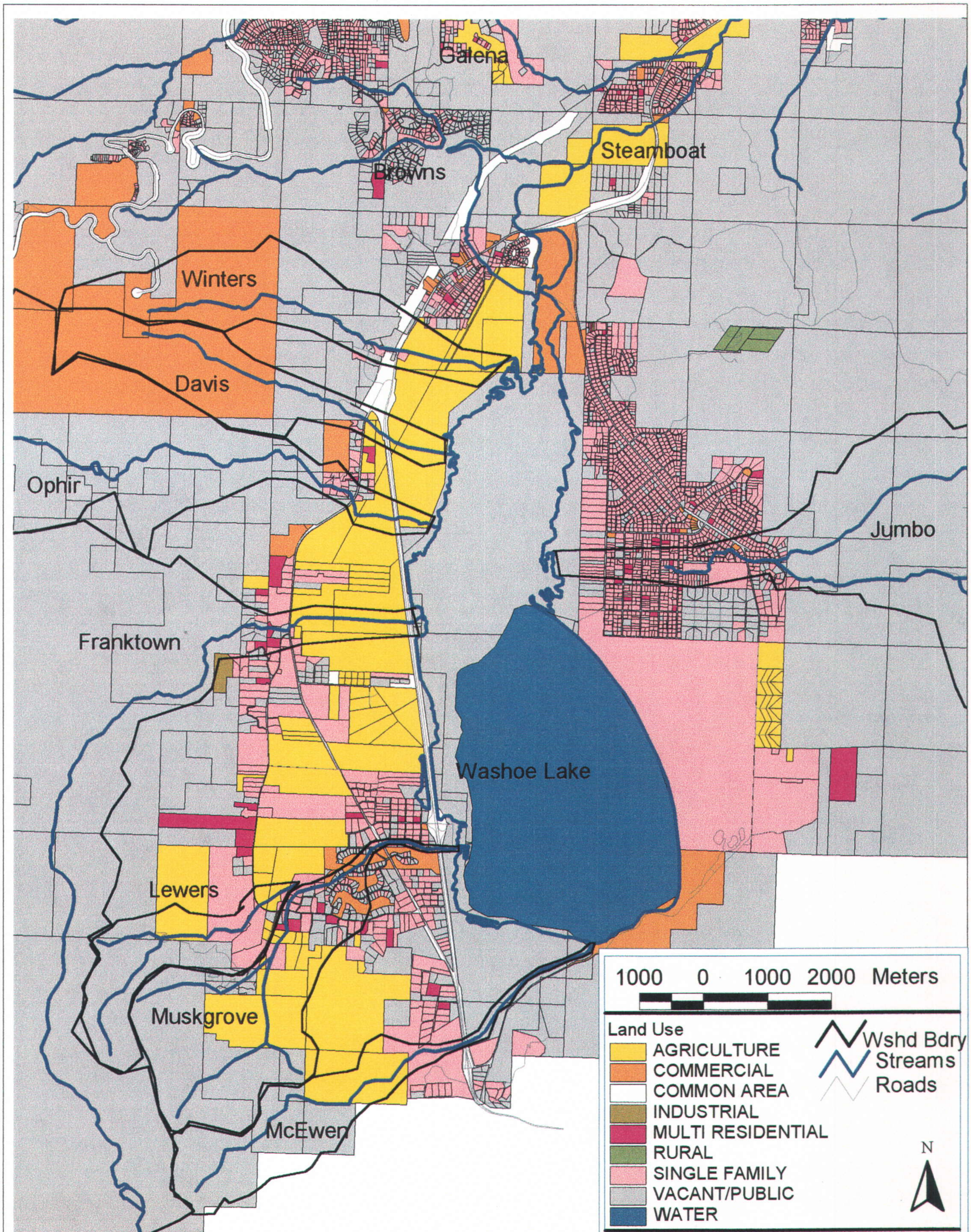


Figure 4.7 Land Use. Vacant lands are both public and private

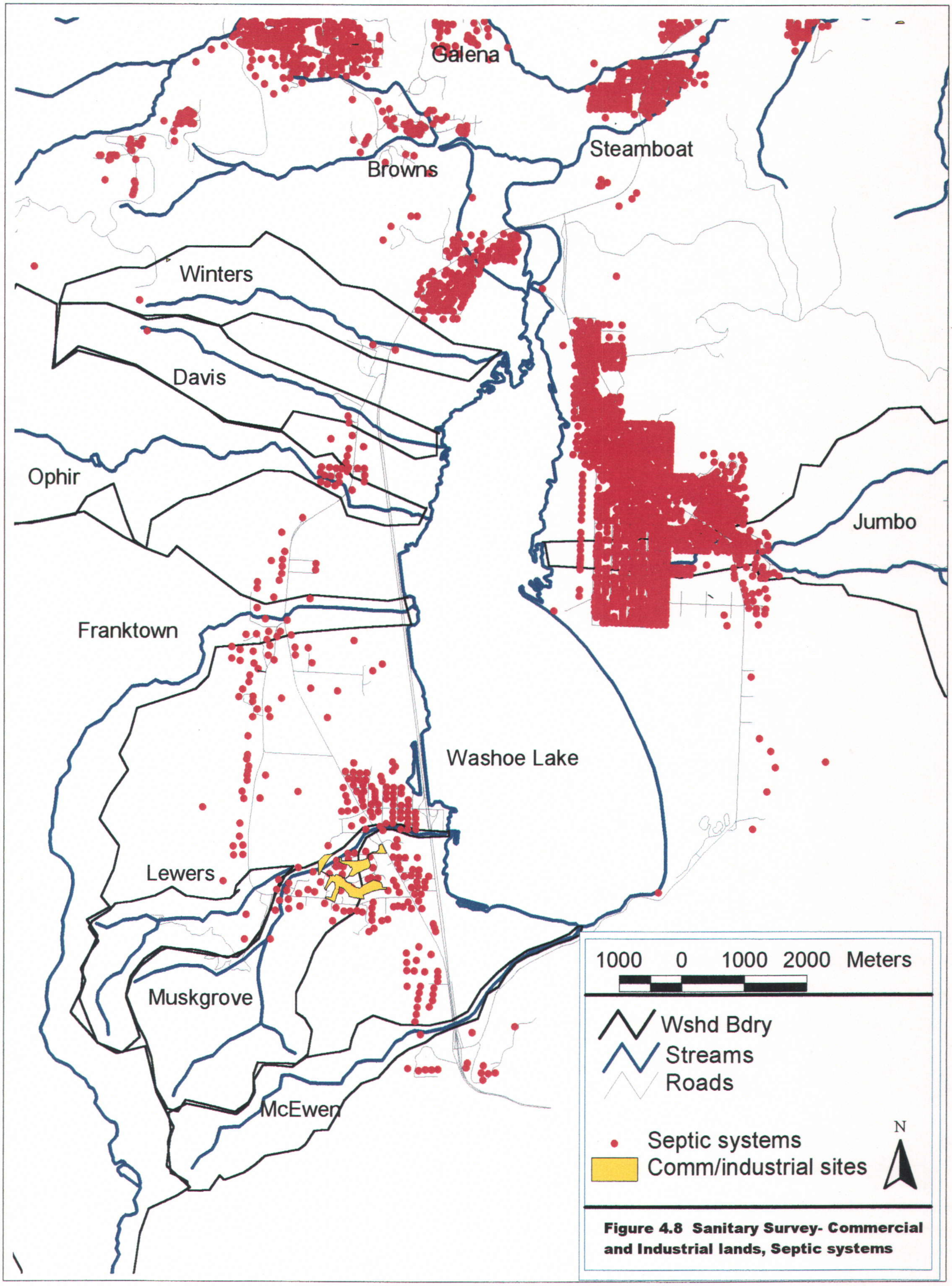


Figure 4.8 Sanitary Survey- Commercial and Industrial lands, Septic systems

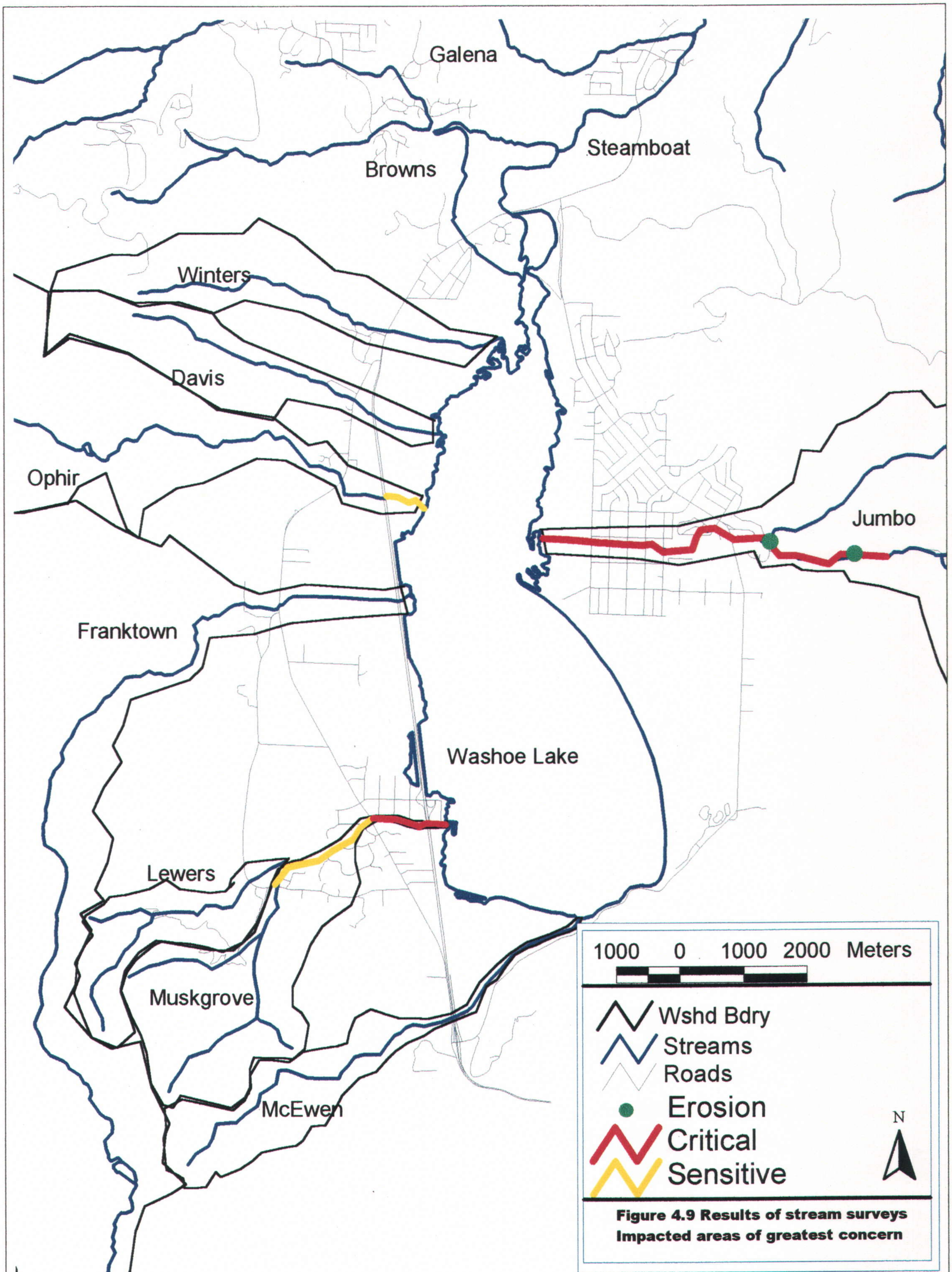


Figure 4.9 Results of stream surveys
Impacted areas of greatest concern

CHAPTER 5
SOUTH TRUCKEE MEADOWS
Evans, Dry, Thomas, Whites, Galena, Jones, and Browns

Physical Description

These creeks are the largest tributaries to Steamboat Creek, which emanates from Washoe Lake in Washoe Valley. These creeks are, from north to south, Evans, Dry, Thomas, Whites, Galena, and Browns (see Figure 5.1). These creeks drain the east slope of the Carson Range, a chain of the Sierra Nevada Mountains. Their primary source of water is snowmelt in the Carson Range during the winter and spring months and groundwater supplied base flow from the Carson Range in the late summer and fall. These creeks represent some of the largest flowing creeks in the community with average flows ranging from 1 to 32 cfs (Widmer, 2000). Flood flows on any of these creeks can easily reach 100 cfs or greater.

<u>Creek Narratives</u>

Historically, Evans Creek flowed easterly to its confluence with Dry creek, probably in the Longley Lane area. As Evans Creek discharged from the Carson Range mountain block (~4,800 feet elevation) it built alluvial fans on the west, north and south sides of Windy Hill. Irrigation practices within the last 140 years have altered its natural channel whereby Wheeler reservoir was used to capture its flows for farming uses. Today, the reservoir is still used to capture Evans creek flows, but used exclusively for golf course irrigation. Flows that are not diverted to the reservoir flow downstream to the Last Chance Ditch where they are captured. However, high run-off periods or flood flows can keep Evans Creek alive downstream of these diversions. During these periods the creek flows eastward and is captured in a drainage ditch that parallels DeLucchi Lane, finally confluencing with the Dry Creek drainage near Home Gardens road.

Throughout much of its course Dry Creek is ephemeral and primarily discharges snow melt and high intensity rainfall such that it is dry during most of the year, its upper drainage area being relatively small. The upper watershed is deeply incised upon the Mt. Rose alluvial fan. However, the creek does become perennial as the stream channel crosses the toe of the alluvial fan and throughout its course northward of the Huffaker Hills. This is due to springs and seeps that have formed due to historical irrigation practices and from natural groundwater discharges. As the channel is directed northward from the Huffaker Hills it becomes part of a drainage network with the Boynton Slough for the Reno-Tahoe Airport. It is heavily influenced by groundwater discharges and storm drainage east of the airport.

Thomas and Whites creeks drain a major portion of the northeastern Carson Range. They both emanate from the Carson Range at approximately 6,000 feet and have built alluvial fans upon the Mt. Rose Pediment. They too are fairly deeply incised upon the alluvial fan until they reach the 5,000 feet elevation, near the base of the fan. Fault structures appear to have altered their easterly direction northeasterly onto the South Truckee Meadows, east of Highway 395. These creek flows have been used for irrigation since at least 1860 such that their channels have been adapted or moved for these purposes downstream of where they cross Steamboat ditch (at approximately 4,760 feet elevation). East of Highway 395 the South Truckee Meadows is a flood plain of these creeks and Steamboat Creek as well as a pronounced groundwater discharge area. Man has altered this land use from wetland and flood plain to yesterday's farming and ranching activities to today's urbanization. As a consequence, wetlands that were drained in the past have been somewhat restored though channelized. In this area both creeks serve mainly as flood control and storm water infrastructures. They join in the northern area of the meadows immediately south of the Huffaker Hills and soon confluence with Steamboat Creek where it flows into the Central Truckee Meadows along the west slope of the Virginia Range.

Galena Creek has largely been unaltered by man as it flows from the Carson Range (6,200 feet elevation) across the Galena alluvial fan and west of the Steamboat Hills. This creek drains a large upper watershed with a very steep gradient. As a consequence, large flood flows are easily generated and are capable of carrying large sediment loads (big boulders!). Near the eastern portion of this alluvial fan it is joined by Jones creek (at about 5,400 feet elevation) where it flows southward around the Steamboat Hills into Pleasant Valley. Galena creek has a short traverse across Pleasant Valley before its confluence with Steamboat Creek. Unlike Thomas and Whites, this creek passes through gaining and losing reaches of groundwater on the Galena alluvial fan. Historically, the channel upon this section required a much larger flood plain than Thomas and Whites because it is not entrenched upon the fan. Today's urbanization is attempting to contain these flood flows through channelization. During the non-irrigation season a large portion of the creek is diverted southward to Browns creek and Washoe Lake for later use in the South Truckee Meadows.

Browns Creek has a small upper watershed where flows are mostly derived from snowmelt. It is often dry in the summer along its mid to lower reaches. Its stream course flows entirely eastward towards its confluence with Steamboat creek at 5,000 feet in the extreme south end of Pleasant Valley. The flow in Browns creek is captured during the non-irrigation season where it is diverted to Washoe Lake along with flows from Galena creek. Much of its flow is also diverted to Washoe Valley during the irrigation season as well to irrigate lands near Washoe City.

Geologic and Hydraulic Description

Figure 1.2 shows the geology of the greater study area including this watershed study area. The upper Evans and Dry watersheds are composed primarily of volcanic bedrock of the Kate Peak formation (Tk, Tki). These volcanics are largely andesitic flows and lahars (consolidated mudslide material) that can quickly, at least geologically, decompose to clays and silts. The upper watersheds of Thomas, Whites, Galena and Browns are composed also of the Kate Peak formation, but also of granodiorite (Kgd). Granoditorite weathers from silts to coarse sands. The middle portions of these watersheds flow across well developed soils that are composed of these aforementioned clays, silts and sands as well as cobbles and boulders. It is important to know this as the water retention and erodability of these soils is based, in part, upon the composition of clays, silts and sands. Silts and clays typically retain moisture and are not very permeable whereas coarse sands do not retain much moisture and are very permeable. The potential for soil erosion is mostly dependent upon its vegetative cover where exposed soils will easily erode. Exposed sandy soils will erode more easily than silty and clayey soils. Silty and clayey soils however will add more sediment and suspended sediment load to creeks.

Figure 5.2 shows the classified hydric soils for the study area, meaning their potential to adsorb or repel water (rain and snow). Soils with a high to very high classification will have a high runoff capability whereas soils rated low will have a low potential to generate runoff (high rate of infiltration) from precipitation. One could view Figure 5.2 as a map of low-permeability soils, which can be seen throughout the Evans and Dry watersheds, and the upper and lower watersheds of Thomas and Whites creeks. Figure 5.3 is a map showing percent slopes of these watersheds. Washoe County has determined that the slopes in red are unsuitable areas for development. These areas will also generate substantial runoff to creeks during high intensity precipitation events. Precipitation within these drainages ranges from 60 inches at the crest of the Carson Range to 10 inches on the south Truckee Meadows valley floor (Klieforth, et. al., 1983). Table 5.1 lists the physical description statistics for these creeks.

Table 5.1
Physical description statistics

Watershed	Drainage area (sq mi)	Average range in streamflow (cfs)	Range in precipitation (in)	Range in elevations (ft)
Evans	9.0	1 - 5*	10-44	4,440-8500
Dry	14.8	0 - 3*	10-32	4,395-7,800
Thomas	16.1	3 - 8	10-56	4,420-10,000
Whites	18.5	4 - 16	10-60	4,420-10,780
Galena	18.5	7 - 32	11-60	4,770-10,780
Browns	5.2	0 - 4*	11-40	5,000-7,900
Bailey	28.7	0-3	12-24	4,620-7,440

*Estimates as there are little or no measured record.

Figure 5.4 is a map of the 100-year flood zones as determined from the US Federal Emergency Management Agency (FEMA). These areas are susceptible to flooding during most high intensity, long duration precipitation events and not just during 100-year rainstorms. While flooding obviously occurs within the active creek channels, floods overflowing their banks create problems for development built within floodplains, which these maps help illustrate. Flooding is a problem in the Plumas and Lakeside Dr. area south of McCarran in the Evans watershed. In the Dry creek watershed flooding is a problem throughout much of its watercourse particularly east of US 395 and north of Longley Lane. Flooding on Thomas creek occurs downstream of the Foothill road crossing in the Thomas Creek road and Holcomb Lane areas. Whites creek flooding occurs near US 395, but recent work has lessened much of the problems. Major flood problems have occurred on Steamboat creek at the Thomas and Whites confluences, but development work continues to alleviate these problem areas. Flood prone areas on Galena creek occur on the alluvial fan and throughout its course in Pleasant valley.

Figure 5.5 outlines wetland areas as mapped by Washoe County, the US Army Corps of Engineers, the Federal Emergency Management Agency, the Nevada Department of Wildlife and the Desert Research Institute (Washoe County, 1999). These wetlands are based upon vegetation, hydric soils (soils frequently saturated) mapping, playas, floodways, and of course observations. Within the Steamboat Tributaries study area, the highest density and areal extent of the wetlands are located east of US Highway 395 on the South Truckee Meadows proper. This area is also a groundwater discharge area. Large-scale residential, and commercial and industrial development of this area is occurring such that the wetlands are being drained or condensed. Consequently, this map is not accurate for current conditions within certain areas. Much of the other wetland areas occur within the upper and undeveloped watersheds. An exception to this is within the middle reaches of Galena creek particularly where the creek leaves the Callahan Ranch area before flowing into a canyon that leads to Pleasant Valley.

Figure 5.6 is a map of the types of vegetation mapped during the late 1980s. The upper watersheds are mapped as coniferous and brushland. Within the mid reaches of the watersheds or the alluvial fans the vegetative type is brushland dominated with sage and bitterbrush. On the lower reaches wetlands, agriculture and urban development dominate the landscape. If this map were updated, the urban development would probably replace much of the agriculture and wetlands of the lower reaches and would also replace most of the brushland on the alluvial fans or mid reaches.

Land Use

Land use within these watersheds is diverse ranging from federally designated wilderness to areas of high-density commercial and industrial use. The City of Reno and Washoe County share the lower watersheds as depicted on Figure 5.7. The upper headwaters of all the creeks are in national forest (Evans, Dry, Browns) or wilderness (Galena, Whites, Thomas). From the figure, the creeks flow through rural, single family residential developments, and golf courses (ArrowCreek, Montruex, Wolf Run) upon their middle reaches. Thomas and Dry creeks also flow through small ranch lands upon the lower-mid reaches. These ranch lands are mostly used to raise livestock that impact the creeks. This is also the case for the very lower portion of Galena Creek. Upon reaching US 395 the creeks (excluding Galena and Browns) flow through commercial and industrial properties. The most intense industrial properties are on Dry Creek east of US 395. Near the confluences with Steamboat creek Dry, Thomas and Whites flow again through agricultural, residential and golf course properties (Hidden Valley and Rosewood Lakes).

Sanitary Survey

A sanitary survey was conducted to specifically locate and map the following:

- Septic tanks within 300 feet of creek drainages,
- landfills,
- hazardous waste/chemical generators,
- above/below ground storage tanks,
- herbicide, fertilizer and pesticide application areas (golf courses),
- effluent reuse sites,
- industrial sites, and
- road salt storage sites (NDOT and Washoe County).

Figure 5.8 shows the results of this survey. Lots that border creeks with septic tanks are shown on this figure. They are found nearly throughout the courses of all of these creeks. However, the actual number of these and their influence is probably small. This is stated because the water table is generally deep such that septic tank effluent does not flow directly to these creeks. Whether or not septic tank effluent does degrade creek water quality has not been investigated. No historic landfills were noted. Hazardous waste-generators or on site storage locations are shown to be minor and located north of McCarran Blvd. on Dry Creek. Underground storage tanks (UST) are mostly located at gas stations.

Large-scale fertilizer, herbicide and/or pesticide application is limited to the golf courses (ArrowCreek, Wolf Run, Hidden Valley, Rosewood Lakes, Montruex) and the Washoe County South Regional Park. Effluent reuse sites are located at the ArrowCreek and Wolf Run golf courses, for landscape irrigation within the South Meadows properties, and at the Washoe County Parks Southern Regional Park. Currently the use of this effluent is restricted to landscape usage, but will soon undergo filtration such that its quality will render its use unrestricted. The Nevada Division of Environmental Protection monitors effluent application to these lands. Buried sewer lines that cross underneath Thomas, Whites and Galena creeks are shown. These pipes present a potential source of pollution only if sewage backs up in the lines and overflows the manholes.

Industrial properties are also noted in the figure and border Thomas and Dry Creeks at their lower reaches. The Nevada Department of Transportation operates a road salt and sand storage site at the junction of US 395 and the Mt. Rose Highway that is in use during snowstorm periods.

Stream Chemistry

Thomas, Whites and Galena creeks have twenty years of water quality data taken from the upper watershed areas. However, very little data exists from any of these creeks taken at mid to lower portions of the watersheds. During the autumn of 2001, water quality samples were taken (see Figure 5.1) at upper, mid and lower reaches of Galena, Whites and Thomas creeks (Table 5.2). This data represents low flow conditions. Samples were also taken on select reaches during a rainstorm in January 2002 to sample the effects of urban runoff to these creeks. A discussion of these two data sets follows. Because of this limited data set, more aggressive surveys must be undertaken to better sample runoff events for fully quantifying urbanization effects upon the creeks.

General chemistry

Table 5.2 lists select water quality constituents for most of the creeks within the Steamboat Tributary study area. Evans, Browns, and Dry creek were not sampled as it was assumed that their water quality is comparable to that of the other creeks at upper, mid and lower reaches. The listed constituents represent water quality that is influenced by natural conditions, erosion, human waste (septic tanks), and livestock waste.

Overall the water quality is very good with suspended sediment loads, nitrogen, and bacterial counts relatively low. It is instructive to review the reaches of each of these creeks to assess how the water quality changes from the upper watershed where man has no influence to the lower reaches where man has effected the quality, to some extent. From the TDS perspective it is also interesting to be able to identify groundwater influxes to the creek.

Table 5.2
General water chemistry

creek/reach	TDS	TSS	TP	NO3	TKN	Fecal coli	Fecal strep	coli/strep Ratio
	Mg/l	mg/l	mg/l	mg/l	mg/l	count	count	
Galena								
upper	87	4	0.02	0.1	0.33	51	>60	<0.85
mid	134	5	0.04	1	0.21	14	22	0.64
lower	99	3	0.09	0	0.26	34	22	1.5
Whites								
Upper*	55	2	0.03	0	0.1	10	NA	NA
mid	64	2	0.02	0.7	0.18	29	>60	0.5
lower	62	<1	0.02	0	0.26	50	80	0.62
Thomas								
upper	96	2	0.06	0.1	0.19	8	34	0.24
mid	133	62	0.12	0.4	0.62	20	110	0.18
lower	172	21	0.1	0.1	0.68	50	130	0.4

TDS= total dissolved solids (inorganic chemistry)
TSS= total suspended solids (sediment)
TP = total phosphate (organic phosphate)
TKN=total Kjeldahl nitrogen (organic nitrogen)
Coli= coliform (fecal coliform is feces derived bacteria)
Strep=streptococci (fecal bacteria)
* sampled Oct 2000

Galena creek TDS concentration is relatively stable although groundwater is known to discharge into the creek within the mid-reach (located on the west-side of the Steamboat Hills before the creek descends into a canyon above Pleasant Valley). A decrease in the concentration in the lower reach (Pleasant Valley) may be from Steamboat creek induced groundwater recharge. The fecal ratios are relatively low, but trend towards a human influence as the concentrations change as the creek waters move downstream. This is most likely a result of septic tanks located on the mid- and lower-reaches.

Whites creek TDS concentration was also found to be relatively stable with very low values. Low values were also found for suspended solids, phosphate, nitrogen and bacteria. This indicates that urban development near this creek was not having much effect during this low flow period.

As surface water flowed downstream in Thomas creek the TDS level increased. This may be the results of livestock activities in the mid reaches and groundwater influx at the lower reaches. The suspended sediment load increased significantly from the upper to mid section and decreased at the confluence with Steamboat creek (lower reach). The lower sediment load at the confluence is probably due to the substantial decrease in the streamflow velocity such that some of the suspended load settled to the creek bed. Bacterial levels increased downstream, but the coliform ratio remained relatively stable.

Stormwater chemistry

During a four-hour moderate rainstorm in January 2002, water samples were taken at South Virginia street on Evans and Thomas creeks. The creeks were sampled for total hydrocarbon products, total suspended solids, total dissolved solids, nitrogen and phosphate. Dilute levels of oil were found in both Evans (0.64 mg/l) and Thomas (0.71 mg/l) creeks. Although the suspended sediment load in the creeks was visibly noticeable and of concern, the lab results showed that the TSS levels rose only slightly from the measurements taken earlier in the year and displayed in Table 5.2 (84 versus 62 mg/l for Thomas creek). Both of these suspended levels are significant compared to the other creeks and to Thomas Creek in the upper watershed. Clearly water quality degrades in this watershed in the middle to lower reaches. More sampling should to be undertaken during storm events and high runoff periods to better assess the sediment load in Thomas creek. From this initial sampling of suspended sediment erosion appears to be a significant problem for Thomas creek.

Stream Survey

During the months of January and February extensive field surveys of the streams were conducted. These surveys made assessments of the "functionality" of these streams. The assessment format was adapted from the US Bureau of Land Management (BLM, 1998). Several reaches of each stream were assessed for its functionality. Generally, these creeks have three definitions of reaches: an upper-middle reach, a lower-middle reach (both on the alluvial fan), and a flood plain reach, generally east of US 395. The streams within the mountain block were assumed to be properly functioning and were not assessed as there is no development near these creeks. Upon the mid-reaches, the naturally incised streams are not influenced much by man. However, the lower, mid-reaches are influenced by man through ranching activities and residential manipulation of the streams. Within the lower reaches, the streams are no longer natural streams, but flood control channels. Consequently the assessment had to consider the stream condition as a flood control channel as well as a properly functioning stream. The full assessments are included in the Appendix. Assessment summaries are given below.

Browns creek

The headwaters of Browns creek are located about mid-slope on Slide Mountain. The stream is fed by springs and snow melt. The upper reach of the creek is undeveloped and exists in its natural undisturbed condition. Vegetation along the reach is very good and provides excellent wildlife habitat.

Downstream, Browns creek flows through a low-density residential development and undeveloped canyons. The development does not affect the creek and water quality is not impacted. The creek was significantly altered during the 1997 flood. This resulted in bank erosion and up to twenty inches of channel incision. Riparian vegetation is healthy and provides good wildlife habitat. Development does not encroach on the stream and flood flows are conveyed without damaging property. Water quality is not impacted along the reach. Browns creek converges with Steamboat creek in a pond, about one mile north of Little Washoe Lake.

Galena creek

The headwaters of Galena creek are located high in the mountains between Mount Rose and Slide Mountain. Much of the upper reach is located in pristine wilderness area, and is unaffected by human influences. The Mount Rose Highway roughly parallels Galena creek. Riparian vegetation is very healthy and provides good wildlife habitat in the mountainous reach of the creek.

East of Galena Park, Galena creek flows through a low-density residential development in an undisturbed natural condition. Residential lots typically do not encroach on the stream. Water flows clear and healthy riparian vegetation provides good wildlife habitat. Galena creek responded to the 1997 flood event by incising one to two feet. Roots are exposed and vertical banks exist. This appears to be a natural process not accelerated by development. The channel characteristics are very stable. Boulders, woody debris and roots resist further erosion.

East of the Montreux Subdivision, Galena creek flows through a broad meadow near Callahan Ranch Road. The creek is relatively undisturbed along this reach. The channel geometry is in balance with the watershed and topography. Vegetation is healthy and provides good wildlife habitat. Water quality is not affected in the reach. The north bank of the creek was bermed downstream of the Callahan Ranch road, apparently to protect a development in the adjacent meadow. The meadow was subdivided into about six lots several years ago. The berm along Galena creek prevents the creek from spreading across the meadow during high flows, its natural flood plain.

In Pleasant Valley, Galena creek flows through horse and cattle property. The upper section is narrow with very little floodplain and maintenance will be ongoing to keep flows in the bermed channel. Vegetation is good along the reach and provides wildlife habitat and stabilizes the channel banks. Water quality may be impacted by nutrients from ranching operations. Restoration opportunities are limited due to proximity of structures along the creek, but could include floodplain development and reshaping channel banks.

Galena Creek is very entrenched east of Highway 395, where it flows through cow pastures. Significant incision and bank erosion occurred during the 1997 flood. High stream flows continue to erode the channel banks as a new floodplain evolves. Livestock accelerate the bank erosion. Erosion and animal waste influence water quality. Riparian vegetation is beginning to emerge in the channel, however livestock grazing slows recovery. Wildlife habitat is minimal. Restoration may include excavating a wide floodplain and re-vegetating with willows and other woody plants. The channel would benefit from fencing that prevents livestock from grazing in the creek.

Jones Creek

The upper reach of Jones creek flows from the east slopes of the Sierras west of the Mount Rose Highway. The headwaters are in National Forest and have been undisturbed by mans activities. Development begins east of the Mt. Rose Highway where Jones creek flows generally unaffected. However, east of the Callahan Ranch road, extensive erosion has occurred. Jones creek is severely entrenched through a meadow setting that has been de-watered due to subdivision activities. Potential flood damage to future homes may occur. Sediment loading to Jones Creek will continue to be a problem through this reach to its confluence with Galena creek.

Whites creek

The upper reach of Whites Creek flows from the east slopes of the Sierras just north of the Mount Rose Highway. The headwaters of Whites creek are fed by springs and snow melt. The headwaters are located within a wilderness area and are relatively undisturbed by human activities. East of the wilderness area and west of Thomas Creek Road, the primary land use is low-density residential development. This does not have a heavy impact on the stream. The riparian vegetation is healthy and provides good wildlife habitat.

The natural characteristics of the upper reach of Whites Creek are valuable to the public. The natural functioning stream provides flood protection, wildlife habitat, water quality benefits and recreational opportunities. Development is beginning to occur atop the steep slopes overlooking the creek and within the Whites creek floodplain. Proposed development should be carefully reviewed to ensure compliance with environmental standards. Construction sites should be monitored and existing ordinances enforced. Concentrated stormwater runoff from the Mount Rose Highway, near the Galena Market, has resulted in significant soil erosion and large quantities of sediment transported to Whites creek. This has an impact on water quality and has attracted attention from members of the community downstream. A solution to protect the stream channel and its water quality should be developed by Washoe County and the Nevada Department of Transportation.

About a mile downstream of the Thomas Creek road crossing of Whites creek, a man made concrete splitter distributes flows about evenly between the two forks in the stream. The North Fork flows from south to north along an undeveloped fault scarp before entering the Wolf Run golf course. Upstream of the golf course, the stream exists in an undisturbed natural condition. Riparian vegetation is very good and provides excellent habitat for wildlife and water quality is not impacted. Within the golf course, riparian vegetation has been removed and the channel has been altered to improve playing conditions. Altering the stream and riparian vegetation increases the risk of erosion, reduces wildlife habitat and limits the filtering process and nutrient uptake provided by native vegetation. This is especially critical in a golf course setting where fertilizers, herbicides, and pesticides are applied. To the extent possible, a buffer zone of native vegetation should be reestablished along the creek.

Urban development and encroachment control the characteristics of the North Fork of Whites Creek down stream from the Field Creek subdivision and Wolf Run golf course. The construction of a detention basin and a road crossing at the Field Creek subdivision caused significant channel degradation. Property owners are removing riparian vegetation and doing earth work along the creek in violation of the existing Washoe County Stream ordinance. Farther downstream, the creek is severely channelized through an existing housing development. This has resulted in property damage from eroding banks, increased the risk of flooding, sediment transport and affected water quality. The lack of riparian vegetation along the reach provides little wildlife habitat. There are significant challenges to stream improvement along this reach due to its complexity. Numerous property owners, difficult access and proximity of structures to the creek are limitations to stream restoration, which is needed.

The North Fork of Whites creek is conveyed in a ditch along the new Wal Mart's north property line, between South Virginia Street and the Old Virginia City road. Water quality is affected by untreated storm water runoff directed from the Wal Mart parking lot to the creek and the straight channel alignment that increases the risk of bank erosion. The lack of native riparian vegetation and the presence of invasive species, such as Tall Whitetop, limit the usefulness of the reach for wildlife habitat. Whites creek, along Wal Mart's north property line, is a good site for stream restoration. This may involve excavation to create a floodplain, reshaping the channel banks and establishing riparian vegetation. This would result in improved flood characteristics, reduced maintenance costs and wildlife habitat that could be enjoyed by the public.

Thomas creek

Thomas creek flows from the east slope of the Sierras and enters the valley about one and a half miles north of the Mount Rose Highway. The upper reach of Thomas creek and Whites creek are separated by a ridgeline and the two streams have very similar characteristics. There is very little disturbance along the steep mountainous reach, and the healthy riparian vegetation is excellent habitat for wildlife and aquatic species.

Thomas creek emerges from the steep mountain terrain near Timberline road. Downstream of Timberline road, Thomas creek flows through low-density urban development, before entering ranches near Thomas Creek road. The steep canyons that rise from the stream have prevented development from encroaching. The undisturbed channel and healthy riparian vegetation provide resistance to erosion and the channel is capable of carrying flood flows without damaging property or the environment. Development does not appear to impact water quality. The stream is well suited for pedestrian trails and other low impact recreational uses along the reach.

The Southwest Vista development along Thomas creek, at Ventana Parkway, has resulted in two structures that affect the stream. Storm flows are conveyed to a very large detention basin located near the channel. Flows are diverted through two culverts that discharge directly to Thomas creek. The culvert inlets are very low in the basin. Therefore, the detention basin has no sediment storage capability to prevent sediment from reaching the creek. The low elevation of the culvert inlets also increases the risk of the basin becoming clogged with sediment and potentially impairing its functionality. Raising the culvert inlets may allow for sediment storage and limit the risk of the culverts becoming clogged. Box culverts were used to bridge Thomas creek at the entrance to the subdivision. The natural stream was replaced by approximately 250 lineal feet of channel armored with white rock riprap. No characteristics of the existing channel were preserved. This configuration can have serious impacts on aquatic life, including trout populations that can no longer pass through this obstructed section. Possible restoration could include defining a low flow channel through the rock riprap, reintroducing riparian vegetation and developing natural appearing drops and pool structures.

Downstream of the intersection of Thomas creek and Foothill road, Thomas creek flows through relatively new residential lots that range from two and a half to ten acres in size. Historically the land was irrigated pasture that produced hay and livestock. The new development has treated the stream channel fairly well. The lots typically do not encroach on the stream and in some cases, fencing protects the stream buffer zone. Water quality may actually be improving as development replaces livestock production along the stream.

A few existing ranch operations affect the creek from Holcomb Lane to Highway 395. The stream is channelized and realigned to allow for pasture irrigation, and the realignment causes bank erosion that contributes sediment to the creek. Animal wastes, from cattle and horses, is also a source of pollution. The reach has a good potential for recovery. Implementing low cost management changes such as enforcing the buffer zones, fencing along the creek, and removal of animal waste would significantly enhance habitat and water quality along the stream.

Three stream types characterize Thomas creek, east of Highway 395. They include relatively narrow channels with steep banks, broad flood control channels with 3:1 banks and streams that serve as amenities to landscapes. The landscaped channels and the broad flood control channels are stable, provide wildlife habitat and, in most cases, function properly. The narrow channels are the most problematic.

Thomas creek emerges from under Highway 395 near the Marriott Hotel in a narrow, confined channel that extends about 1000 feet east of the Highway. This is the most impacted reach of Thomas creek. The channel has very steep banks and no active floodplain. Significant erosion is occurring that contributes sediment to the creek. Tall Whitetop weeds are the only plant species observed along the channel. This is problematic as Whitetop out-competes native species and is not good habitat for wildlife. Restoration would require excavation to create an active floodplain and reshaping the channel banks to reduce their steepness.

Downstream of the confined reach, the creek transitions to a very wide flood control channel that flows through the Double Diamond Subdivision, and into a created lake. The creek flows from the created lake to Lake Alexander in a wide channel, and from Lake Alexander it flows to Steamboat creek in a narrow incised channel.

Dry creek

Numerous tributaries come together east of Lakeside Drive and Holcomb Lane in Southwest Reno to form the main channel of Dry creek. The tributaries are both spring fed and ephemeral drainages created by stormwater runoff. The headwaters typically form at the transition between the alluvial fan and the east slope of the Sierras. For the most part, the upper tributaries are undisturbed and not yet influenced by urban development. Northern phases of the ArrowCreek Subdivision are being developed into low-density residential lots adjacent to Dry creek tributaries. Sensitive areas exist along the tributaries that include wetlands, springs and riparian zones. These sites provide excellent wildlife habitat for deer, small mammals, birds and aquatic life and should protected from encroachment by development and road building. Water quality is currently very good, but with development comes the risk of pollution from construction-related sediment and erosion, stormwater runoff, illicit discharges, and fertilizers. Proper planning can potentially preserve the health of this undisturbed watershed.

East of Lakeside Drive, and west of Highway 395, three tributaries of Dry creek flow through small ranches that range from 2.5 to 10 acres. Impacts from livestock overgrazing is intense along much of the reach. The banks of the creek are eroding and vegetation is stripped leaving bare soil. Water in the creek is discolored apparently due to sediment and animal waste. Some areas are inaccessible to livestock and have developed good riparian vegetation. These isolated areas are good habitat for wildlife. Numerous small dams exist along the channels. The structures often result in downstream erosion and sediment deposition. Tall Whitetop and other invasive species were observed along the channel. Management changes such as fencing riparian areas and better livestock management could potentially improve the stream corridor. Enforcement of existing ordinances and public education may also reduce impact on the stream.

Just west of Highway 395, near Huffaker Lane, the Dry creek channel is unstable with over-steep banks that erode and contribute sediment to the creek. This appears to be the result of increased peak flows following residential development upstream. The increased sediment load affects water quality. Tall Whitetop is thick along the channel and is out-competing more desirable native species. Restoration should include developing a wide floodplain with gently sloping channel banks. Native vegetation should be planted and Tall Whitetop should be controlled.

A stream restoration on Dry creek was recently completed east, or downstream, of US 395. The relatively wide floodplain, combined with an active low-flow channel promotes healthy riparian vegetation. The riparian vegetation provides relatively good wildlife habitat for shore birds, hawks and small mammals. It appears that channel maintenance and competition from native species controls invasive weeds. The restored channel floodplain serves as open space available to the public and includes a pedestrian trail system. This promotes a connection between the community and the watershed and is a good practice. The restored reach provides water quality benefits that include sediment filtration, nutrient uptake by wetland plants and stable banks that do not erode and contribute more sediment to the system.

East of the restored reach of Dry Creek, the stream is channelized to accommodate anticipated flood flows through commercial and industrial development. The valley bottom is about 60 feet wide and the banks of the channel are sloped at about 2:1. Most of the banks of the channel are armored with rock riprap. A low flow channel is beginning to develop sinuosity and desirable rushes and sedges are growing in the channel. Some Tall Whitetop weeds were observed, however the wetland species predominate. The riparian vegetation provides good habitat for wildlife and benefits water quality. Willows, Cottonwood trees, and other woody vegetation are removed to improve flood capacity.

Near the Reno-Tahoe Airport, the wide, flood control, channel transitions to Boynton slough. Boynton slough conveys Dry creek flows to Steamboat creek. This reach does not have characteristics of a natural functioning stream. There is no defined low flow channel and the banks are very steep. The channel gradient is very low and flows are slow. Tall Whitetop weeds out-compete native riparian species. The reach is poor wildlife habitat, due to the lack of riparian vegetation. Vertical banks slough off and contribute sediment to the channel.

There is a potential for successful stream restoration along the reach of Boynton slough. Undeveloped land is adjacent to the stream that could allow for excavation and floodplain development. Restorations upstream can serve as examples of suitable restoration methods along this reach. Restoration could incorporate pedestrian trails, open space and wildlife viewing.

Evans creek

Evans creek flows from the east slopes of the Sierras and enters the Truckee Meadows near the Lake Ridge golf course and subdivision in Southwest Reno. The upper reach flows from steep canyons and through medium density residential developments. The creek is relatively undisturbed and the riparian vegetation provides excellent wildlife habitat. Water quality is very good and not affected significantly by soil erosion or human activities. Homes and fences do not encroach on the stream. This allows the channel to function naturally and provides a wildlife and pedestrian corridor. The reach is considered to be a sensitive zone and planners should not allow excessive encroachment by development. Road crossings should be designed to avoid damage to the creek and riparian vegetation. Stormwater drainage should not increase bank erosion or add pollution to the creek. Tall Whitetop weeds were observed along the reach and should be controlled.

The middle reach of Evans creek flows through a public park and small ranches. The creek is channelized along much of the reach, resulting in stream banks that are unstable and eroding. Flood events cause property damage in about ten year intervals. A lack of vegetation and canopy causes thermal pollution and wildlife habitat is not available. Water quality is impacted by sediment from erosion, individual septic systems, and waste from livestock. Tall Whitetop and other invasive species are observed along the reach. Head cut erosion is beginning to cut through a wetland meadow. Based on the site characteristics, stream restoration may be appropriate. Much of the property is located on publicly owned land within a park setting. The public could potentially support a restoration project that would provide water quality improvement, flood control benefits, improve wildlife habitat and provide watershed education.

The lower reach begins east of South Virginia street and flows through commercial properties before it converges with Dry creek. The straight alignments, lack of riparian vegetation, and hard armoring limit the channels natural characteristics and reduce the usefulness of the stream for wildlife habitat. Water quality is impacted by the upland watershed and stormwater runoff from commercial properties. The channel design appears adequate to convey flood flows without damage to property. Reestablishing riparian vegetation and realignment of the low flow channel would improve the appearance of the channel and improve wildlife habitat. This may also provide water quality benefits. Upstream impacts should also be addressed.

Bailey Creek

Bailey Creeks is an ephemeral stream that flows in response to precipitation and snow melt. The channel does not receive enough flow to promote riparian vegetation, therefore, plants are mostly upland species such as bitter brush, sage brush and rabbit brush. Its headwaters are in the upper canyons on the west slope of the Virginia Range. Bailey Creek terminates in Steamboat Creek near the intersection of the Virginia City Highway and U.S. 395. Toll Road roughly parallels much of Bailey Creek.

The upper reaches of Bailey Creek are relatively stable due to the rocky soils in the steep canyons. The middle reach flows through an alluvial fan in a low and medium density urban setting. Existing and new development has encroached on the creek and has resulted in vertical instability and stream bank erosion. Planners should avoid allowing new development to place fill in the floodplain, or the stream channel, as this results in erosion and degrades water quality.

The invasive weed, Tall Whitetop, heavily affects the lower reach. The weed out-competes desirable native vegetation and its root structure is less able to resist erosion than native species. This increases the risk of stream bank erosion and reduced water quality. A Tall Whitetop management program should be implemented that includes mechanical removal of old growth followed by herbicide treatments. The plan must include a comprehensive revegetation program so the Tall Whitetop will ultimately be out-competed. The revegetation plan should incorporate grass species that are not affected by the herbicide treatments.

Conclusions and Recommendations

Invasive biota

Within these watersheds the most prevalent invasive plant species is Tall Whitetop. Figure 5.9 shows surveyed areas along these creeks where this plant is particularly troublesome. This plant is a problem because it out-competes native plants, does not provide useful habitat or forage, and is difficult to eradicate. The figure illustrates that Tall Whitetop is a problem in the lower reaches of Evans, Dry, Thomas and Whites creeks particularly east of US 395. Serious consideration should be given to an eradication program particularly east of US 395. Other forms of invasive biota were not discovered or noted.

Stormwater and erosion

During the field inspections and stream assessments note was made of areas where moderate to significant erosion was occurring. Particular note is made of the following areas as shown on Figure 5.9. Areas of significant stream incision and therefore erosion on Galena Creek occur east of US 395 and on Jones Creek east of Callahan Ranch Road. On Whites Creek, east of Thomas Creek Road, storm waters off of the Mt. Rose Highway and nearby subdivisions have contributed significant sediment into the creek. The south fork of Whites Creek contributes sediment load due to erosion throughout this reach to US 395. Severe erosion occurs on this fork east of US 395 where channel restoration has failed. On the north fork, east of Wolf Run golf course, severe urban encroachment has resulted in deeply incised banks and provides a constant source of sediment to the creek. Additionally, flood flows are increased and property damage and erosion is significant. Flood control efforts east of US 395 flood control efforts appear to be adequate to control erosion.

On Thomas Creek, east of Last Chance Ditch to US 395, ranching has contributed to channel degradation and therefore contributes sediment loads to the creek. Near and immediately east of 395, significant incision of stream banks is causing increased sediment loads. On Dry Creek, east of Lakeside Drive, intense development along the stream channel (alteration of creek for ponds and livestock access) has created degradation of the stream. North of McCarran and southeast of the airport, the channel is altered for flood control, where steep and un-vegetated banks promote erosion and increased sediment load. Evans Creek becomes an erosional problem east of Lakeside Drive to within a few hundred feet east of S. Virginia.

Stormwater detention basins are constructed on Whites Creek at Silver Wolf Road and on Thomas Creek at Ventana Parkway. The field survey conducted for this report visually inspected these facilities. The basin at Whites Creek may soon become ineffective due to erosion of the basin and may eventually create a significant sediment source to Whites Creek. This is also the case for the basin located on Thomas Creek as the outflow is at grade with the basin such that sediment will enter the outflow and discharge to the creek during storm events.

Stream health rating

The creeks are defined as having three reaches: an upper reach or the headwaters generally located in the Carson Range, a mid-reach on the alluvial fans west of US 395, and a lower-reach where the historical flood plain and wetlands are located east of US 395. Assessments were not made on the upper watershed, but were made on the creeks at two locations on the mid-reach, an upper and lower, and at least one assessment made for each creek on the lower reach. A sensitive rating means that while the creek is acting in a natural form, alteration of the creek or development encroachment can degrade the creek to a non-functional state. A critical rating means that the stream is no longer acting as a properly functioning stream. This is "critical" in the sense that water quality is degraded, riparian habitat is lost and in some cases flood protection is reduced. The "quality of life" for residents and the general public is also reduced.

The most obvious problem for these creeks is erosion and sedimentation. This is due to development encroaching upon or alteration of the creeks and stormwater discharges to the creeks. Table 5.4 lists the ratings for the three reaches on each creek, based upon the assessments.

Table 5.4
Stream Health Ratings

Creek	mid-reach		lower-reach
	upper	lower	
Evans	good	critical*	critical*
Dry	good	critical*	critical to sensitive*
Thomas	sensitive*	sensitive*	sensitive to critical
south fork Whites	sensitive*	sensitive*	sensitive*
north fork Whites	sensitive*	critical*	sensitive*
Galena	good	good	sensitive
Jones	sensitive*	critical*	none
Browns	good	good	good

* restoration is possible

East of Lakeside Drive ranching activities have degraded Evans, Dry and Thomas creeks. The alteration of these streams by man and livestock cause an increase in erosion, increased sediment load and degradation of water quality. Encroachment by residential development on Jones and Whites creeks on the lower mid-reaches have created excessive erosion, head cutting, steep banks and therefore increased sediment loads as well as a loss in flood protection. East of US 395, the streams Dry, Evans, Thomas, and Whites have, for the most part, been altered for flood control. As a result these creeks no longer function properly as streams. However, they do function well as flood control works. It is possible to restore these creeks to serve both purposes. More discussions of these critical and sensitive areas are found in the assessments (appendix) and in the individual summaries in the previous section. Restoration efforts can be successful for many of the reaches listed critical and or sensitive and are marked with an asterisk (*).

Stream Ordinance

In 2000, the Washoe County Development Code, Article 418, Significant Hydrologic Resources was enacted. The purpose of this article was to regulate development activities and protect perennial streams. A "critical stream zone buffer area" was set to within 30 feet of the stream thalweg and a "sensitive stream zone buffer area" set to within 150 feet of the stream thalweg.

During the stream survey it became apparent that the ordinance is not being entirely administered or enforced. For example, on Silver Wolf Road near Wolf Run golf course, a newly constructed house is encroaching upon Whites creek. As a result erosion and sediment are degrading the creek, vegetation has been removed within 30 feet of the thalweg and the potential for pollution (lawn care products) is great. A home is being constructed on Whites Creek where the creek is split into north and south forks. The creek bed will suffer from this residence and will also easily flood the home during moderate flooding events. The resident most likely will alter the creek for flood protection and/or for landscaping. It is also apparent that residences along all the creeks are not aware of this ordinance. Public education is needed in this area.

Recommendations

The results of these stream assessments will be used to help develop watershed management programs. The following recommendations are made as a starting point in determining what components are necessary for the management plan. The recommendations are made based upon maintaining or improving the functionality of each stream.

1. A more detailed erosion and sediment source survey should be made for each creek. This will help identify areas where improvements to water quality and sediment transport can be made. The surveys can be conducted at a very low cost. The cost of making improvements is unknown and could be expensive.

2. A public education program on the Stream Ordinance is strongly recommended. This may also include a survey of individual lots and communication with these owners.

3. Conduct water quality monitoring in association with the stormwater management program. This would include sediment loading sources, construction site erosion, urban runoff (oil and other petroleum based products), and golf course management of chemicals.

4. Increase construction site erosion control through enforcement and education. Currently erosion control measures at construction sites near streams and drainages are not always effective.

5. Improve on general water quality analysis and databases of different reaches of each creek. To date there is little or no information on water quality for several of these creeks. This type of program would be effective in periodically assessing the condition of the watershed. The sampling should be conducted during wet and dry conditions. This could be done two or three times a year for three years followed by periodic sampling.

6. Each creek should be analyzed for restoration potential. Reporting of this should include project description, feasibility, limitations and first approximation cost estimates. This type of work can be as simple as re-vegetating the creek with native plants, fencing reaches for livestock control, or allowing the creek access to a natural flood plain. It could also be expensive such as redesigning and constructing culverts at major road crossings.

7. A White Top Eradication program is strongly recommended for the flood plain area of the South Truckee Meadows, generally east of US 395. Programs for eradication are available. Because this invasive plant is so wide spread, total eradication would be relatively expensive. Program elements would be:
    - mow in early spring
    - treat with appropriate herbicide such as 2,4,D
    - repeat 2 times a year for a two to three years.

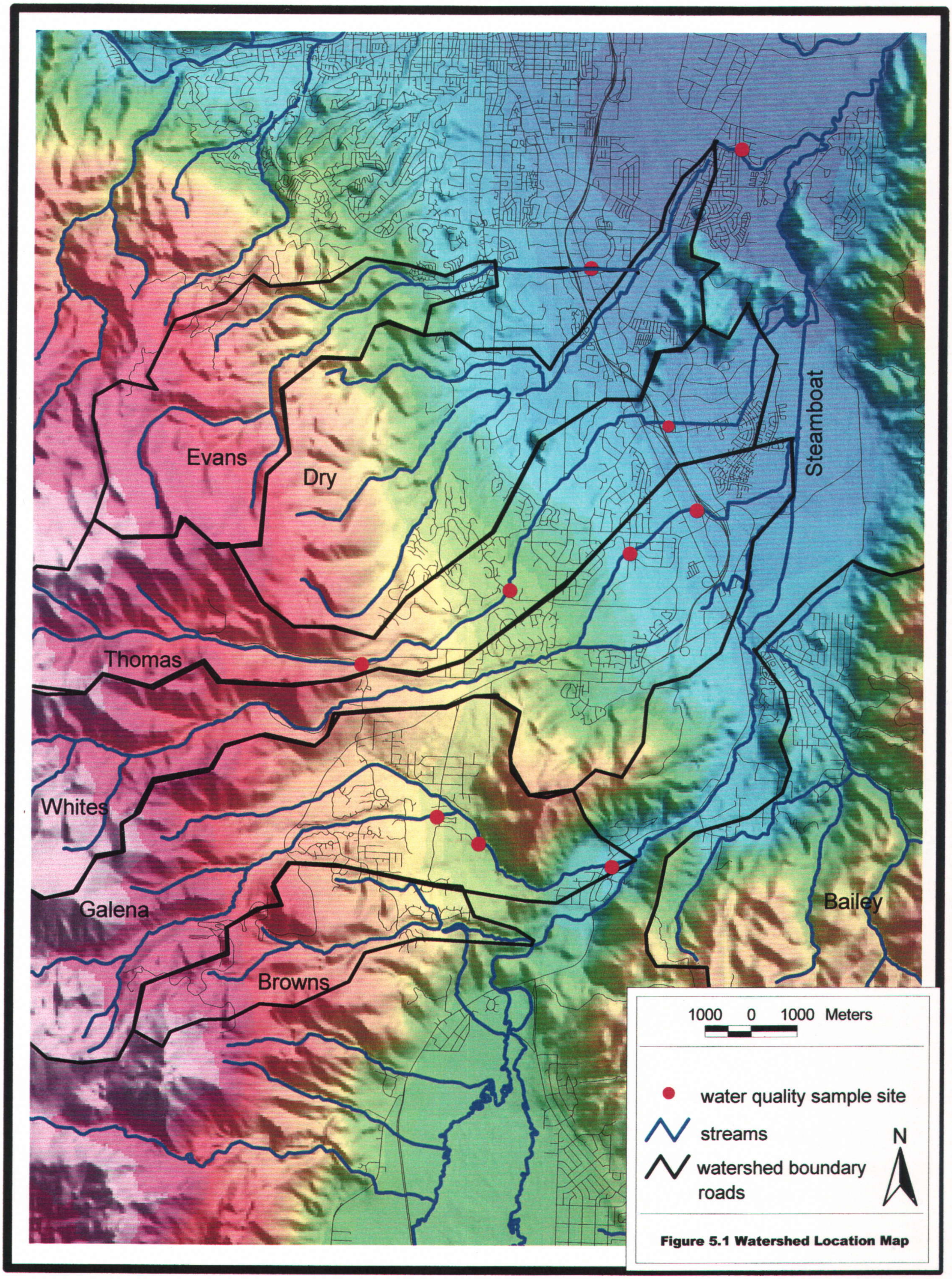


Figure 5.1 Watershed Location Map

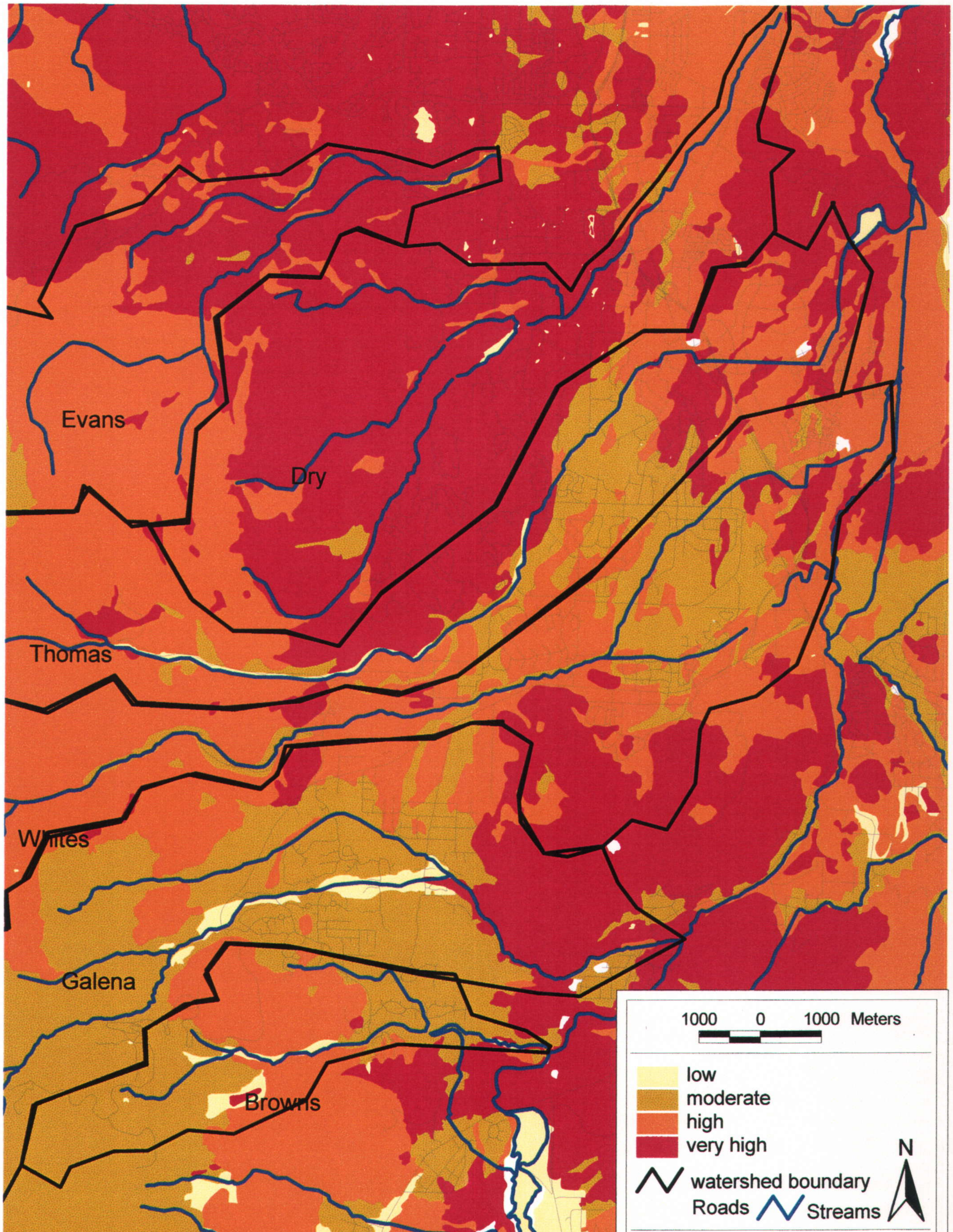


Figure 5.2 Relative Soil Permeability Map

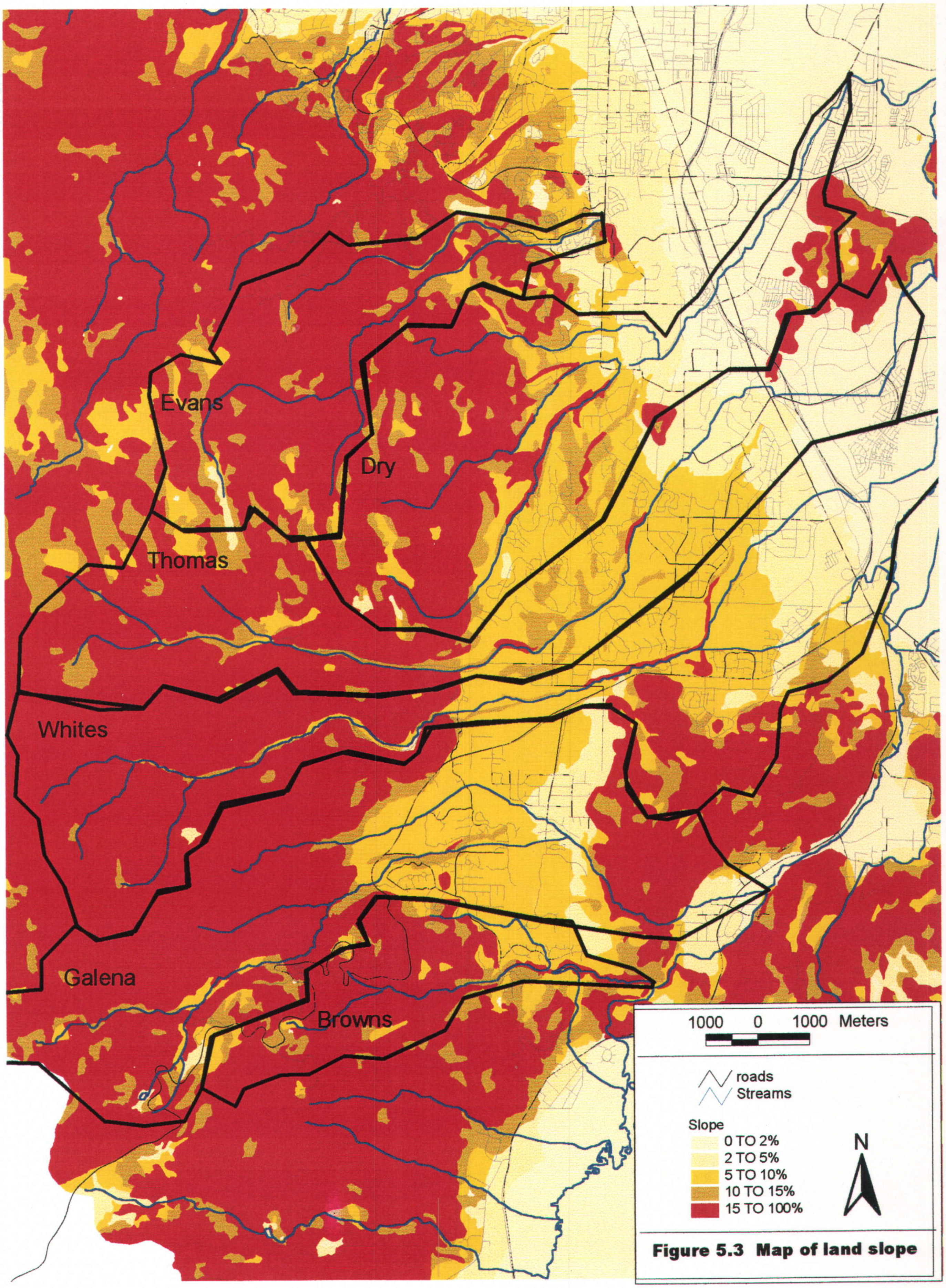


Figure 5.3 Map of land slope

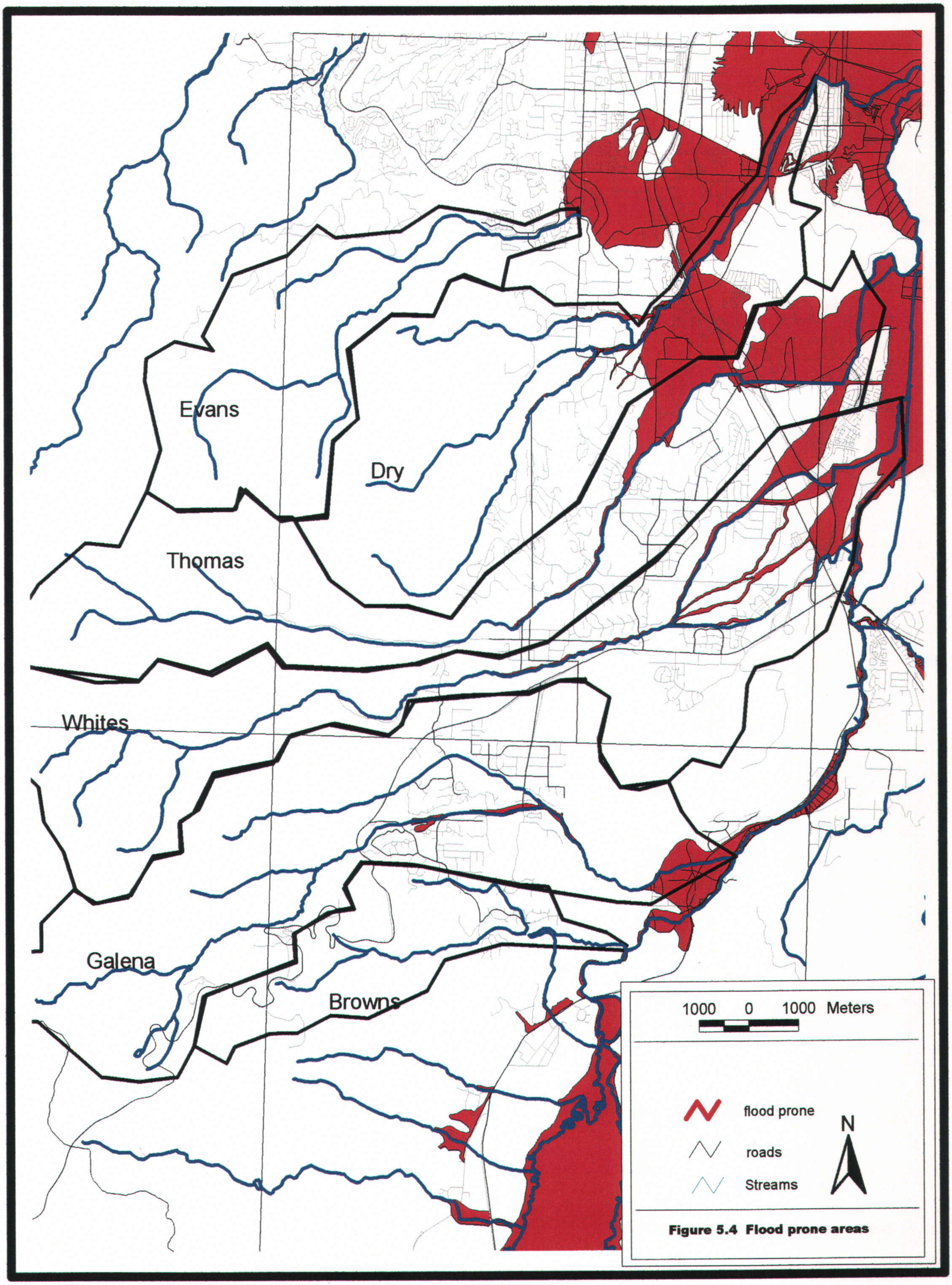


Figure 5.4 Flood prone areas

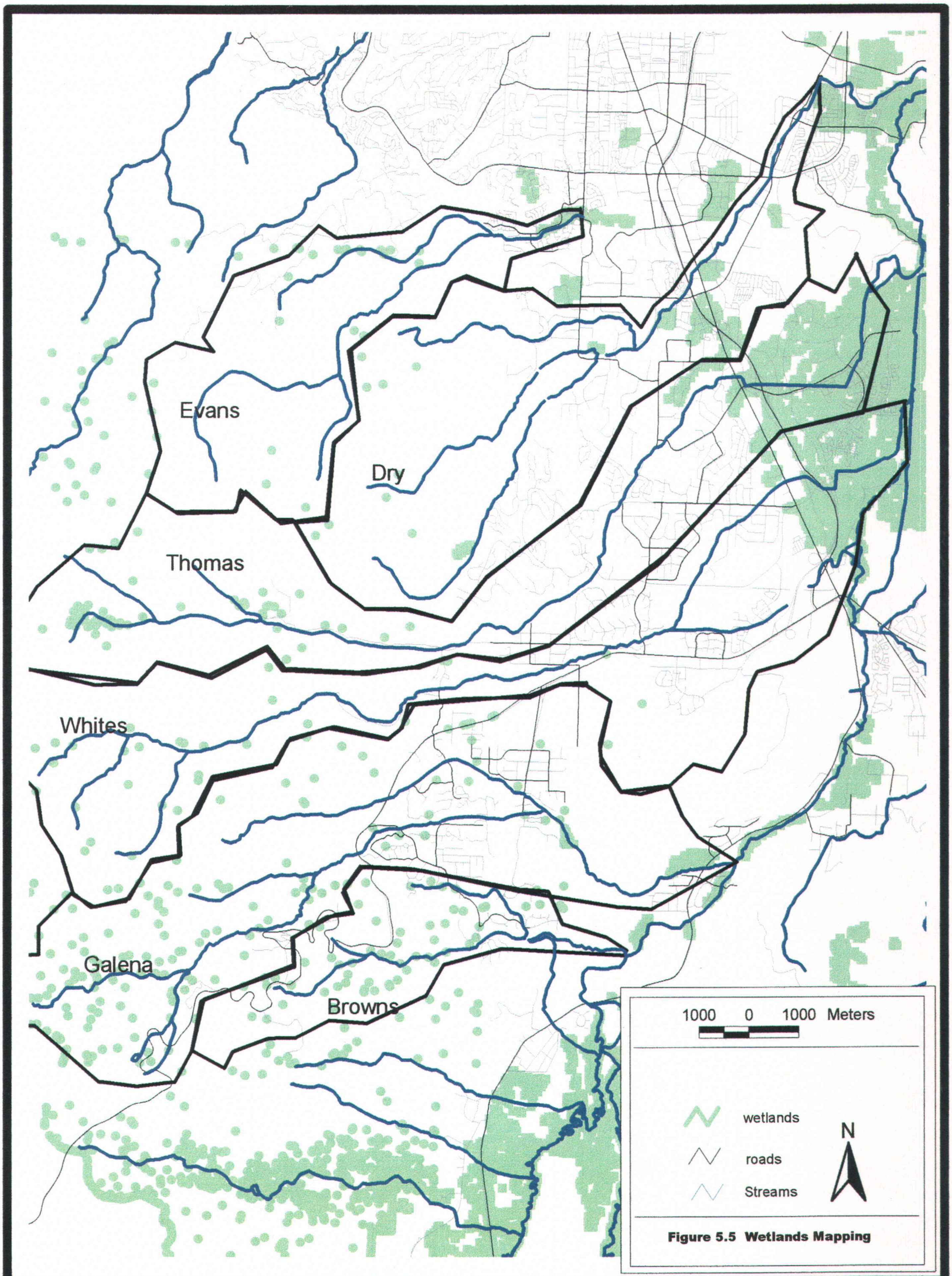


Figure 5.5 Wetlands Mapping

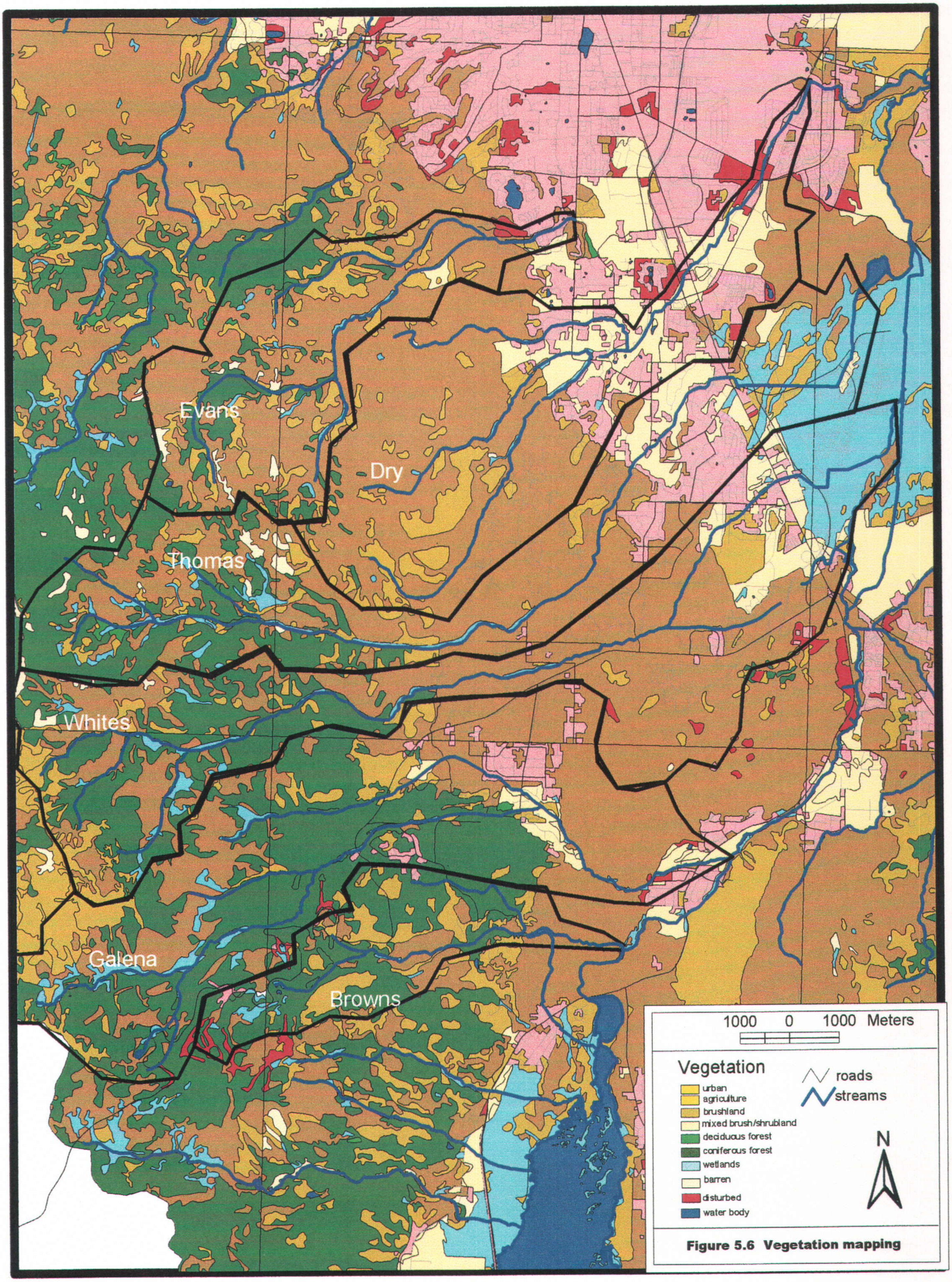


Figure 5.6 Vegetation mapping

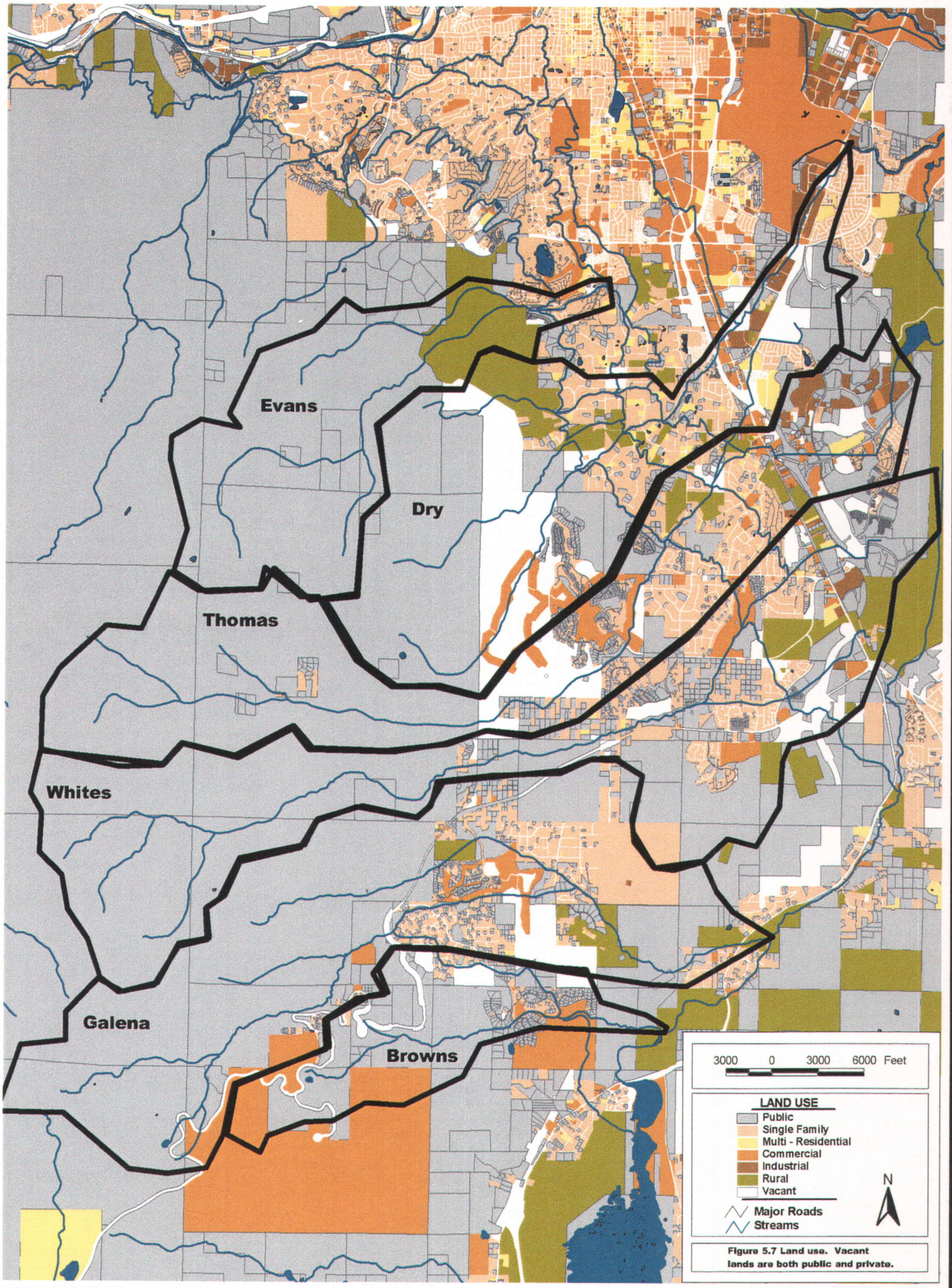


Figure 5.7 Land use. Vacant lands are both public and private.

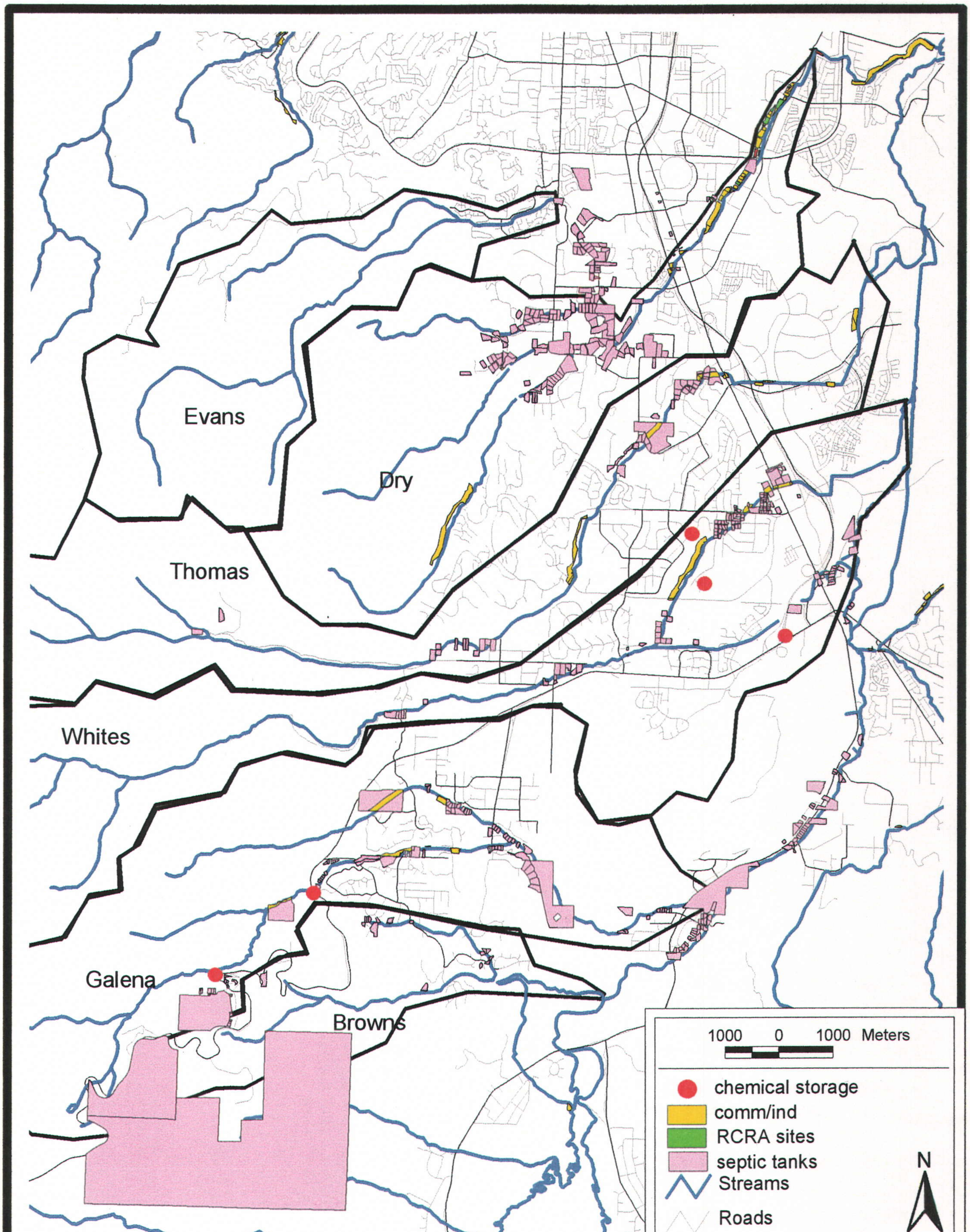


Figure 5.8 Sanitary Survey Commercial/industrial lands chemical storage sites

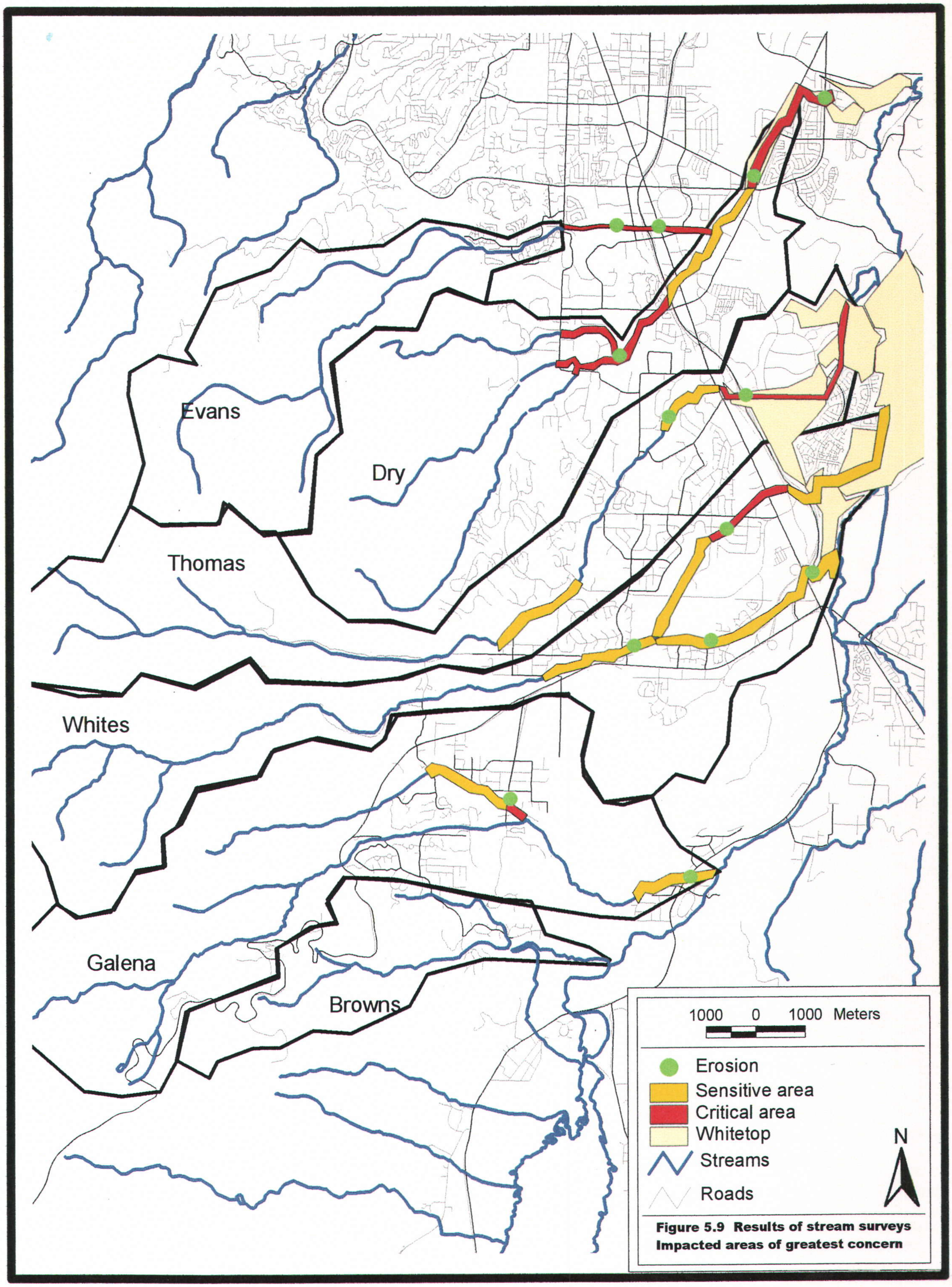


Figure 5.9 Results of stream surveys
Impacted areas of greatest concern

CHAPTER 6
GENERAL RECOMMENDATIONS

The results of these stream assessments will be used to help develop watershed management programs. The following recommendations are made as a starting point in determining what components are necessary for the management plan. The recommendations are made based upon maintaining or improving the functionality of each stream.

1. A more detailed erosion and sediment source survey should be made for each creek. This will help identify areas where improvements to water quality and sediment transport can be made. The surveys can be conducted at a very low cost. The cost of making improvements is unknown and could be expensive.

2. Conduct water quality monitoring in association with the stormwater management program. This would include sediment loading sources, construction site erosion, urban runoff (oil and other petroleum based products), and golf course management of chemicals.

3. Increase construction site erosion control through enforcement and education in association with the stormwater quality program. Currently erosion control measures at construction sites near streams and drainages are not always effective.

4. Improve on a water quality databases of different reaches of each creek. To date there is little or no information on water quality for several of these creeks. This type of program would be effective in periodically assessing the condition of the watershed. The sampling should be conducted during wet and dry conditions. This could be done two or three times a year for three years followed by periodic sampling.

5. Each creek should be analyzed for restoration potential, if needed. Reporting of this should include project description, feasibility, limitations and first approximation cost estimates. This type of work can be as simple as re-vegetating the creek with native plants, fencing reaches for livestock control, or allowing the creek access to a natural flood plain. It could also be expensive such as redesigning and constructing culverts at major road crossings.

6. A public education program on the Stream Ordinance is strongly recommended for unincorporated area residents. This may also include a survey of individual lots and communication with these owners.

7. The City of Sparks and the City of Reno should develop a Stream Ordinance policy and actively engage in a public education program. This is to help restrict development's encroachment upon creeks and the North Truckee Drain. It could also be used to bring these water features to the public's attention and thereby increase public support for access, enhancement and/or restoration.

8. A review of the City of Sparks stormwater discharge program to the drain and its effectiveness should be undertaken. The review should address stormwater effects on erosion

and sediment transport to the Truckee River. The surveys can be conducted at a very low cost. The cost of making improvements is unknown and could be expensive.

9. The City of Sparks and Washoe County should explore recreational development of the drain throughout its course in Spanish Springs. This could entail the same type of design the City of Sparks has done for the drain south of Shadow Lane. The design might actually increase the drain width, develop room for more flood plain, and increase native vegetation. This would provide wildlife habitat and result in a water feature that increases the quality of life to the City of Sparks community.

10. A White Top Eradication program is strongly recommended for the flood plain area of the South Truckee Meadows, generally east of US 395, Chalk Creek and the North Truckee Drain. Programs for eradication are available. Because this invasive plant is so wide spread, total eradication would be relatively expensive. Program elements would be:
    - mow in early spring
    - treat with appropriate herbicide such as 2,4,D
    - repeat 2 times a year for two to three years
    - revegetate with desirable plants

11. Restoration efforts on Jumbo Creek should be undertaken to eliminate erosion, restore the creek to its natural state and to create better flood protection.

12. Ranching operations are potential sources of nutrient (nitrogen and phosphate) loading to the Truckee River, particularly for Thomas, Evans and Sunrise Creeks. Proper land management practices should be used to alleviate this problem.

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APPENDICES

List of appendices contained in volume 2

APPENDIX 1
Stream Assessments

APPENDIX 2
Stream Chemistry