GIS Model for Assessment of Land Use and Urban Development Effects on Stormwater Runoff: Puhinui Catchment Case Study

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Abstract

As local authorities are becoming more interested in the assessment of pollutant loads, this study offers a Geographic Information System (GIS) model for assessing nonpoint source of pollution for two scenarios: the current and ultimate stage of urbanization.

The Puhinui Catchment, Manukau City, has been used as a case study in developing and testing this model. This catchment has all the attributes of a “typical” urban area and gives a good representation of the effects of land use on the receiving waters of Puhinui Stream and its estuary.

Annual mass contaminant loadings were calculated by firstly assessing the physical characteristics of the Puhinui catchment (case study catchment) and secondly describing the nature of stormwater quality and calculating the annual mass contaminant loadings.

GIS is used to multiply the annual runoff volume by a mean pollutant concentration to acquire an average annual pollutant load. The annual runoff volume is calculated from the drainage area, runoff coefficient and annual rainfall. To calculate the total mean pollutant load, the pollutant loads for all land use types within the catchment are summed and the process is applied for each pollutant.

This GIS model determines the connection of typical pollutant concentrations with land uses in the catchment and offers a characterisation of nonpoint source pollution in that catchment. This model can be used for:

- Identifying catchment areas that contribute considerably to the pollution of waterways
- Determining the appropriate treatment of the stormwater runoff for particular subcatchment
- Stormwater quality improvement prioritization and cost-benefit analysis
- Selecting locations for water-quality monitoring stations
- Improvement in maintenance practices
- Assessment of proposed development environmental effects

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Statement of originality

'I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgment is made in the acknowledgments.'

.... (signed)

.... (date)

Abbreviations

ADT	Average daily traffic
AGNSP	Agricultural Nonpoint Source Pollution
ANSWERS	Areal Nonpoint Source Watershed Environment Response Simulation
BASINS	Better Assessment Science Point and Nonpoint Sources
BMP	Best Management Practice
CREAMS	Chemicals Runoff and Erosion from Agricultural Management Systems
E.COLI	Escherichia coli
EPA	Environmental Protection Agency
EMC	Expected Mean Concentration
ERDAS	Earth Resources Data Analysis System
GIS	Geographic Information System
GLEAMS	Groundwater Loading Effects of Agricultural Management Systems
GRASS	Geographic Resources Analysis Support System
HSPF	Hydrologic Simulation Program-FORTRAN
NIWA	National Institute of Water and Atmospheric Research
PRZM	Pesticide Root Zone Model
SCS	Soil Conservation Service
SMP	Stormwater Management Policy
SLAMM	Source Loading and Management Model
STORM	Storage, Treatment, and Overflow Model
SW	Stormwater
SWAT	Soil Water and Assessment Tool
SWMM	Storm Water Management Model
TIN	Triangulated Irregular Network
USEPA	United States Environmental Protection Agency
VBA	Visual Basic for Applications
WW	Wastewater

1 Introduction

1.1 Background

Nonpoint source pollution originates from wide areas and the pollutant transport is highly variable. It can be depicted as pollution that is not associated with a specific location thus representing a unique challenge for control and abatement. Duda (1993) described nonpoint sources of pollution including agricultural activities, urban and industrial runoff, joint sewer overflows and leaks, hazardous waste dumpsites, septic tank systems, mining and forest harvesting activities, spills, atmospheric deposition, and hydrologic modifications. Schreier et al (1991) lists three major sources of nonpoint pollution:

- Urban: Atmospheric deposition (long range contaminant transport, local atmospheric input from industrial deposits), transportation (corrosive material, wear – tires and breaks, leakages – oil and grease, combustion products), gardening (fertilizer and pesticide applications), illegal dumping (oils, chemicals, paints) and accidental spills (industry, transport, household input to pervious and impervious surface and into streams)
- Rural: Atmospheric deposition (acid rain from urban and industrial areas), transportation (motorway traffic and spills), agriculture (excess nutrients from fertilizers and manure, pesticides, trace metals, sediments from soil erosion, microbial problems) and septic systems (excess nutrients, microbial problems)
- Forestry: Tree harvesting (sediments from soil erosion, nutrients leaching caused by removal of vegetation), road building (sediments from soil exposure and bank cuts), tree planting (nutrients from fertilizers, pesticides for weed and insect control) and fire fighting (fire retardants).

The Environmental Protection Agency (EPA 2003: www.epa.gov/owow/nps/qa.html) offers a very detailed description of nonpoint source pollution:

‘Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. These pollutants include:

Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;

Oil, grease, and toxic chemicals from urban runoff and energy production;

Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks;

Salt from irrigation practices and acid drainage from abandoned mines;

Bacteria and nutrients from livestock, pet wastes, and faulty septic systems;

Atmospheric deposition and hydromodification are also sources of nonpoint source pollution.' (EPA, 2003)

In recent years the relative impact of nonpoint sources of pollution in the overall range of pollutants has been reassessed (Saunders, 1996). It was stated in a national assessment prepared by the United States Environmental Protection Agency (USEPA, 1992) that there were four times more waters found to be polluted by agricultural activities than by municipal point source discharge.

The effects of nonpoint source pollutants on particular waters are different and may not always be fully or easily calculated and assessed. Nevertheless, these pollutants have damaging effects on water supplies, recreation, fisheries, and wildlife.

As the interest in the characterisation and assessment of pollutant loads is increasing amongst the local authorities, this study offers a reliable method of assessing nonpoint source of pollution in the Puhinui catchment, Manukau City, and it also provides a GIS model to calculate annual mass contaminant loadings.

Loading estimates predict the amount of various pollutants entering waterbodies. Loading represents the mass of pollutants delivered to a waterbody over a period of time eg kilograms per year. Catchment pollutant loadings can be estimated in a variety of ways: published loading values, runoff volume and typical concentrations, simple empirical model, published regression equations, site specific or modelled data, computerised model.

Annual loadings are useful as an input into water quality modelling or comparing with other inputs into the same system or with other systems. Spatial patterns of annual loadings offer differentiation between sites or subcatchments in pollutant loadings. They are useful for identification of specific sources and land uses of concern to water quality (Marsalek 1990).

Annual mass contaminant loadings in this study were calculated by first assessing the physical characteristics of the Puhinui catchment, then describing the nature of stormwater quality based on various land use types and finally calculating annual mass contaminant loadings in stormwater runoff using median contaminant concentrations typical for specific land use.

This project follows the basic guidelines set up in the Waitakere City Contaminant Loading Study developed by Babich and Lewis (2001).

1.2 Objectives

The main objectives of this study are:

- Identification and location of point sources of pollution in order to separate them from nonpoint sources of pollution in further analysis.
- Development of the digital database required by Geographic Information System (GIS) software and documentation on this database so other users can benefit from this effort.
- Customisation of the GIS software with development of GIS model for the needs of the annual contaminant mass loadings calculation.
- Development of the GIS model that can be easily adaptable to any changes in the data or geographical area with minor adjustments in programming scripts.
- Assessment of the nonpoint sources of specific pollutants within the Puhinui catchment (case study).
- Visualisation of the calculated results.

A method of nonpoint source pollution assessment and estimation of the annual mass contaminant loadings is developed using ArcInfo Geographic Information System (GIS) software. Geographic Information System serves as means of storing, manipulating and displaying the tremendous volumes of spatial data associated with nonpoint source pollutants. This method uses land use specific runoff factors and mean annual rainfall depths. The annual contaminant mass loading was calculated for each subcatchment in the Puhinui catchment area. This calculation was performed by multiplying the annual runoff volume for each land use by the typical median contaminant concentrations consequent for stormwater runoff. The annual contaminant mass loadings were calculated for two conditions: the current level of development and the ultimate level of development (fully developed stage as per Manukau City District Plan 2002). The District Plan was approved by Manukau City Council on 26th September 2002 and became operative on 21st October 2002. According to District Plan, land development is the process of modifying the land for changes in land use through site works and the construction of facilities and structures. It was projected that it would take twenty years to achieve the ultimate development as planned per District Plan. The ultimate level of development is achieved future, planned development as per District Plan.

This research indicates that the connection of typical pollutant concentrations with land uses in the catchment can present a characterisation of nonpoint source pollution in that catchment. The method presented in this research can be used to identify areas within the catchment that contribute significantly to nonpoint source pollution and to prioritise each subcatchment on the basis of the importance of its contaminant loading in stormwater runoff. This method is also useful in selecting locations for water quality sampling stations.

1.3 Study Area

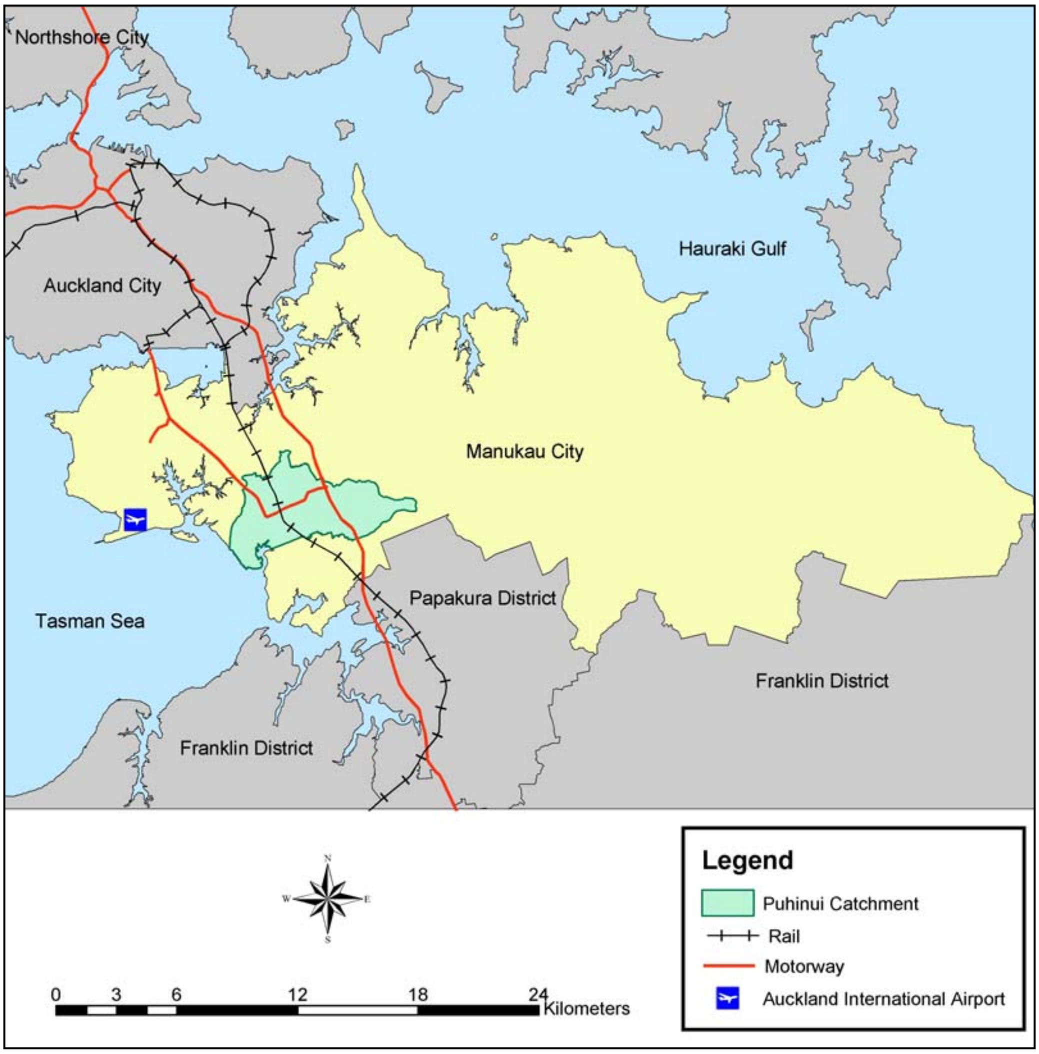
For this study the region of interest is Puhinui catchment located in Manukau City Council area, Auckland region. The catchment is approximately 2,525 hectares in size (25,246,436 square metres) and it has eight subcatchments: Fitzroy, Homai Stream, McLaughlin, P17, P18, Puhinui Coast, Puhinui Stream and Wiri Station subcatchments.

Table 1.3.1 shows the name of the catchments, their catchment numbers and area size, and Figure 1.3.1 represents the spatial distribution of the Puhinui catchment.

Table 1.3.1: Puhinui subcatchments

Subcatchment Name	Subcatchment Number	Area (hectares)
Fitzroy	595	114
Puhinui Stream	611	1624
P18	613	159
P17	627	110
Wiri Station	620	178
Homai Stream	599	162
McLaughlin	605	91
Puhinui Coast	612	87

Figure 1.3.1: Study Area – Puhinui catchment



Puhinui catchment includes one major waterway, Puhinui Stream that flows to the southwest into Manukau Harbour, Tasman Sea.

Topographically, the Puhinui Catchment is determined by particularly flat terrain in the western part of the catchment and hilly terrain in the eastern part of the catchment, away from the coast. Most of the catchment is used for industrial, commercial and residential purposes, with only one small piece of terrain in the western part and one larger part in the eastern part of the catchment used for rural purposes.

Geology of the Puhinui Catchment area is represented through three different group formations: Waitemata, Tauranga and Kerikeri.

Auckland International Airport is in the close proximity to the Puhinui Catchment and Manukau City Centre is within its boundaries.

The population of Puhinui catchment is around 26, 000 according to New Zealand Census 2001 data and its spatial distribution is as shown in Figure 1.3.2.

Figure 1.3.2: Puhinui Catchment Population Distribution

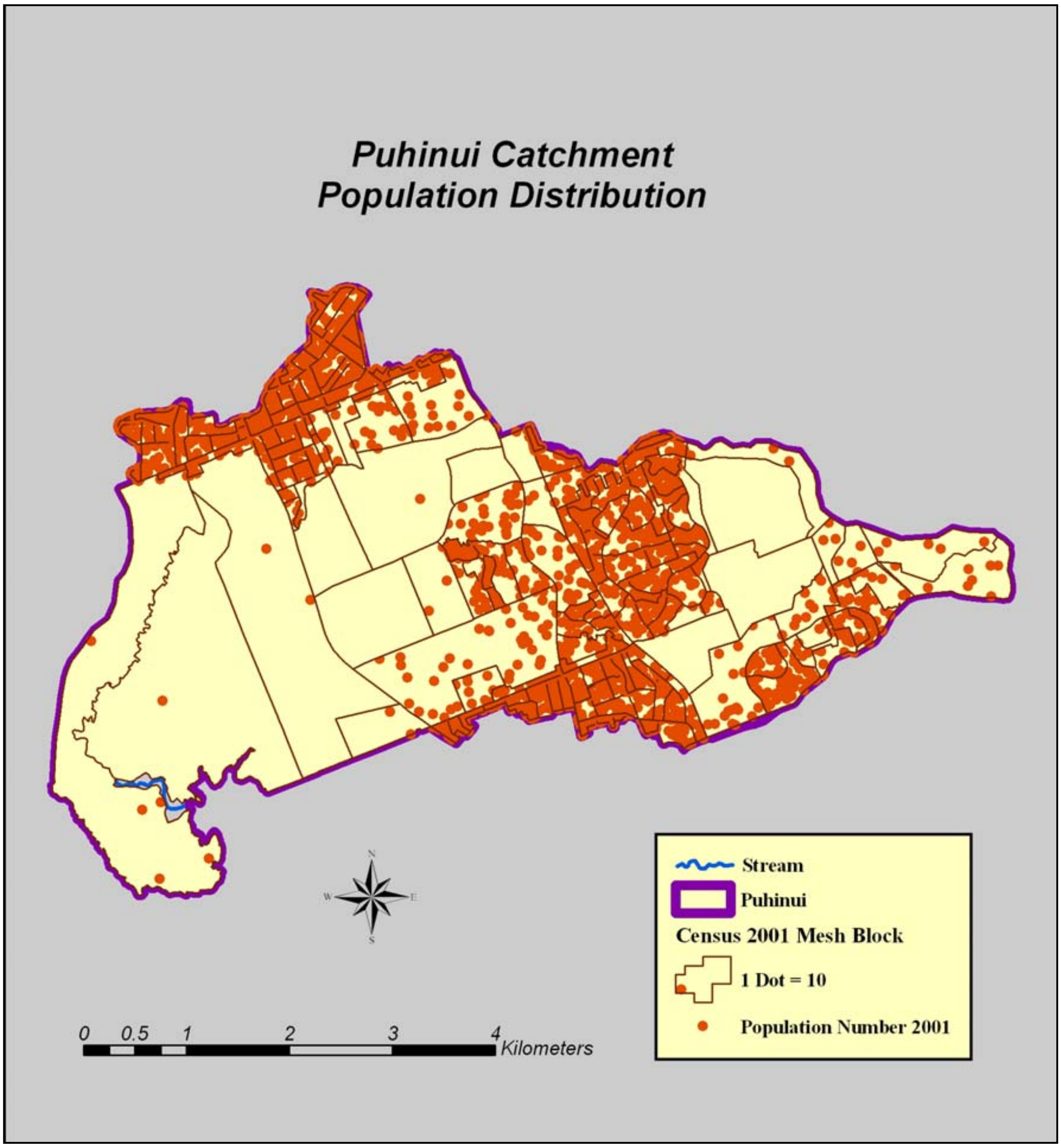


Figure 1.3.3 represents the aerial view of the Puhinui catchment and Figure 1.3.4 shows all the subcatchments in the Puhinui catchment.

Figure 1.3.3: Aerial image

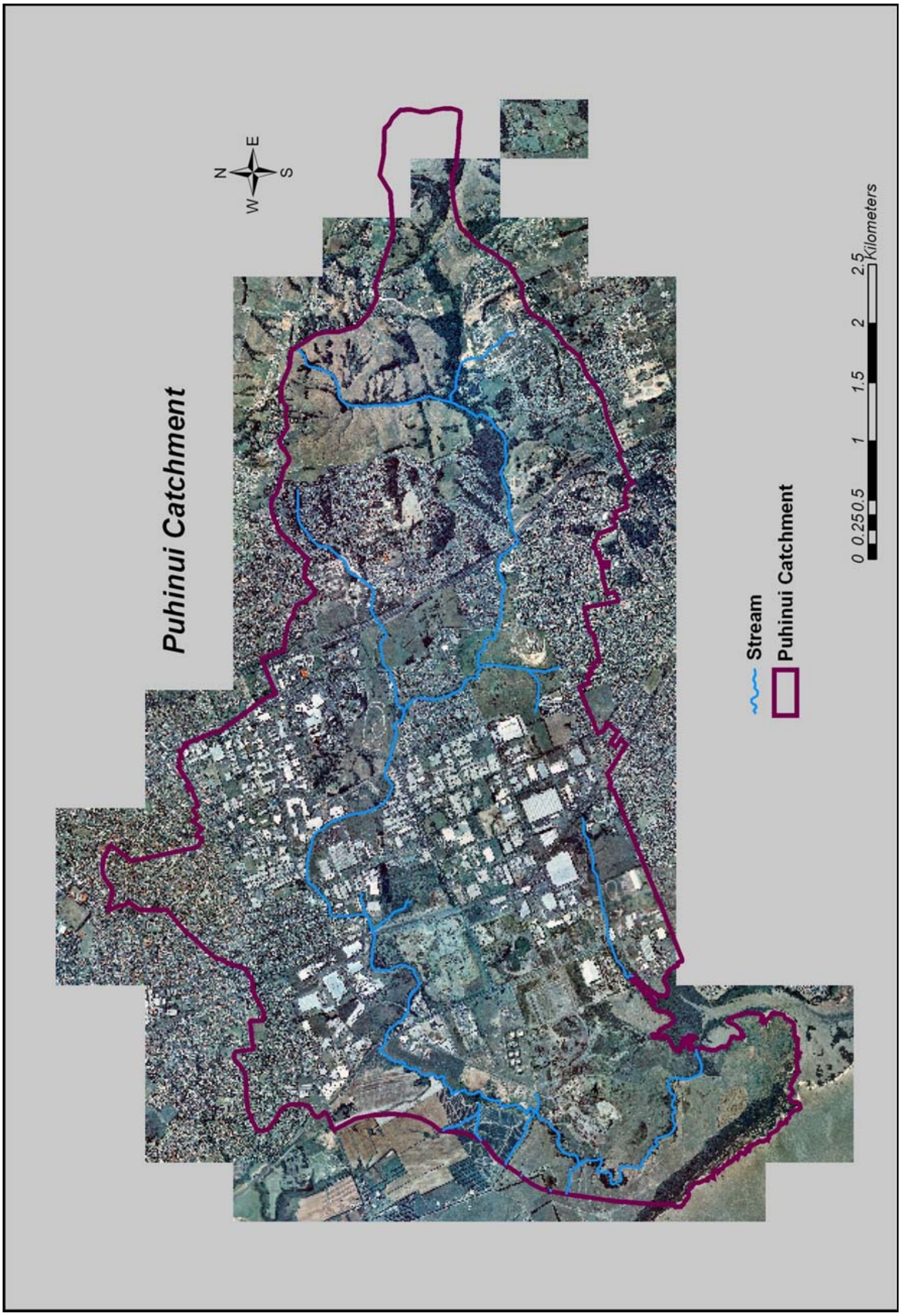
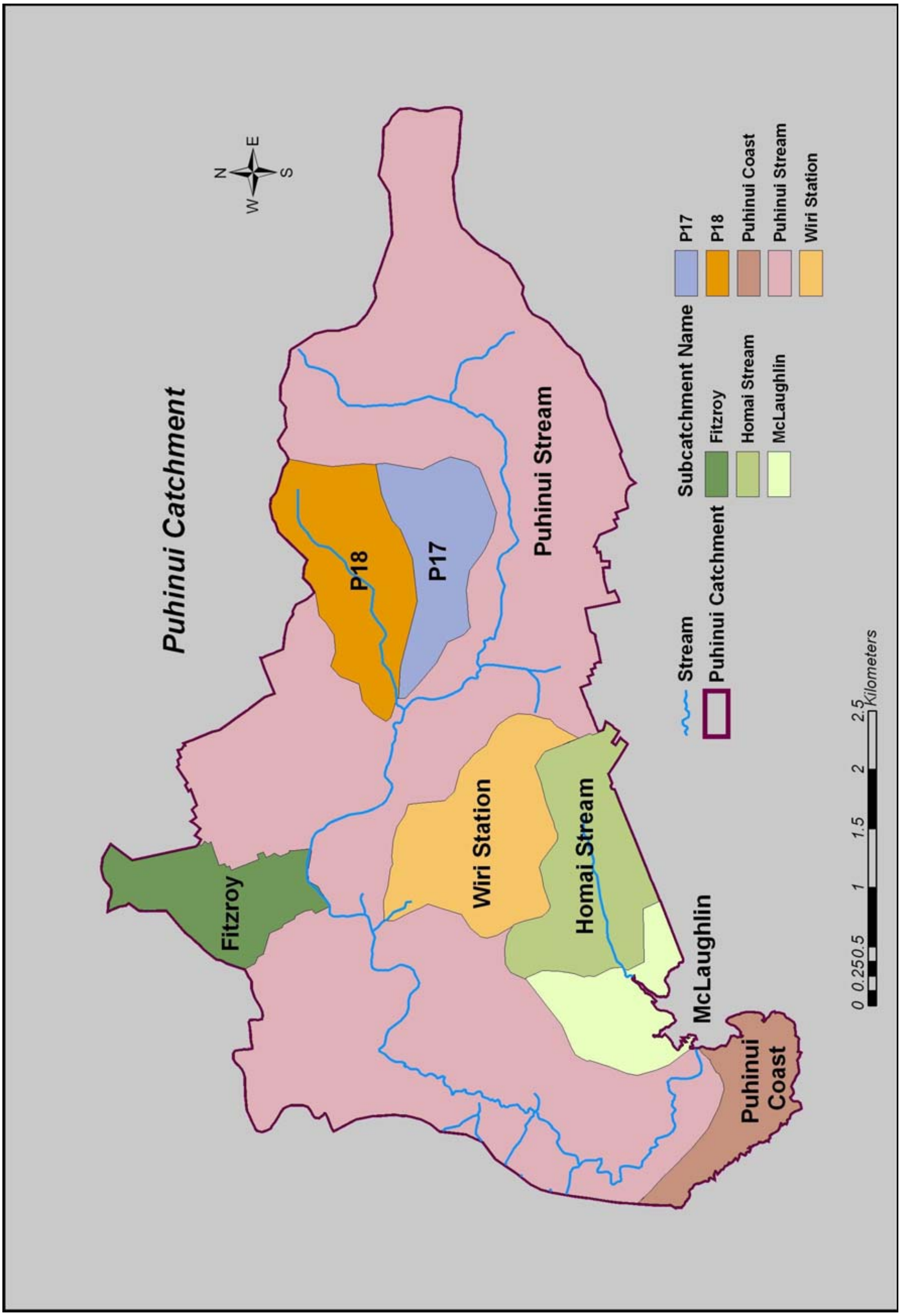


Figure 1.3.4: Puhinui subcatchments



1.4 Research Approach

The GIS software used for this study was ArcGIS ArcInfo 8.3 with Spatial Analyst and 3D Analyst extensions. ArcGIS system is an integrated geographic information system with high-level geographic data model for representation of spatial information. ArcGIS Desktop is made of 3 integrated applications: ArcMap, ArcCatalog and ArcToolbox. The ArcGIS Desktop can be accessed using three software products: ArcView, ArcEditor and ArcInfo (ESRI, 2001).

The methodology used to achieve the objectives of this study is partitioned as follows:

1. Establishment of the digital database.
2. Assessment of the physical characteristics of the Puhinui catchment in terms of the catchment area, aerial imagery, population distribution, elevation, land use types, imperviousness, road network and stormwater network.
3. Identification of point and nonpoint sources of pollution.
4. Assessment of stormwater quality by reviewing the available local and international literature associated with stormwater runoff quality data based on different land use types and stormwater contaminants. Expected Mean Concentration (EMC) values for a number of pollutants linked with the various land uses in the catchment were established.
5. Land use data aggregation for each subcatchment followed by intersection with impervious area data to be able to calculate impervious area for each land use type.
6. Acquiring of annual rainfall depth data and calculation of evapotranspiration/evaporation factors and runoff coefficients.
7. Calculation of annual runoff volume for each land use type.
8. Calculation of annual contaminant mass loadings for two conditions: the current level of development and the ultimate level of development, using annual runoff volume and Expected Mean Concentration (EMC) values.
9. Data visualisation and subcatchment results comparison.

The process developed here, although specific to the Puhinui catchment, could also be applied for similar nonpoint source pollution assessments in other geographic regions. For this study, only average annual loads and annually averaged concentrations have been considered and estimated. However, the GIS model can be easily adopted for calculation of average seasonal or average monthly loads and concentrations.

2 Literature review

Overseas, New Zealand and Auckland data was obtained through a literature review of stormwater runoff quality for different land use types.

Waitakere City Contaminant Loading Study (Babich and Lewis, 2001) was specifically used as a major source of median contaminant concentrations used to estimate pollutant loads in stormwater runoff.

Other literature reviews utilised the Auckland University of Technology and University of Auckland libraries, Manukau City Council and Auckland Regional Council technical libraries, United States Environmental Protection Agency website (www.epa.gov.com) and general Internet searches.

Recently, research and academic institutions, government bodies and consulting companies have been paying more attention to assessment of nonpoint sources of pollution. This caused quite a few methods to be developed to assess of nonpoint sources of pollution. Many methods are computer-based models and some have been linked with Geographic Information System (GIS). Computerisation, especially link with GIS, is extremely useful in organising and maintaining data management and automation and calculation of processing tasks.

This chapter reviews some of the nonpoint source models and some of the surface water quality models. Finally, a discussion is presented of stormwater contaminants and earlier studies that have taken place in the Puhinui catchment study area.

2.1 Nonpoint source pollution models

- AGNSP (Agricultural Nonpoint Source Pollution Model)

AGNPS was created by the United States Department of Agriculture-Agricultural research Service (Young et al 1986) as a tool of comparison of the effects of different watershed pollution control management practices. AGNSP model simulates sediment and nutrient loadings from agricultural catchments for single storm events or for continuos data input.

AGNSP is a very popular model and it has been used in various studies with other models and GIS. Evans and Miller (1998) combined ERDAS (Earth Resources Data Analysis System) with AGNPS and used an ERDAS algorithm called AGNPSIN to calculate average AGNPS cell values for land slope, curve number, channel slope, roughness coefficient, surface condition constant, soil texture, chemical oxygen demand and cropping factor.

The sensitivity of AGNPS to variations of Arc/Info grid-cell sizes was researched in Vieux and Needham (1993) study. By changing the Arc/Info grid-cell sizes it was established that simulated flow path lengths decreased with the increase of grid-cell sizes.

Mitchell et al (1993) combined Geographic Resources Analysis Support System (GRASS) with AGNPS to perform a validation of the model for small mild topography catchments. Using GRASS it was possible to obtain 22 input parameters for the AGNPS model from only for GIS layers.

Morse et al (1994) integrated AGNPS with Arc/Info and demonstrated that AGNPS input parameters could be efficiently processed and obtained through and interface with Arc/Info.

- ANSWERS (Areal Nonpoint Source Watershed Environment Response Simulation)

ANSWERS model was created by the Agricultural Engineering Department of Purdue University in the late 1960’s. This is an event-based, distributed parameter model for predicting the hydrologic and erosion response of agricultural watersheds. Primary model inputs are the rainfall hyetograph, antecedent soil moisture, and the soil and physical characteristics of each cell. Von Euw et al (1989) found ANSWERS to be very sensitive to rainfall input and infiltration variables for small events.

- BASINS2 (Better Assessment Science Point and Nonpoint Sources)

BASINS was developed by the Environmental Protection Agency (EPA). It is a GIS based program for analysis of catchments and water quality. The program is downloadable from the EPA Internet site (EPA, 1998): http://www.epa.gov/OST/BASINS. The program allows the user to define the catchment of interest, calculates nonpoint source loads in that catchment, analyse point source loads, houses national watershed data, and integrates environmental assessment models. The nonpoint source loads are calculated using the Nonpoint Source Model (NPSM) with the help of the HSPF model. The point and nonpoint source analysis is run within the BASINS program, which runs within the GIS environment.

- CREAMS (Chemicals Runoff and Erosion from Agricultural Management Systems)

CREAMS (Knisel, 1980) is physically based, field-scale model developed for making relative comparisons of pollutant loads from alternate management practices. This model is intended for use as a continuous simulation model but it can also be used as an event-oriented model. CREAMS estimates runoff volume, peak runoff, infiltration, soil moisture, percolation, sediment yield and particle-size.

- GLEAMS (Groundwater Loading Effects of Agricultural Management Systems)

GLEAMS model (Leonard et al, 1987) is similar to CREAMS and adds components to simulate the movement of water and chemicals within the crop root zone. GLEAMS does not consider movement between the root zone and the water table. Pesticide application can be partitioned between the soil and foliage and can be incorporated to any depth. Pesticide degradation rates can vary by soil zone. GLEAMS can simulate the transport of 10 chemicals simultaneously as well as their degradation products and multiple applications of pesticides are allowed each year.

- HSPF (Hydrologic Simulation Program-FORTRAN)

HSPF model (Johanson et al, 1981) is probably the most extensively used nonpoint source pollution model. It is a continuous, lumped watershed-scale model developed to simulate the movement of dissolved oxygen, organic matter, temperature, pesticides, nutrients, salts, bacteria, sediment and plankton from the land surface through streams, reservoirs, and groundwater. Both point and nonpoint source pollution can be simulated. This allows comparisons between the relative magnitudes of point and nonpoint source pollution during water quality planning. HSPF requires historical hydrologic records for calibration. The model's required calibration and lumped parameter approach makes it difficult to evaluate changing watershed conditions caused by Best Management Practice (BMP) implementation because the model is calibrated to existing conditions and it is difficult to modify parameters for future conditions

- PRZM (Pesticide Root Zone Model)

PRZM is a field-scale, continuous simulation model developed by the USEPA to simulate the effects of agricultural management practices on pesticide fate and transport. Its primary use is for pesticide registration testing.

- QUAL2E (Enhanced Stream Water Quality Model)

QUAL2E is maintained by the U.S. Environmental Protection Agency’s Centre for Exposure and Assessment Modelling (EPA, 1995). The model is solved for steady state conditions using computations for nutrient cycles, algal production, benthic and carbonaceous oxygen demand, atmospheric reaction, and their effect on the dissolved oxygen balance.

- SLAMM (Source Loading and Management Model)

SLAMM was originally developed to better understand the relationships between sources of urban runoff pollutants and runoff quality. It has been continually expanded since the late 1970s and now includes a broad selection of source area and outfall control practices (infiltration practices, wet detention ponds, porous pavement, street cleaning, catch basin cleaning, and grass swales). SLAMM is strongly based on actual field observations, with minimal reliance on pure theoretical processes that have not been adequately documented or confirmed in the field. SLAMM is mostly used as a planning tool, to better understand sources of urban runoff pollutants and their control. Many SLAMM users have integrated the use of the model with a GIS (Thum et al 1990; Kim et al 1993; Kim and Ventura 1993; Bachhuber 1996). The main reason SLAMM was developed was because of errors contained in many existing urban runoff models. These errors were obvious when comparing actual field measurements to the solutions obtained from model algorithms (Haubner and Joeres 1996).

✧ STORM (Storage, Treatment, Overflow, Runoff Model)

STORM was developed by the Corps of Engineers Hydrologic Engineering Centre (Abbott, 1997). It simulates the quantity and quality of runoff from small, primarily urban, watersheds, but rural areas can also be simulated. Modelled parameters include total and volatile suspended solids, biochemical oxygen demand, Nitrogen and Phosphorus. The model does not route surface runoff and runoff volumes can be highly inaccurate even with calibration. STORM considers storage and treatment of stormwater and can consider urban Best Management Practices (BMPs) such as sediment detention basins. STORM is a surface water quality model used for runoff simulations in an urban area. Hourly precipitation data is used along with runoff coefficients, which are estimated from handbooks and textbooks. Soil Conservation Service (SCS) parameters are available if soil information is known. Output includes storm event summaries of runoff volume, loads and concentrations in the receiving waters (Quenzer, 1998).

✧ SWAT (Soil Water and Assessment Tool)

SWAT was developed as an extension to the Simulator for Water Resources in Rural Basins at the Texas Water resource Institute in College station, Texas (Arnold et al, 1992). It is a continuous spatially distributed catchment model operating on a daily time step. SWAT simulates runoff, sediment, nutrient and pesticide movement through a catchment and helps in assessing water supplies and nonpoint source pollution in large basins.

- SWMM (Storm Water Management Model)

SWMM (Huber, 1993) is one of the most sophisticated and widely used models for urban stormwater management. SWMM is a continuous simulation, semi-distributed, watershed-scale (5 to 2000 hectares) model that simulates runoff quantity and quality from pervious and impervious areas, erosion, scour, sediment transport, dry weather flow and pollutant routing in sewers, stormwater storage and treatment, and receiving water quality. Loadings of pollutants other than sediment are generated from sediment yields using user supplied potency factors.

- WASP

The U.S. Environmental Protection Agency's Centre for Exposure and Assessment Modelling maintains the water quality modelling system WASP5 that is the generalised framework for contaminant fate and transport in surface waters (EPA, 1993). The modelling system is made up of three sub-models: TOXI5, EUTRO5 and DYNHYD5. The Toxic Chemical Model (TOXI5) predicts dissolved and sorbed chemical concentrations in the surface waters and the sediment. The Eutrophication Model (EUTRO5) predicts dissolved oxygen, carbonaceous biochemical oxygen demand, phytoplankton, carbon, chlorophyll-a, ammonia, nitrate, organic nitrogen, and ortho-phosphate in the surface water and the sediment. The Hydrodynamic Model (DYNHYD5) calculates the surface water's flow, volumes, velocities, and depths.

- WATERSHED

The point and nonpoint source loading model WATERSHED was developed by the US Environmental Protection Agency and the US Soil Conservation Service as an accounting system to manage water quality (Walker et al, 1989). The model contains a series of worksheets containing background information, such as basin name, area, and location, information about urban loads, rural non-cropland and cropland loads, information about the loads totals and information about the cost of load reduction programs and finally information about the cost effectiveness of the programs. Inputs are estimated equations or data from measurements. The loads are routed downstream using transmission losses.

✧ GIS MODELS FOR NPS POLLUTION

Geographic information system (GIS) is a difficult term to define because it represents the integration of many subject areas, and as a result of this there is no agreed upon definition of it.

Rhind (1988) defined GIS as a computer system for collecting, checking, integrating and analysing information related to the surface of the earth.

There are lots of others definitions of GIS. Some of them put the emphasis on the strong connection between manual and computer based methods of map analysis (Dickinson and Calkins 1988, Aronoff 1989, Star and Estes 1990), and others describe GIS as a tool for analysing data about the earth (Parker 1988, Dueker 1979, Cowen 1988, Smith and al 1987).

DeMers (1992) divides GIS description into four subsystems:

'1. A data input subsystem that collects and pre-processes spatial data from various sources

2. A data storage and retrieval subsystem that organises the spatial data in a manner that allows retrieval, updating and editing.

3. A data manipulation and analysis subsystem that perform tasks on the data, aggregates and disaggregates, estimates parameters and constraints, and performs modelling functions.

4. A reporting subsystem that displays all or part of the database in tabular, graphic or map form.' (DeMers, 1992)

GIS is widely used for a broad variety of land use planning purposes. For nonpoint source pollution control planning, they have been shown to be very effective in targeting and prioritising nonpoint source pollution control resources. GIS contains data layers such as: soils, land use, surface water, elevations, watershed boundaries, political boundaries, and locations of homes, livestock facilities and point sources. Additional data layers derived from the base data layers may include cell slope, slope length, length-slope factor, erodibility factor, soil loss tolerance factor, delivery ratio, water quality index and erosion index. GIS can be used in combination with existing hydrological models or on its own in assessment of nonpoint source pollution.

Most of the previously described nonpoint source models are not as widely used as GIS, some are mainly developed for agricultural modelling of nonpoint source pollutants (eg AGNPS, ANSWERS, CREAMS, GLEAMS and PRZM), some are calibrated to existing conditions and not easily modified (eg HSPF) and some are difficult to use, time consuming to calibrate or require additional software expenditure on top of the existing GIS software.

Saunders (1996) describes GIS assessment of NPS pollution in the San Antonio-Nueces Coastal Basin. This method makes use of publicly available elevation, stream network, rainfall, discharge, and land use data and uses a basin grid representation for the estimate of average annual pollutant loads. A digital grid replica of the basin stream network is first created, precipitation is then compared with historical discharge at five gauge locations in the basin and a mathematical relationship between rainfall and runoff is established. Literature-based pollutant Expected Mean Concentrations are associated with land uses. The products of these spatially distributed EMC's and the runoff in each digital basin grid cell are calculated and then summed in the downstream direction to establish spatially distributed grids of average annual pollutant loads in the basin. Finally, grids of nonpoint source pollutant concentrations are created by dividing the average annual pollutant load grids by a grid of total annual cumulative runoff.

Quenzer (1998) depicts GIS model of total constituent loadings and their impacts on receiving water quality for the Corpus Christi Bay system. The model functions are the same as Saunder's, but Quenzer applies the loads from the model to the receiving water to calculate the equilibrium concentrations in the bay system.

Both models proved the ability and importance of GIS in NPS pollution assessment and pointed out the high variability of pollutant Expected Mean Concentration values between land uses and the need for their further investigation.

In this project GIS is used as it serves as means of storing, manipulating and displaying the remarkable volumes of spatial data associated with nonpoint source pollutants. GIS software is present in almost all land information departments nowadays. The decision to develop GIS nonpoint source model in this project was influenced by the wide accessibility of GIS, its analytical capabilities, customisation options, excellent visualisation tools and the availability of spatial data already stored in GIS software.

2.2 Stormwater contaminants

Stormwater runoff contains various pollutants that are produced through the activities in different residential, commercial, industrial and other land use types within a catchment. Runoff pollution occurs every time water flows across the ground and picks up contaminants.

The stormwater pollution problem has two main components: the increased volume and speed of surface runoff and the concentration of pollutants in the runoff. Both components are directly related to development in urban and urbanizing areas. Together, these components cause changes in hydrology and water quality that result in a variety of problems including habitat loss, increased flooding, decreased aquatic biological variety, and increased sedimentation and erosion, as well as affects on the health, economy, and social well-being (USEPA, 1997).

Although all land uses can affect water quality, in undeveloped areas natural processes can lessen the impact of contaminants or even remove contaminants from runoff through infiltration and evaporation (Minnesota Pollution Control Agency, 2000). Impervious areas reduce the opportunity for natural processes to treat stormwater and that is why stormwater runoff must be adequately controlled and treated to reduce pollutants before it is discharged into surface water, groundwater or wetlands (Schueler, 1994).

Table 2.2.1 shows the most common stormwater pollutant, their sources and impacts (Babich and Lewis, 2001).

Table 2.2.1: Stormwater Pollutants

Stormwater Pollutant	**Sources**	**Impacts**
Nutrients: nitrogen, phosphorus	Animal waste, fertilizers, failing septic systems	Algal growth, reduced clarity and other problems associated with eutrophication
Sediments: suspended and deposited	Construction sites, eroding banks, road sanding, plant litter	Reduced clarity, increased turbidity, deposition of sediments, smothering of aquatic habitat
Organic materials	Leaves, grass clippings	Oxygen deficit in receiving water body

Pathogens: bacteria, viruses	Animal waste, failing septic system	Human health risk through drinking water, contaminated swimming beaches
Hydrocarbons: oil and grease, PAHs	Industrial processes, vehicle wear, emission and fluid leaks, waste oil	Toxicity of water column and sediment, bioaccumulation in aquatic species and through food chain
Metals: lead, copper, zinc and others	Industrial processes, vehicle breaks and tires wear, emission and fluid leaks, metal roofs	Toxicity of water column and sediment, bioaccumulation in aquatic species and through food chain, fish kill
Pesticides	Industrial processes, pesticides	Toxicity of water column and sediment, bioaccumulation in aquatic species and through food chain, fish kill
Chlorides	Road salting and uncovered salt storage	Toxicity of water and sediment
Trash and debris	Litter from storm drainage	Threat to wildlife, degradation of the look of surface waters

2.3 Earlier Studies in Puhinui Catchment

Puhinui Stream Upper Catchment Improvement Scheme (GHD, 2001) study addresses the stormwater quality issues in the Upper Puhinui catchment, proposing management response via two stormwater quality ponds and improvements of the exiting culverts.

McLaughlin's Catchment Comprehensive Catchment Discharge Consent Application (Harrison Grierson Consultants, 2001) is an assessment of McLaughlin's catchment, which is one of the subcatchments of the Puhinui catchment.

The Wiri Pond 15 Upgrade Report on Infrastructure Auckland (GHD, 2001) study assesses treatment effects of the land use on the Puhinui stream regarding upgrade of the Wiri pond located in the middle part of the Wiri catchment, another subcatchment of the Puhinui catchment.

Resource Consent Application to the Auckland Regional Council and Manukau City Council (GHD, 2001) is a report on upgrading of Puhinui stream - Wiri Pond 15.

Puhinui Upper Catchment Improvement Scheme (Manukau Consultants, 1999) is an initial study for Puhinui upper catchment improvement scheme.

The study 'Interactions of Copper, Lead and Zinc with Stormwater-impacted Sediment in the Puhinui Stream, Manukau City, New Zealand' (Gaw, 1997) investigated the particle size distribution of the suspended sediment and the interactions of copper, lead and zinc with suspended and deposited sediment samples in the Puhinui Stream. The study showed that large quantities of fine sediment were collected in the stream during rainfall events.

Puhinui Stream Catchment Study (Oldfield, 1992) focuses on flooding issues within middle and lower Puhinui catchment.

Puhinui Stream Management Plan (Oldfield, 1992) sets the response management for the issues identified in the Puhinui Stream Catchment Study.

Homai Stream Comprehensive Drainage Scheme (Beca Carter Hollings and Ferner, 1977) is a study that supports Comprehensive Catchment Discharge Consent and its focus is mainly on flooding issues.

3 Data Description

This study uses raster, vector and triangulated irregular network (TIN) data sets to describe the landscape and perform analysis. Vector model represents the world with points, lines and polygons. This model is specifically useful for representing features such as parcels, pipes, buildings, water outlet points and similar. Arc Info stores vector data as features in feature classes and collection of feature classes. Raster model represents the world as a surface divided into a regular grid of cells. This model is useful for representing the data that varies continuously. Aerial images, satellite images, density surfaces are examples of geographic information in raster format. The TIN model represents the world as a network of linked triangles that are drawn between irregularly spaced points with x, y, and z values. TINs are useful to represent and analyse surface data (Booth, 1999).

Vector data layers can be converted into raster data layers and vice versa relying on the conventions that a point may be represented as a single grid cell, a line may be represented as a string of grid cells, and a polygon may be represented as a zone of cells.

ArcInfo contains the tools for format conversion working on raster, vector and TIN data sets (Zeiler 1999).

This chapter describes data sets formats, map projections, the databases needed for the study, as well as the location of the data source. To distinguish data set names from the rest of the text, they were formatted italics.

3.1 Map Projection

ArcInfo stores data using x, y coordinates that are linked to real world locations by a coordinate system. The coordinate system specifies a datum and a map projection (Booth and Mitchell, 2001). Arc Info allows different data sets to be viewed together as long as they have a common datum, map projection and coordinate system.

A datum is a mathematical representation of the shape of the earth’s surface and is defined by a spheroid. A horizontal datum defines the position of the spheroid relative to the centre of the earth providing a frame of reference for measuring locations on the surface of the earth. A datum defines the origin and orientation of latitude and longitude lines and a local datum aligns its spheroid to fit the earth's surface in a particular area (Kennedy and Kopp, 2000).

Horizontal Datum used for spatial data sets in this project is New Zealand Geodetic Datum 1949.

The earth has been surveyed many times to help us better understand its surface features and their peculiar irregularities. The surveys have resulted in many spheroids that represent the earth. Generally, a spheroid is chosen to fit one country or a particular area. A spheroid that best fits one region is not necessarily the same one that fits another region (http://campus.esri.com/courses/projcoord/basics_prj). New Zealand Geodetic Datum 1949 is based on International (Hayford) Spheroid 1924.

A geographic coordinate system uses a three-dimensional spherical surface to define locations on the earth. Geographic coordinate system used for spatial data sets in this project is GCS New Zealand 1949. A projected coordinate system is defined on a flat, two-dimensional surface. A projected coordinate system is always based on a geographic coordinate system that is based on a spheroid. Projected coordinate system used for spatial data sets in this project is New Zealand Map Grid 1949.

Most of the data sets used for analysis in this study originate from Land Information Services, Manukau City Council with above stated map projections, so all the rest of the data sets, either acquired from other sources or created during the analysis process, were converted to the same projection. Arc Toolbox – Arc Info offers Projections Data Management Tools that help in defining a geodataset's coordinate system information if it is missing, modifying a geodataset's existing coordinate system information, and converting a geodataset from one coordinate system into a different coordinate system.

The map units of all data sets used in this study were set to metres and the display map units were set to kilometres.

3.2 Establishing a Digital Database

The establishment of a catchment digital database involves the assembly of the data that is used for each of the steps of the assessment of the nonpoint source pollution and calculation of contaminant annual mass loading.

Geodatabases are a new vector data model introduced with ArcGIS (Esri, 2001). Geodatabases are relational databases that contain geographic information organised into a hierarchy of data objects stored in feature classes, tables, and feature datasets.

There are two types of geodatabases: multi-user geodatabases and single-user personal geodatabases. ArcCatalog allows us to view, manage, and create personal geodatabases and ArcMap is used for display and editing of personal geodatabases. ArcToolbox contains tools for converting other data formats to geodatabases.

There are two basic types of geodatabases: personal geodatabases and multi-user geodatabases.

A personal geodatabase is stored in a Microsoft .mdb file (a format used by Microsoft Access) and is appropriate for personal or small workgroup use.

A multiuser geodatabase resides on a server and these databases require a system administrator for permissions, tuning, and optimisation (Booth et al, 2002).

In this study a personal geodatabase was created containing data for the whole Puhinui catchment and personal geodatabases for each subcatchment. Raster data sets were not part of the personal geodatabases as ArcSDE geodatabases are needed in case of importing raster data sets into a geodatabase.

3.3 Vector data

Original vector data obtained for this study comes from the Land Information Services geodatabase, Manukau City Council (MCC).

Table 3.3.1 summarises the original vector data description and origin, while Table 3.3.2 summarises the vector data description after editing and the data destination.

Table 3.3.1: Original vector data

Name	Type	Source
Urban Contour	Polyline Shapefile	Land Information Services, MCC
Rural Contour	Polyline Shapefile	Land Information Services, MCC
SW Impervious	Polygon Shapefile	Land Information Services, MCC
SW Line	Polyline Shapefile	Land Information Services, MCC
SW Point	Point Shapefile	Land Information Services, MCC
SW Catchment	Polygon Shapefile	Land Information Services, MCC
SW Subcatchments	Polygon Shapefile	Land Information Services, MCC
Parcel Polygon	Polygon Shapefile	Land Information Services, MCC
District Plan Zone Poly	Polygon Shapefile	Land Information Services, MCC
Mesh Block 2001	Polygon Shapefile	Land Information Services, MCC
Road	Polyline Shapefile	Land Information Services, MCC
SW Point	Point Shapefile	Land Information Services, MCC
SW Point	Point Shapefile	Land Information Services, MCC
Stream	Polyline Shapefile	Land Information Services, MCC
House	Point Shapefile	Land Information Services, MCC

Table 3.3.2: Edited vector data

Name	New Name After Editing	Data Type	Geometry Type	Destination
Urban Contour	Contour2m	Personal Geodatabase Feature Class	Line	Puhinui geodatabase
Rural Contour	Contour5m	Personal Geodatabase Feature Class	Line	Puhinui geodatabase
SW Impervious	Puhinui Impervious	Personal Geodatabase Feature Class	Polygon	Puhinui geodatabase
SW Line	SW Line	Personal Geodatabase Feature Class	Line	Puhinui geodatabase

SW Point	SW Point	Personal Geodatabase Feature Class	Point	Puhinui geodatabase
SW Catchment	Puhinui Catchment	Personal Geodatabase Feature Class	Polygon	Puhinui geodatabase
SW Subcatchments	Puhinui Subcatchment	Personal Geodatabase Feature Class	Polygon	Puhinui geodatabase
Parcel Polygon	Puhinui Parcel	Personal Geodatabase Feature Class	Polygon	Puhinui geodatabase
District Plan Zone Poly	Puhinui Land Use	Personal Geodatabase Feature Class	Polygon	Puhinui geodatabase
Mesh Block 2001	Population Number	Personal Geodatabase Feature Class	Polygon	Puhinui geodatabase
Road	Puhinui Road	Personal Geodatabase Feature Class	Line	Puhinui geodatabase
SW Point	Outlets	Personal Geodatabase Feature Class	Point	Puhinui geodatabase
SW Point	Inlets	Personal Geodatabase Feature Class	Point	Puhinui geodatabase
Stream	Puhinui Stream	Personal Geodatabase Feature Class	Line	Puhinui geodatabase
House	House	Personal Geodatabase Feature Class	Point	Puhinui geodatabase

SW Catchment shape file contains all stormwater catchments in Manukau City Council region. Using *Select by Attribute* function in ArcMap - ArcInfo, *Puhinui Catchment* with its subcatchments was selected and exported as *Puhinui Catchment* shapefile. *Puhinui Catchment* shapefile was used to clip the rest of the shapefiles to fit the study area.

District Plan Zone Poly shapefile was edited and a new field named *Land_use* was created. Following the guidelines in the Manukau City Operative District Plan 2002 (http://www.manukau.govt.nz/tec/district/chap.htm) and codes from ZONE field in the *District Plan Zone Poly* shapefile, the new field, *Land_use*, was populated and data exported as *Puhinui Land Use* shapefile. Commercial land use has been assumed to match the following zones specified in the Manukau City Operative District Plan:

Business 1 (Local Shops) Zone, Business 2 (Suburban Centres) Zone, Business 3 (City Centre) Zone, Business 4 (Periphery) Zone and Designated Business 1, 2, 3 and 4 zones. Industry land use has been assumed to match the following District Plan zones: Business 5 (Mixed) Zone, Business 6 (Industry) Zone and Designated Business 5 and 6 Zones. Residential land use has been assumed to match Main and Heritage Residential Zones and Designated Residential Zones. Open Space land use has been assumed to match Public Open Space Zones (1 to 5) and Designated Public Open Space Zones. Road land use has been assumed to match Primary Road, Non Primary Road, Rail and Designated Road Zones. Rural land use has been assumed to match Rural Zones (1 to 4), Mangere Puhinui Rural Zone and Designated Rural Zones.

Land use classes in Puhinui catchment are as presented in Table 3.3.3.

Table 3.3.3: Land Use Classes

Puhinui Catchment Land Use Classes	
Commercial	Residential
Flood Management	Road
Industry	Rural
Quarry Zone	Stream
Surface of Rivers	Water
Open Space	

After careful observation of SW *Impervious* shapefile by comparing the shapefile and aerial image it was clear that it needed updating as Puhinui catchment area is developing fast and the most recently built subdivisions were not included in the existing *Impervious* data set. New records were added by digitising over an aerial image and newly updated file exported as *Puhinui Impervious* shapefile.

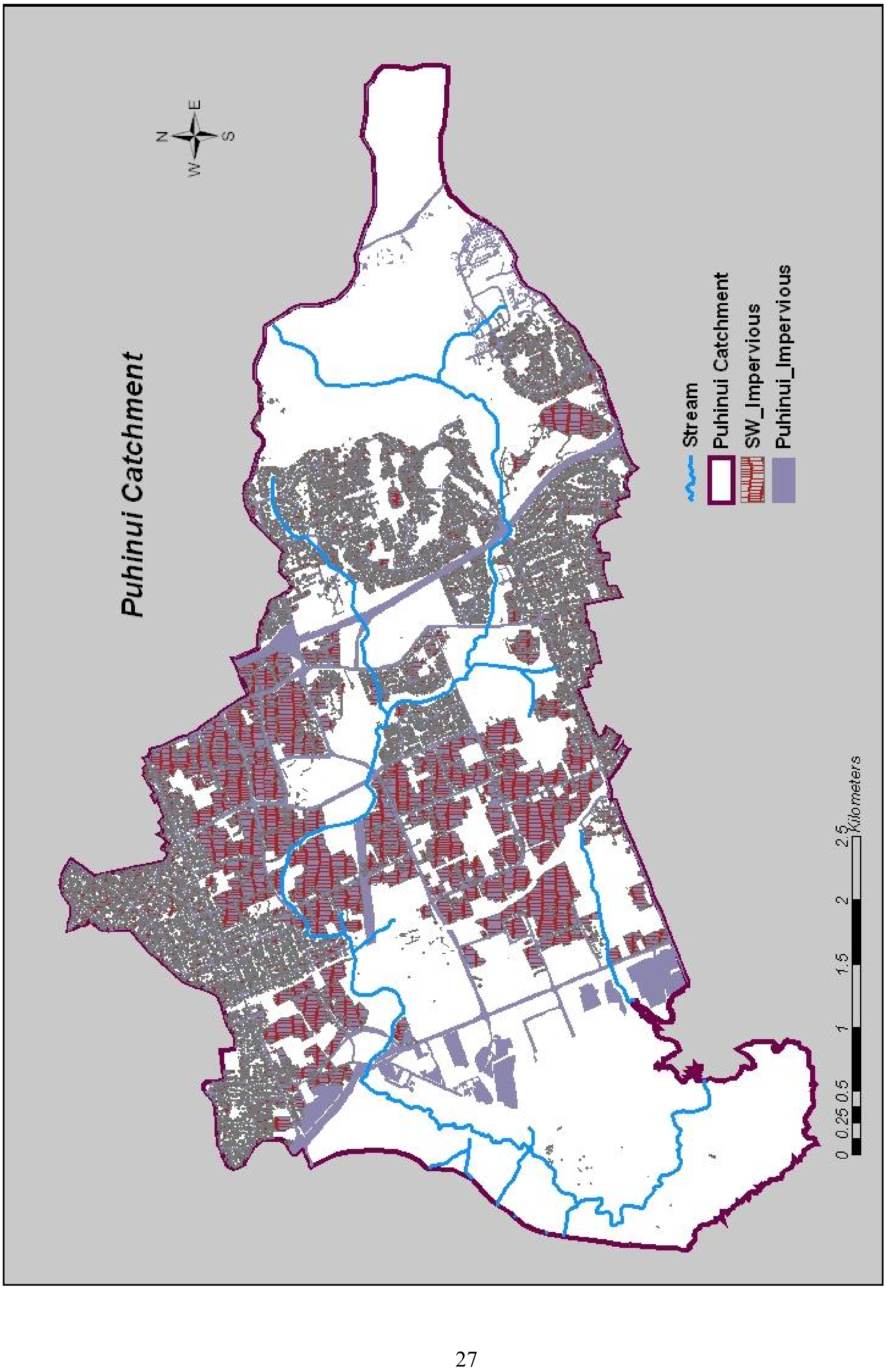
Figure 3.4.1 represents two layers: original *SW Impervious* and edited and updated *Puhinui Impervious* layer.

Using *Select by Attribute* function, *Outlets* and *Inlets* were selected from *SW Point* shapefile and exported as new shapefiles. Finally newly created shapefiles were imported into Puhinui personal geodatabase using ArcToolbox – ArcInfo.

3.4 TIN

A TIN was created for Puhinui catchment area using contour data (containing elevation attributes) and *WW lid heights* data (containing wastewater lid's heights) to demonstrate the catchment elevation as shown in Figure 4.2.1.

Figure 3.4.1: Puhinui Impervious Area



3.5 Raster Data

Original raster data obtained for this study comes from the Land Information Services geodatabase, Manukau City Council (MCC). Aerial images in JPEG format covering Puhinui catchment area were obtained. To be able to access images as one image theme, an image catalog was created. An image catalog is an organized collection of spatially referenced geographic images that can be accessed as one logical image theme. Image catalogs normally contain images that portray the same thematic information for a given geographic area of interest.

When creating an image catalog the first step is to find the spatial extent of each image. The spatial extent of an image is the x, y coordinate of the top left corner of the top left pixel in the image, and the x, y coordinate of the bottom right corner of the bottom right pixel in the image. This information can be found in Layer Properties when the image is added to the map document. A new table with five fields named IMAGE, XMIN, YMIN, XMAX, and YMAX was created in ArcMap.

The values of the spatial extent were added to XMIN, YMIN, XMAX, and YMAX fields, and the image full pathname in the IMAGE field. The table is saved as a dBase file and named *Puhinui_orthophoto*.

3.6 Attribute Table Data

Hazard Industries and *Wastewater lid heights* data was obtained in Excel table format. Table 3.6.1 summarises attribute table data description, origin and destination.

Table 3.6.1: Attribute Table Data

Name	Type	Source	New Name After Editing	Type After Editing	Destination
Hazard Industries	Excel spreadsheet	Manukau City Council	Puhinui Hazard Industries	Point Shapefile	Puhinui geodatabase
			Hazard Density	Raster dataset	Puhinui folder
WW lid heights	Excel spreadsheet	Manukau Water	Lid Heights	Point Shapefile	Puhinui geodatabase

Wastewater lid heights data was first converted from an Excel worksheet to dBase format. As it contained x, y coordinates, it was easy to add it to ArcMap using *Add XY Data* function. Finally, it was exported to Puhinui geodatabase with *Lid Heights* name.

Hazard Industries did not contain x, y coordinates so, in order to display these locations on a map and perform analyses with them, a computer had to be given geometric representations (such as point features) of these locations.

Geocoding (also known as address matching) is the process of creating geometric representations for descriptions of locations. A geocoding service defines a process for converting nonspatial descriptions of places into spatial descriptions (Minami et al, 1999)

The first step was to create a new geocoding service in ArcCatalog, and to specify the data that the geocoding service will use to determine the locations of addresses and all of the options for the geocoding service. The data used for determination of addresses was *House* shapefile as it contained the street address, street number and suburb data.

After creating geocoding services in ArcCatalog, ArcMap was used to find addresses and to geocode tables of addresses. The result was *Puhinui Hazard Industries* point shapefile that was exported to Puhinui geodatabase.

Puhinui Hazard Industries file was used to calculate density surface to be able to show where point features were concentrated. By calculating density point values were spread out over a surface. The magnitude at each sample location is distributed throughout a landscape, and a density value is calculated for each cell in the output raster (McCoy and Johnston, 2002)

Density maps are mostly created from point data, and a circular search area is applied to each cell in the output raster being created. The search area establishes the distance to search for points in order to calculate a density value for each cell in the output raster.

The hazard density map was created using Spatial Analyst Density function.

3.7 Median Contaminant Concentrations

Table 3.7.1 summarises the median contaminant concentrations present in stormwater runoff applied to the assortment of land use types found in Puhinui Catchment. Median contaminant concentration data is obtained from Waitakere City Contaminant Loading Study (Babich and Lewis, 2001). Stormwater runoff quality data published in this study was based on wide literature research and it was obtained from various studies published between 1978 and 2000. Waitakere City Contaminant Loading Study did not contain data for the Quarry land use type so this data was obtained from Auckland Regional Council and literature research (Strager et la, 2000). The only available data for quarry land use type from Auckland Regional Council was Total Suspended Solids and it originates from the monitored data in McLaughlin Quarry, Puhinui Catchment. Roads' median contaminant concentration values have been calculated under four different traffic density categories: less than 1500 average daily traffic (ADT), 1500-5000 ADT, 5000-10000 ADT and more than 10000 ADT.

Table 3.7.1: Stormwater Runoff Median Contaminant Concentrations (Babich and Lewis, 2001)

	Land Use Types						
Median Concentration (g/m^3)	Residential	Commercial	Open Space	Industry	Rural	Road	Quarry
Total Suspended Solids	178	55.6	48	138	95	114	28.6
Biochemical Oxygen Demand	8	8.7	4.35	12.9	5.4	8.9	12.9
Total Phosphorus	0.39	0.28	0.28	0.509	0.255	0.255	0.1
Total Copper	0.04	0.05	0.006	0.053	0.003	0.041	0.053
Total Lead	0.18	0.155	0.003	0.226	0.015	0.04	0.226
Total Zinc	0.273	0.278	0.011	1.23	0.054	0.199	1.23
Total Kjeldahl Nitrogen	1.96	2.45	0.895	1.75	1.9	1.67	3.9
Total Petroleum Hydrocarbons	2.03	1.41	1	5	1	10	5

3.8 Mean Annual Rainfall Depths

Rainfall data was obtained from NIWA based on the daily rainfall data (from January the 1st 1990 to December 31st 2002). The measuring station where the data originates from is at the Auckland Airport, Manukau City. Calculated mean annual rainfall depth is 1127 mm (1.127 m). It should be noted that there is no long term annual rainfall data record for Puhinui Catchment. Auckland Airport rainfall data can be used for any catchment analysis in this area as all Manukau City is located in one climatic zone.

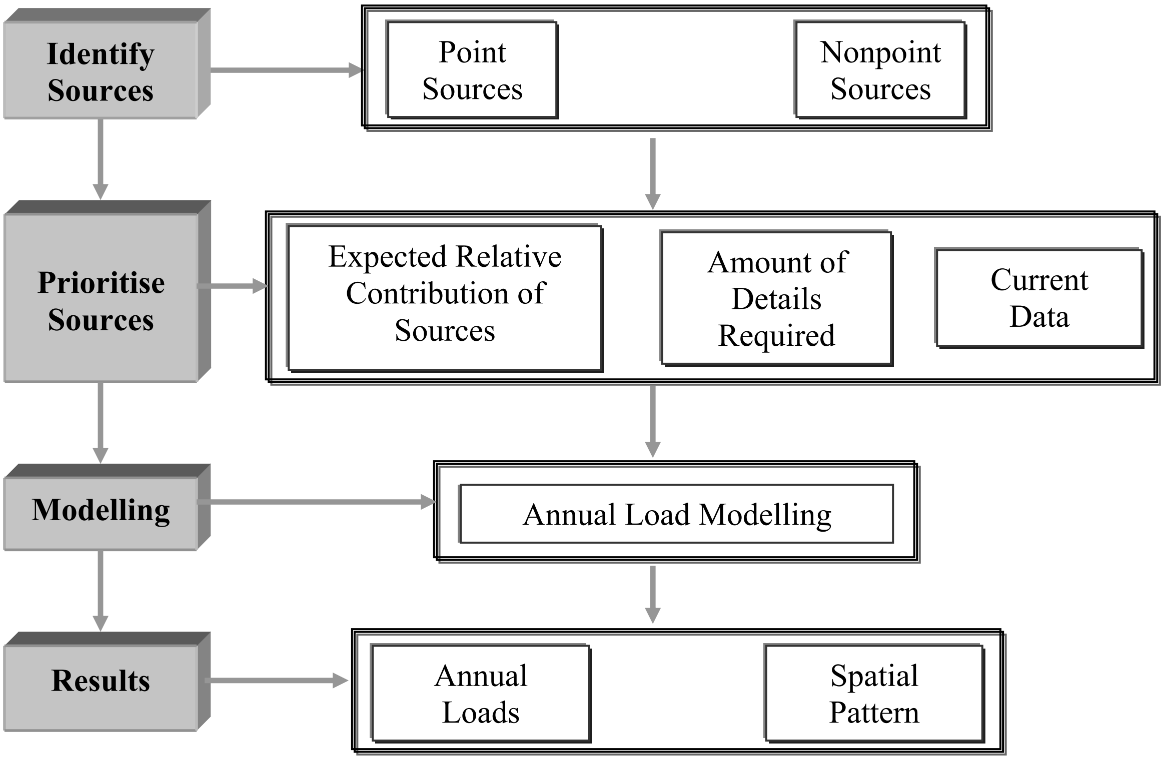
3.9 Mean Evapotranspiration

The mean annual evapotranspitration was taken as 964 mm (0.964 m) according to the estimate provided by the NZ Meteorological Service for the Auckland region.

4 Methodology

The methodology is discussed in three sections. The first section covers the identification of point and nonpoint sources of pollution, the second covers the prioritisation of sources, and the third covers the annual mass loads modelling. The next chapter will discuss the results. Overview of loading estimation is represented in Figure 4.1.

Figure 4.1: Overview of loading estimation



4.1 Identification of point and nonpoint sources

4.1.1. Identification and location of point sources of pollution

Point sources of pollution allow pollutants to enter waterbodies at one point. Industry, oil spills and grease play a major role in point source pollution. Industrial wastewater and discharges include oils, greases, metals and chemicals. Spilled grease, oil, and other hazardous substances from overturned trucks and leaking cars have a major impact by eventually running into rivers. Locations of industrial operations were identified using a Manukau City Council database and georeferenced using georeferencing service in ArcCatalog. There were 109 industrial operations identified in the Puhinui catchment and Figure 4.1.1 shows the location of the Puhinui hazard industries and Figure 4.1.2 represents the density of the Puhinui hazard industries.

Figure 4.1.1: Location of Puhinui Hazard Industries

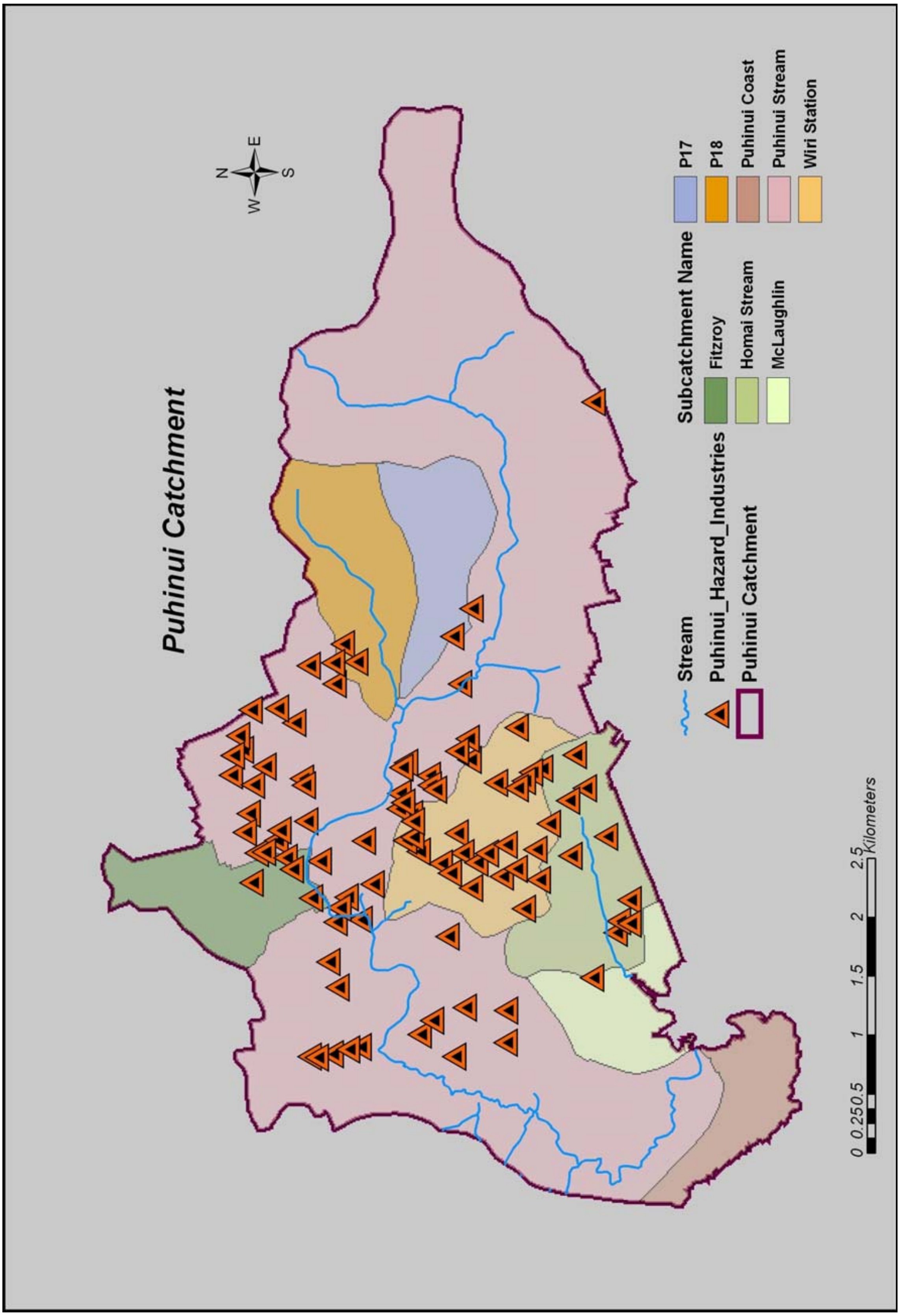
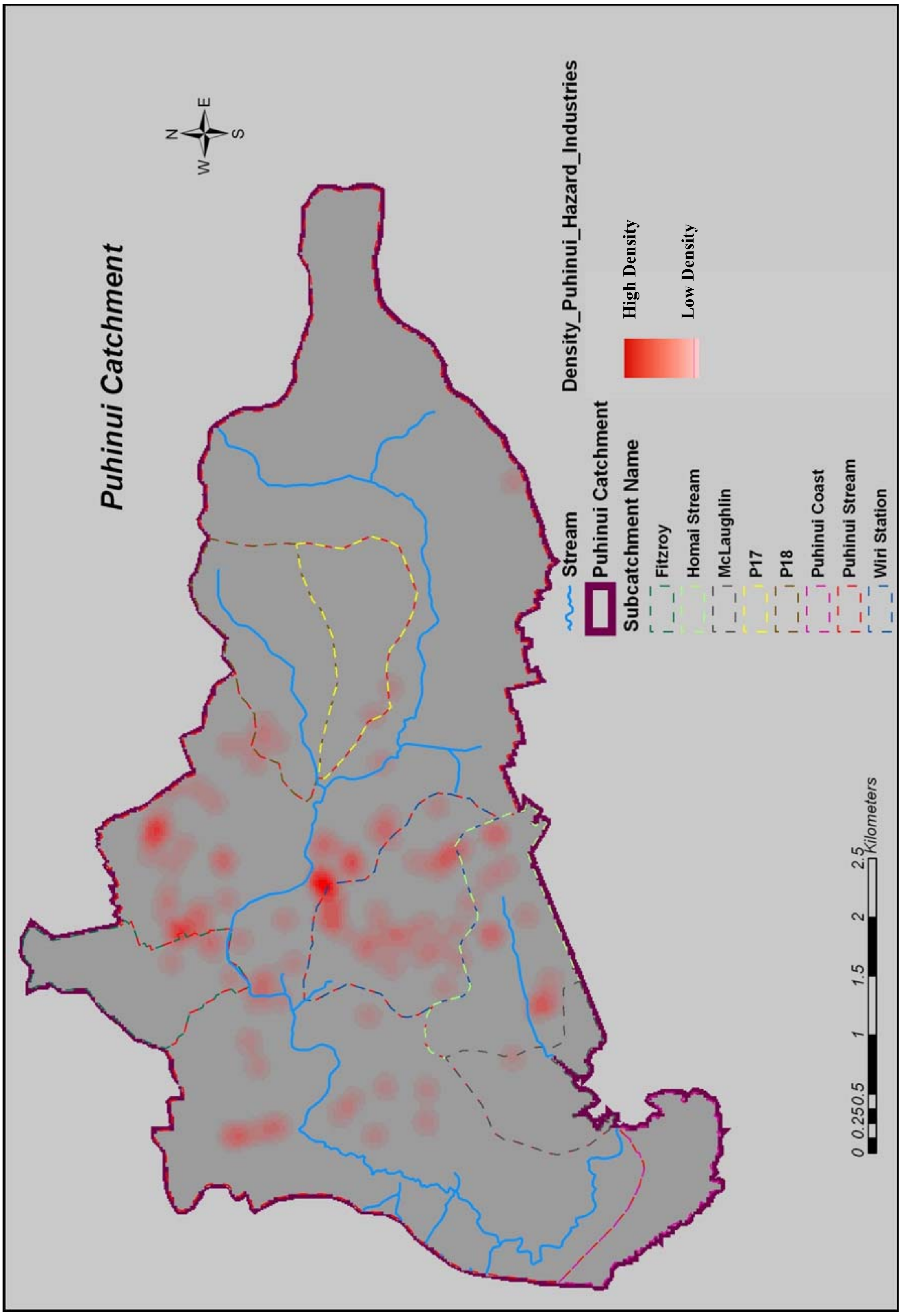


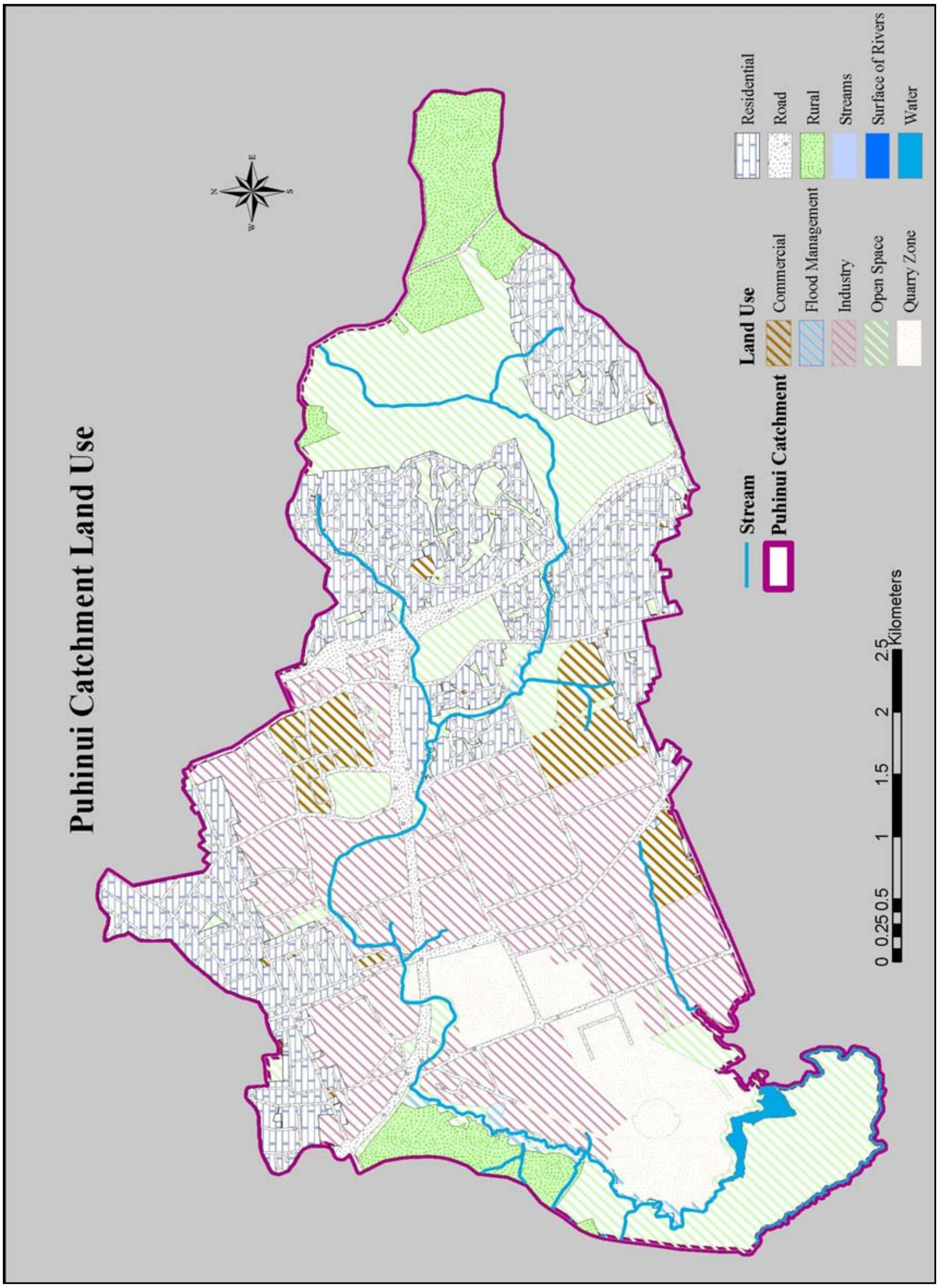
Figure 4.1.2: Density of Puhinui Hazard Industries



4.1.2. Nonpoint sources of pollution

Nonpoint sources of pollution in Puhinui catchment were represented through different land use types. Figure 4.1.3 shows land use types present in the Puhinui catchment.

Figure 4.1.3: Puhinui catchment land use



4.2 Prioritisation of nonpoint sources of pollution

When prioritising pollution sources, given the wide diversity of sources, some decisions will have to be made on the relative importance of various sources. In most areas, many types of sources all participate together and there is usually limited information available to compare them. The point at which certain types of pollutant sources are included will to a great extent depend of the detail necessary in the analysis and the amount and type of information available.

Obtaining detailed information on nonpoint sources is often very difficult and land use types frequently serve as generic description of the contribution of nonpoint sources of pollution as is the case in this study.

4.2.1. Catchment features

Table 4.2.1 includes the total area of each subcatchment and the area of each land use type within these catchments.

Figure 4.2.1 represents elevation of the Puhinui catchment, and Figure 4.2.2 shows stormwater and road networks in the Puhinui catchment.

4.2.2. Open Space land use

Open Space consists of all non-urban land uses and includes forested areas, parks, recreation areas, golf courses, undeveloped residential areas, open fields etc.

Open Space is land 'relatively free of buildings and/or surface infrastructure and is administered and owned by either a central, regional or local government agency for the purpose of providing:

- Public access to open land, foreshore, rivers and streams, and areas of heritage significance and/ or;
- A stock of land including coastal land for the purposes of heritage protection, the protection of biodiversity, landscape enhancement, recreation opportunity, education, and environmental protection' (Manukau City Council Operative District Plan 2002).

Table 4.2.1: Puhinui subcatchments area and land use area

Sub-catchments	Puhinui Catchment Land Use Types											
	Commercial	Flood Management	Industry	Quarry Zone	Surface of Rivers	Open Space	Residential	Road	Rural	Streams	Water	Total Area
	Hectares											
Fitzroy	1		17		0.3	6	70	20				114
Homai	22		108	11		1	5	14				162
McLaughlin			24	48		16		3				91
P17	0.2					36	55	19				110
P18	3	1	6			20	89	40		0.1		159
Puhinui Coast						79					8	87
Puhinui Stream	73	20	315	134	2	417	300	186	167	0.15	11	1624
Wiri	19		136	3				20				178
Total land use in Puhinui catchment	118	21	606	196	2.3	575	519	302	167	0.25	19	2525

Figure 4.2.1: Elevation

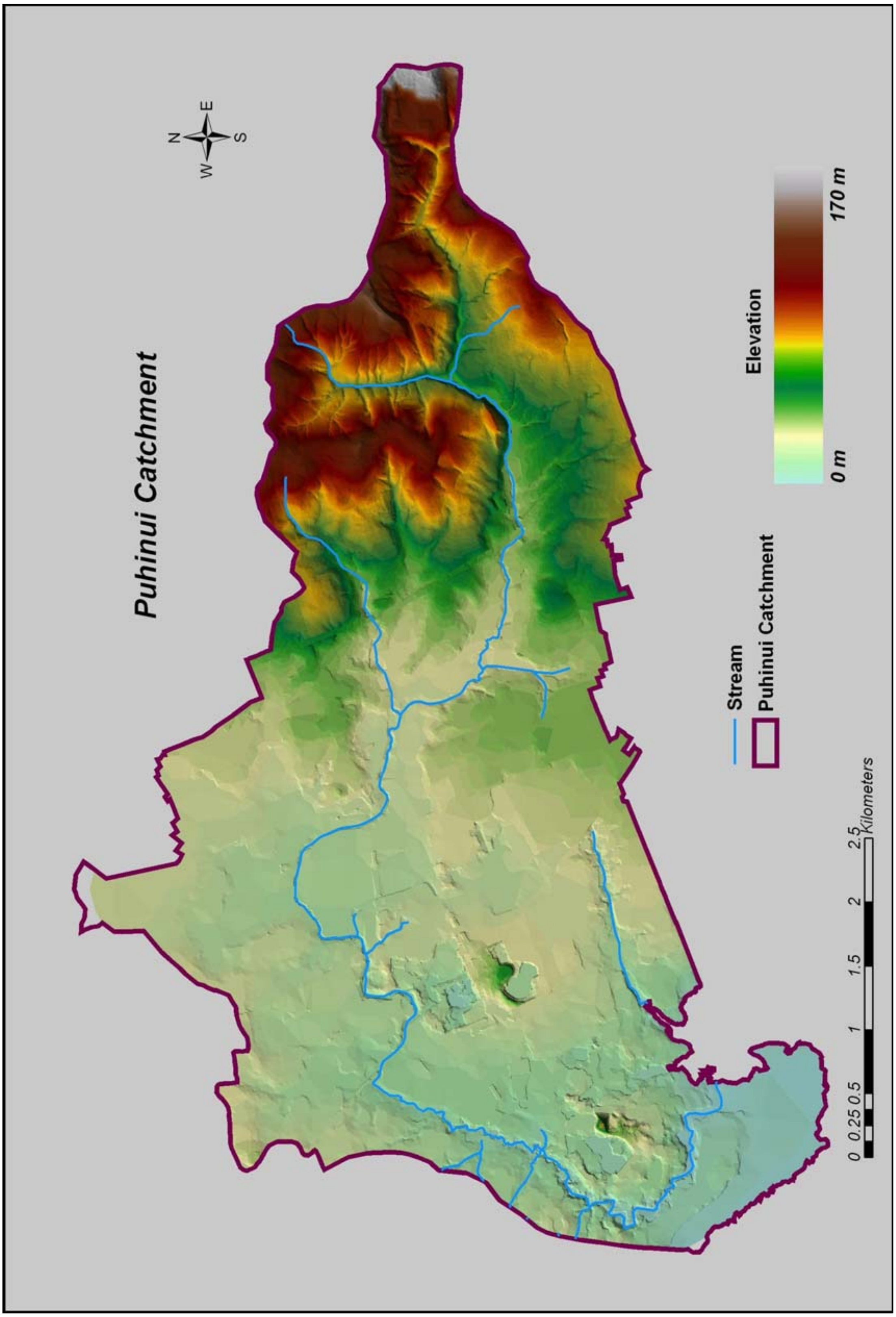
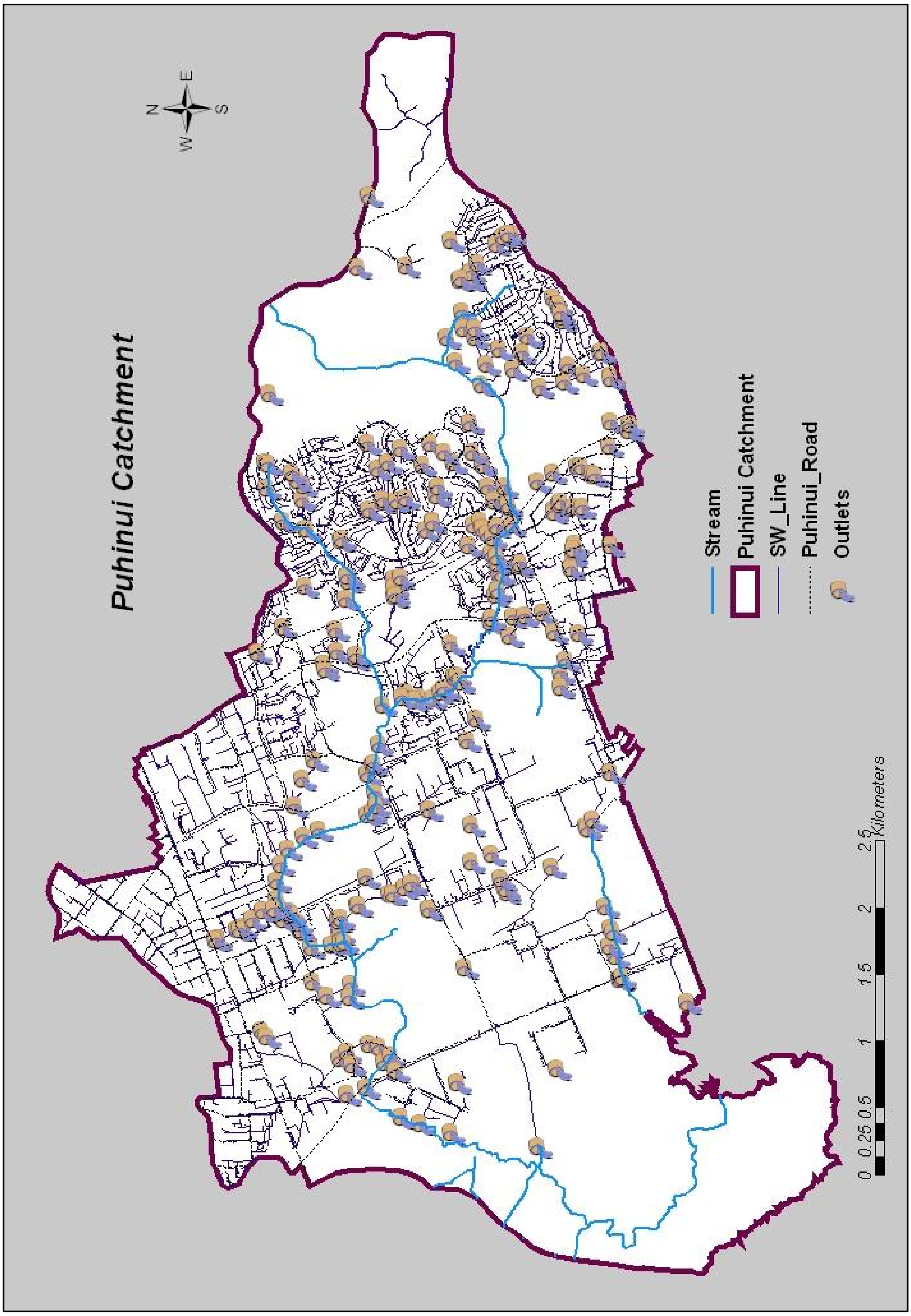


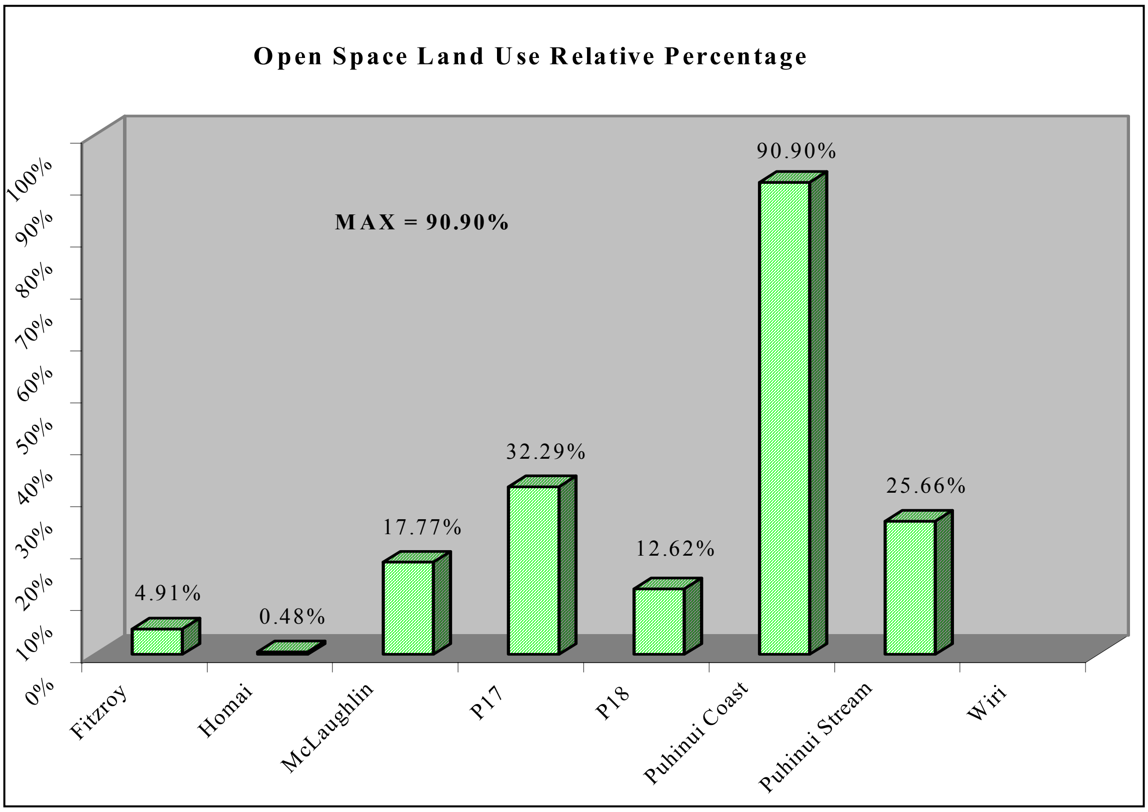
Figure 4.2.2: Stormwater and road network



Open Space has lots of different uses such as leisure activities, socialising, and community development services. Open Space recreation uses include active and passive recreation where active recreation takes place on the areas that have sports fields, courts, athletic tracks, or similar, while passive recreation takes place on both active open space and all the rest of the open space.

Figure 4.2.3 shows Open Space land use in each subcatchment as a percentage of any given subcatchment. Puhinui Coast has the highest percentage of the Open Space land use, and Homai the lowest percentage of the Open Space land use.

Figure 4.2.3: Open Space land use as a percentage of the subcatchment's areas

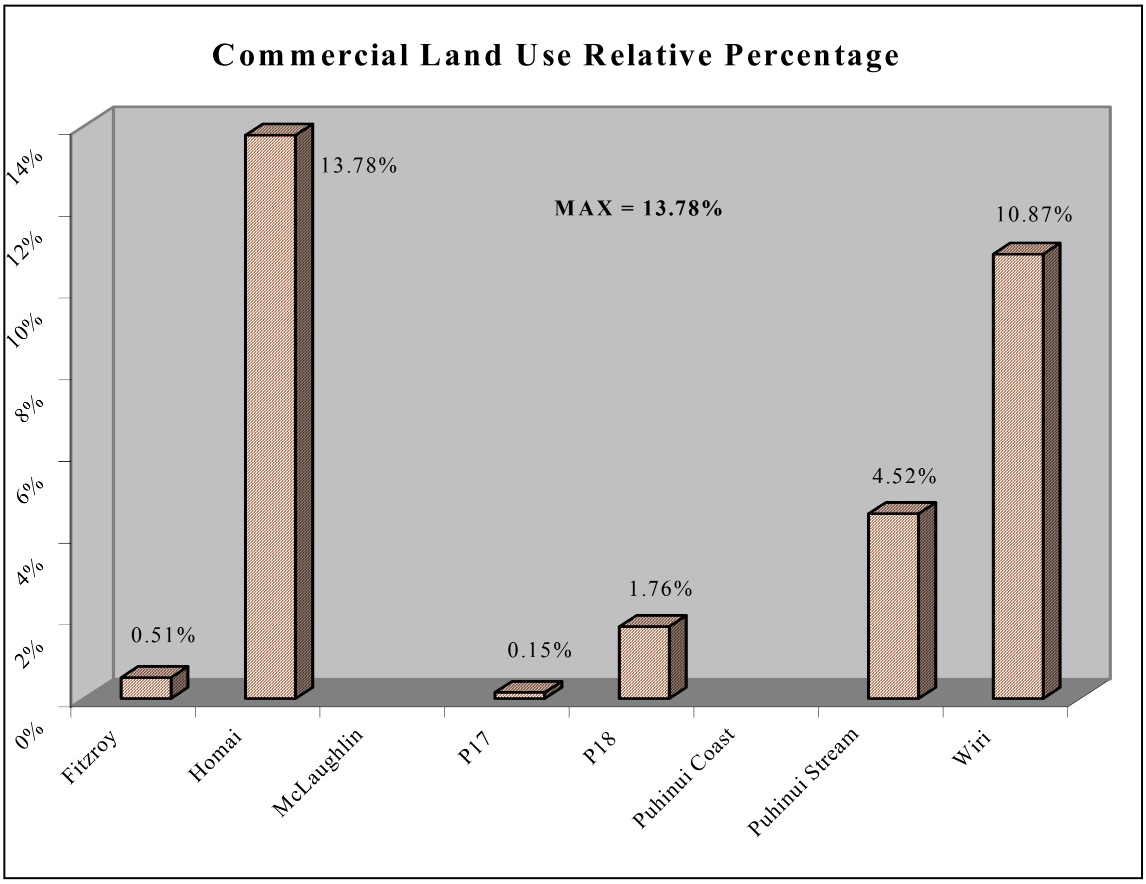


4.2.3. Commercial land use

Figure 4.2.4 shows Commercial land use in each subcatchment as a percentage of the subcatchment's areas. Homai has the highest percentage of the Commercial land use, and P17 the lowest percentage of the Commercial land use. Commercial land use is not present in the McLaughlin and Puhinui Coast subcatchments.

Commercial land use consists of areas with services operated from any premises, where the service consists of, or is similar in character to, the repair and servicing of household and domestic goods and equipment, clothing and footwear, lawn mowers, garden equipment, bicycles (whether or not spare parts and accessories are offered for sale in conjunction with the service provided on the premises) and includes dry cleaning, laundries and the like (Manukau City Council District Plan 2002).

Figure 4.2.4: Commercial land use as a percentage of the subcatchment's areas



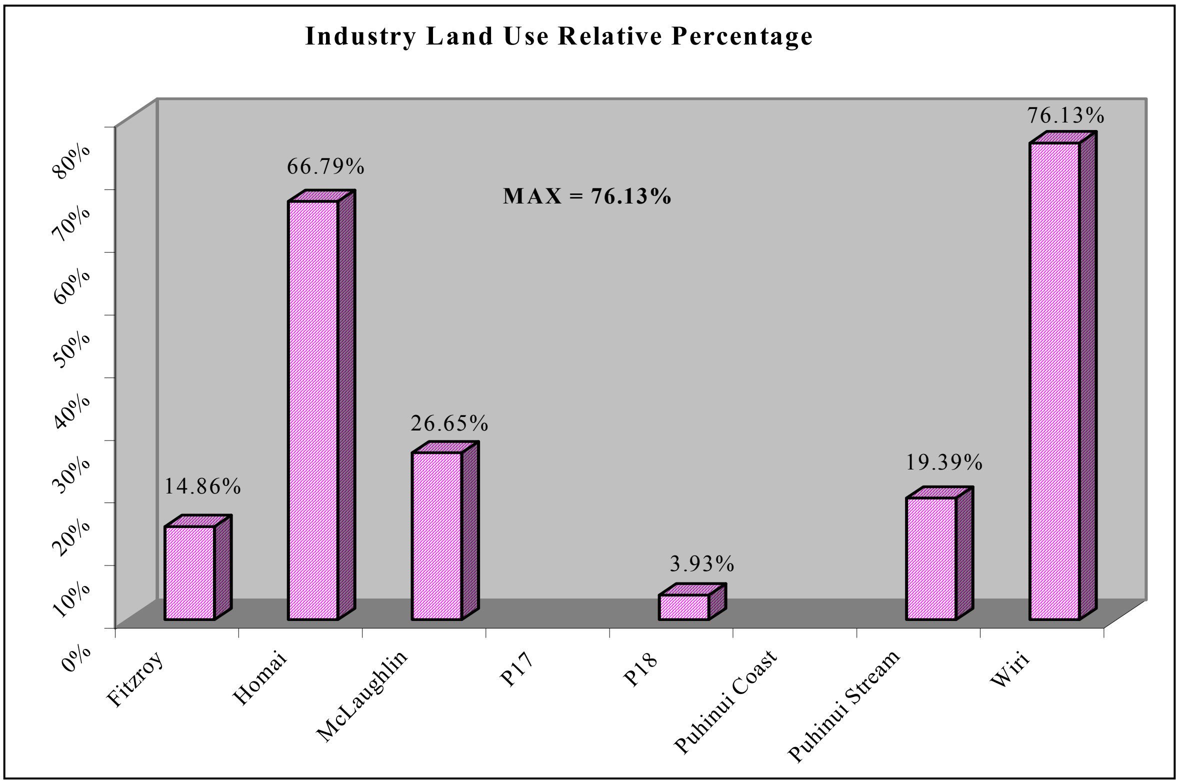
4.2.4. Industry land use

Figure 4.2.5 represents Industrial land use in each subcatchment as a percentage of the subcatchment's areas. Wiri has the highest percentage of the Industry land use, and P18 the lowest percentage of the Industry land use. Industry land use is not present in the P17 and Puhinui Coast subcatchments.

Industrial land use consists of land use areas with the production, processing, packing, assembly, servicing, testing, repair, and/or storage and warehousing of any materials, goods or products, live produce, vehicles or equipment (Manukau City Council District Plan 2002).

The integrated industry centres of the Puhinui catchment involve substantial structural and land resources.

Figure 4.2.5: Industry land use as a percentage of the subcatchment's areas



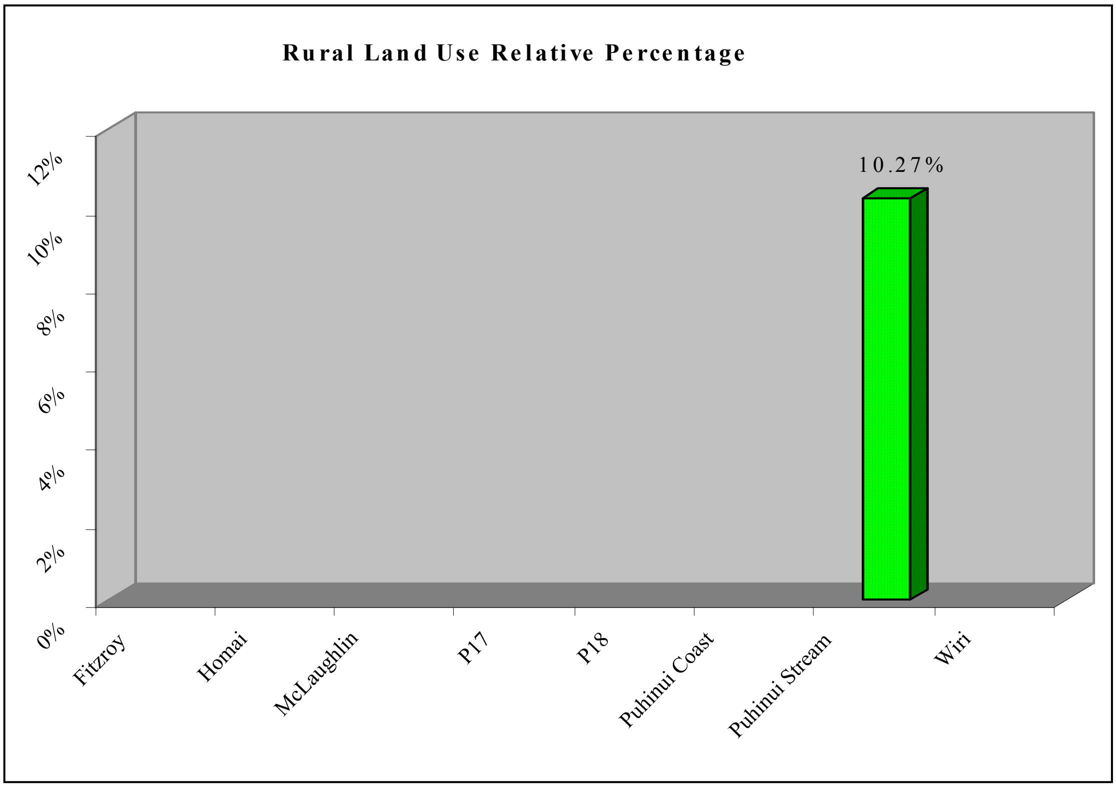
4.2.5. Rural land use

Figure 4.2.6 represents Rural land use as a percentage of the subcatchment's areas. Puhinui Stream is the only subcatchment in the Puhinui Catchment with Rural land use. The rural area contains most of the significant areas of native vegetation in the Manukau City.

The rural landscape is an important resource with a high amenity value for rural residents and for the residents of the large bordering urban area. The open rural landscape, coastal views, areas of native bush, and native vegetation including wetlands all contribute to the amenity values of the rural area.

Because of its proximity to the urban area, the rural part of Manukau City is used for a wide range of activities. Pastoral farming is the main farming type and is dominated by beef and dairy farms, with some sheep farming also occurring. There are also areas of horticulture, forestry and marine farming.

Figure 4.2.6: Rural land use as a percentage of the subcatchment's areas



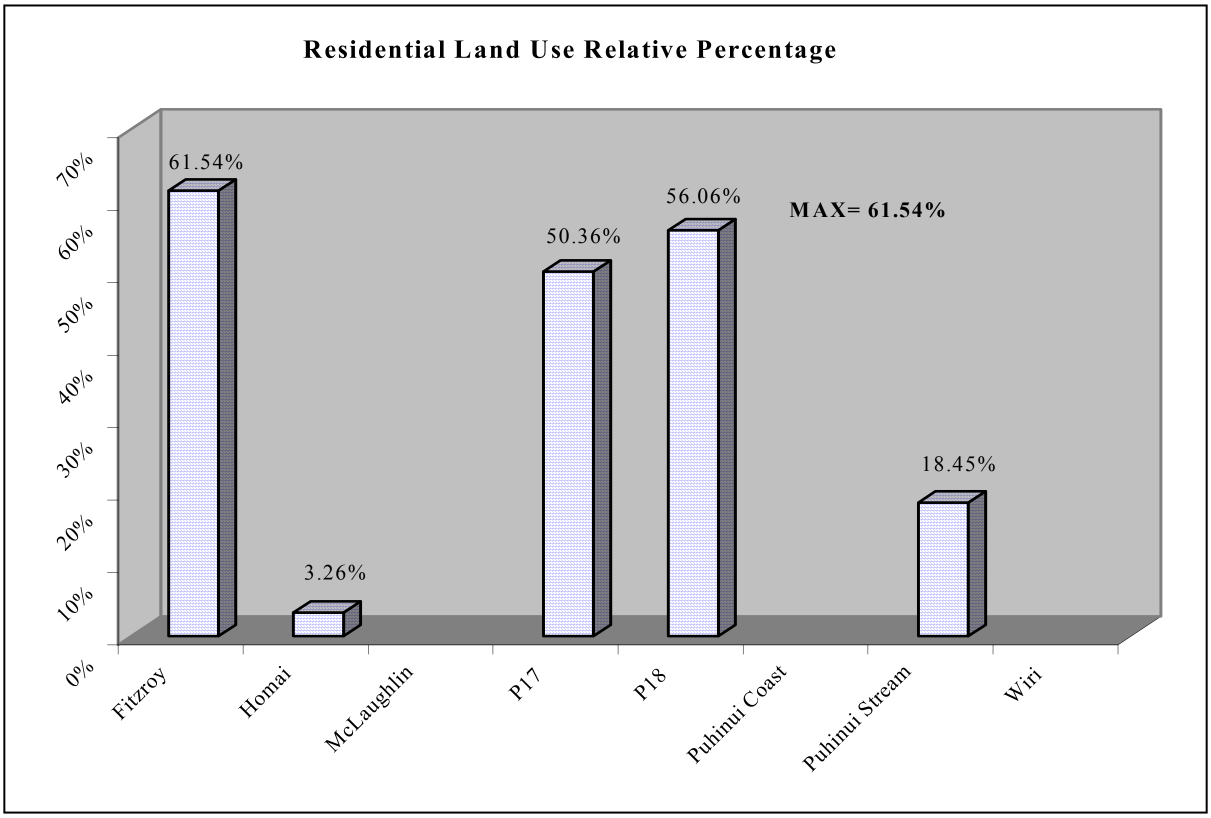
4.2.6. Residential land use

Figure 4.2.7 represents Residential land use in each subcatchment as a percentage of the subcatchment's areas. Fitzroy has the highest percentage of the Residential land use, and Homai the lowest. Residential land use is not present in the McLaughlin, Puhinui Coast and Wiri subcatchments.

Residential activities mean the use of premises (land and buildings) for any domestic or related purpose by persons living alone in whanau/family and/or non-family groups but excludes all the following:

'(a) home enterprises, hotels, motels, camping grounds, motor camps or other travellers' accommodation where residential accommodation for five or more travellers is offered at a daily tariff or other specified time; and
(b) homes for the aged where more than 15 persons (inclusive of owners, family and staff) are accommodated; and
(c) homes or premises of any size for persons who are remanded or accommodated pursuant to the Criminal Justice Act 1985; and
(d) residential centres or other similar homes or premises for persons (under care and supervision of any body or person engaged for the purpose) where more than 10 persons (inclusive of owners, family and staff) are accommodated' (Manukau City Council Operative District Plan 2002).

Figure 4.2.7: Residential land use as a percentage of the subcatchment's areas



4.2.7. Road land use

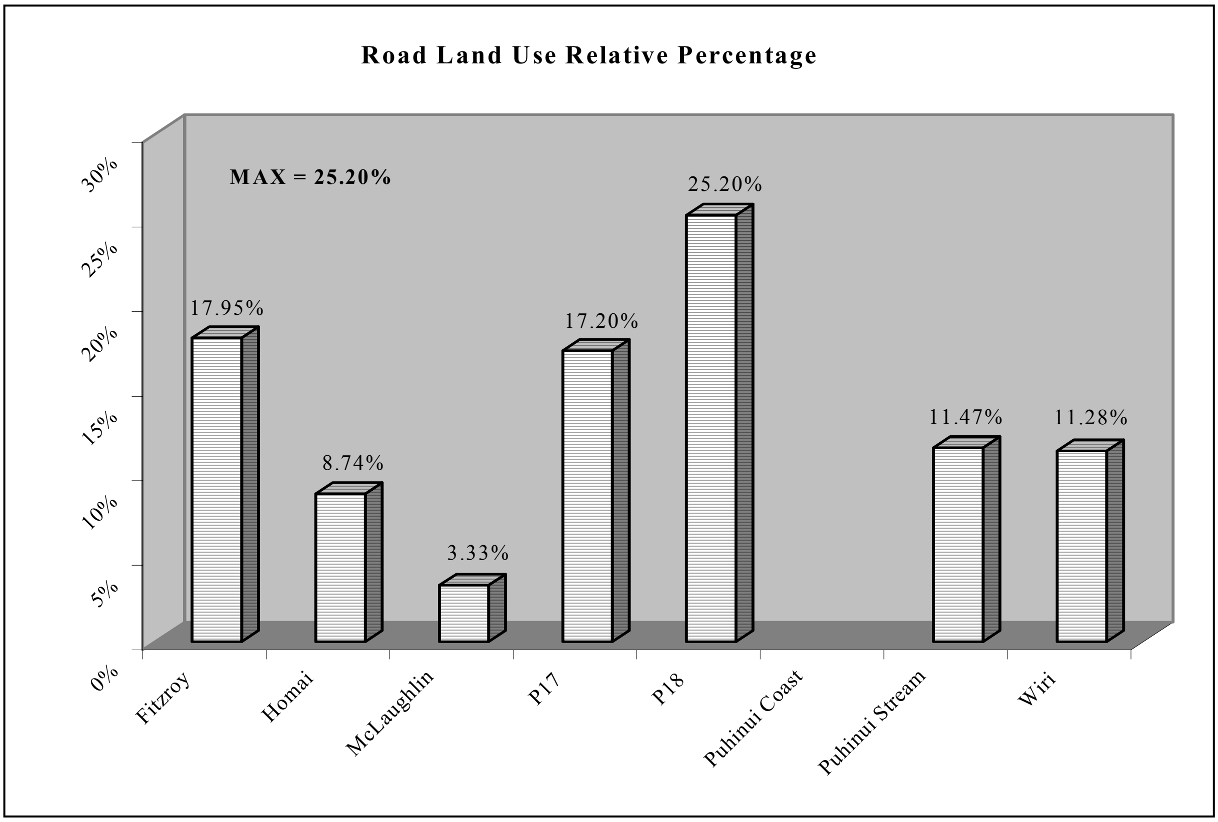
Figure 4.2.8 represents Road land use in each subcatchment as a percentage of the subcatchment's areas. P18 has the highest percentage of the Road land use, and McLaughlin the lowest percentage of the Road land use. Road land use is not present only in the Puhinui Coast subcatchment.

The land transportation system of Manukau City consists of roads, motorways, the railway, cycle ways and footpath networks.

'The effects of transport on the environment and the inhabitants of the City, are however significant and these must be managed in an integrated manner to reduce these effects, particularly in the urban areas where these effects are greatest' (Manukau City Council District Plan 2002).

The Resource Management Act (1991) promotes the sustainable management of natural and physical resources and the relationship between transport and land use is particularly important in this respect, as is the management of the effects of transport such as toxic gas emissions and water pollution.

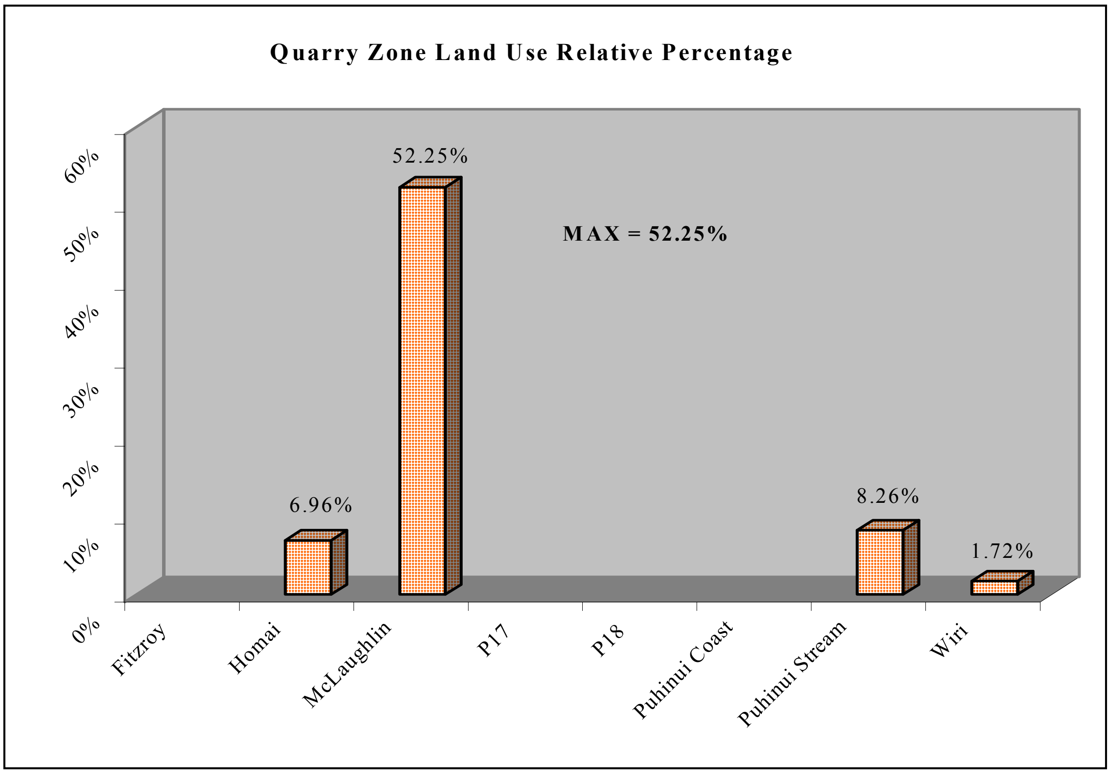
Figure 4.2.8: Road land use as a percentage of the subcatchment's areas



4.2.8. Quarry Zone land use

Figure 4.2.9 represents Quarry Zone land use in each subcatchment as a percentage of the subcatchment's areas. McLaughlin has the highest percentage of the Quarry Zone land use, and Wiri the lowest percentage of the Quarry Zone land use. Quarry Zone land use is present in four subcatchments: Homai, McLaughlin, Puhinui Stream and Wiri.

Figure 4.2.9: Quarry Zone land use as a percentage of the subcatchment's areas



4.3 Annual pollutant mass modelling

A GIS model was used to estimate the mass of pollutants entering waterways in the Puhinui Catchment in stormwater runoff. The model was based on the "simple method" introduced in the U.S. Environmental Protection Agency's guidance manual for preparing National Pollutant Discharge Elimination System municipal stormwater permit applications.

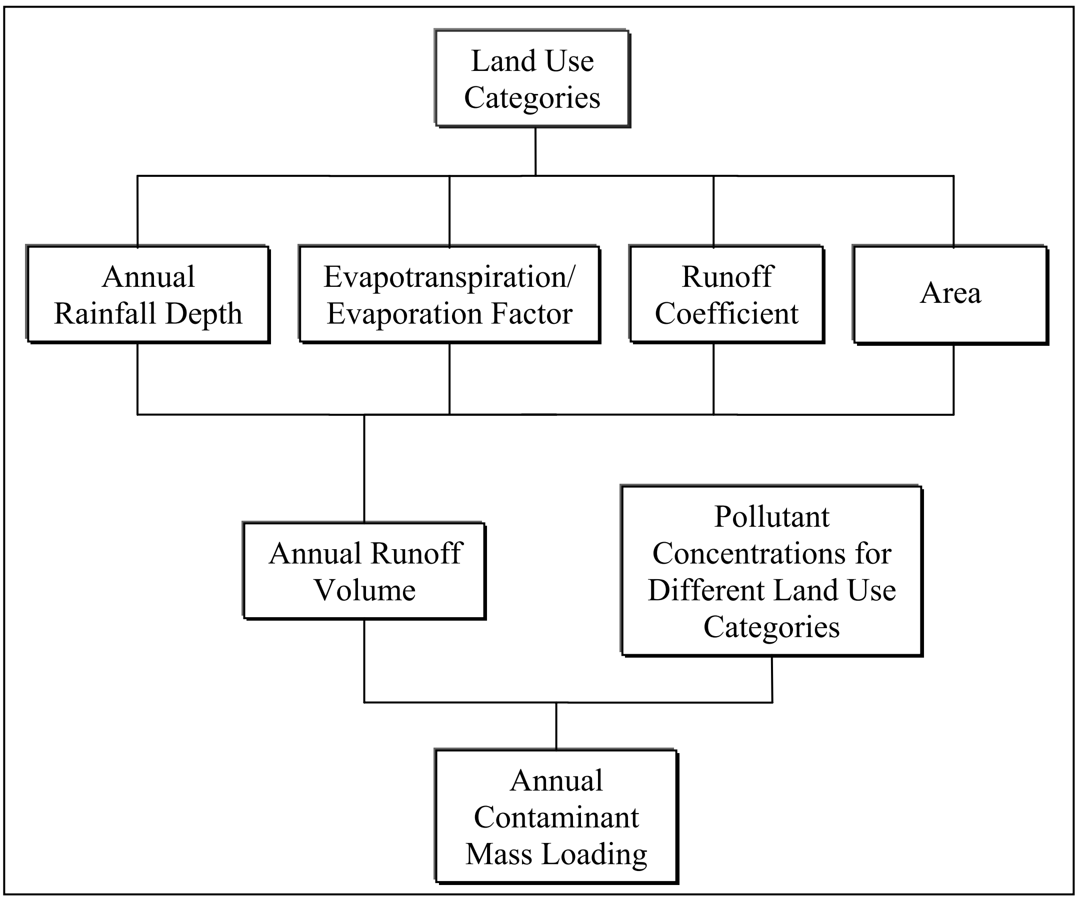
The “simple method” is performed by multiplying the annual runoff volume by a mean pollutant concentration for a particular pollutant to acquire the average annual load of a particular pollutant.

The annual runoff volume is calculated as the product of drainage area, runoff coefficient and annual rainfall (Davis and Pankani, 2001). The mean pollutant concentration for different land uses is obtained from the technical literature (Babich and Lewis, 2001).

To compute the total load of a pollutant discharged from a sub-catchment, the loads of that pollutant for all land uses within the catchment were summed. The computation is repeated for each pollutant of concern.

Figure 4.3.1 represents the flowchart of the GIS model used in the Puhinui catchment for computation of annual mass loading. GIS model was first developed on Puhinui Stream subcatchment and then used for all other subcatchments of the Puhinui catchment.

Figure 4.3.1: Annual pollutant mass loading flowchart



4.3.1. Land use categories

Puhinui Land Use feature class was clipped to each subcatchment area and eight new land use feature classes were created for each individual subcatchment: *Puhinui Stream Land Use, Puhinui Coast Land Use, P17 Land Use, P18 Land Use, Fitzroy Land Use, Homai Land Use, McLaughlin Land Use and Wiri Land Use* feature classes.

Subcatchment land use feature classes were then used to create individual land use feature classes for each subcatchment. Table 4.3.1 shows individual land use classes for each subcatchment.

Table 4.3.1: Puhinui subcatchments individual land use feature classes

Land Use Feature Classes	**Fitzroy**	**Homai**	**Mc Laughlin**	**Puhinui Stream**	**Puhinui Coast**	**P17**	**P18**	**Wiri**
	Subcatchment							
Commercial	✓	✓		✓		✓	✓	✓
Flood Management				✓			✓	
Industry	✓	✓	✓	✓			✓	✓
Open Space	✓	✓	✓	✓	✓	✓	✓	
Quarry Zone		✓	✓	✓				✓
Residential	✓	✓		✓		✓	✓	
Road	✓	✓	✓	✓		✓	✓	✓
Rural				✓				
Stream				✓			✓	
Surface of Rivers	✓			✓				
Water			✓	✓	✓			

In further analysis *Flood Management, Stream, Surface of Rivers* and *Water* feature classes will not be used.

4.3.2. Annual runoff volume

Annual runoff volumes for each land use type were calculated using mean annual rainfall depth, evapotranspiration/evaporation factor, runoff coefficient and land use areas.
The following equations (Babich and Lewis, 2001) were used for the calculation of the annual runoff volumes:

Current Annual Runoff Volume (m^3/yr) =
*= (Annual Rainfall Depth (m/yr) – Evapotranspiration/evaporation Factor (m)) * Current Runoff Coefficient * Area (m^2)* (4.1)

Ultimate Annual Runoff Volume (m^3/yr) =
*= (Annual Rainfall Depth (m/yr)–Evapotranspiration/evaporation Factor (m)) * Ultimate Runoff Coefficient * Area (m^2)* (4.2)

Rainfall data was obtained from NIWA based on the daily rainfall data for the last ten years. Calculated mean annual rainfall depth in Manukau City region is 1127 mm.

The *Evapotranspiration/evaporation Factor* was calculated using a mean annual evapotranspiration value, 964 mm, as provided by NZ Meteorological Service for the Auckland region and calculated imperviousness for each land use type. For a completely impervious areas the amount of evaporation is assumed to be equal to Evapotranspiration * 0.7 (Babich and Lewis, 2001).
The following equation (Babich and Lewis, 2001) was used for the calculation of the Evapotranspiration/evaporation Factor:

Evapotranspiration/evaporation Factor =
*(Evapotranspiration * (%imperviousness / 100) * 0.7 + (Evapotranspiration * (1 - % imperviousness))* (4.3)

Imperviousness percentage was calculated for each land use as a percentage of impervious area in relation to specific land use area in each subcatchment. Road land use Ultimate Runoff Coefficient was calculated according to Manukau District Plan 2002 information on roads. Table 4.3.2 shows road land use runoff coefficient calculated as a result of imperviousness and runoff coefficients of carriageway, footpath and berm.

Runoff coefficients were calculated using Ultimate Runoff Coefficients (runoff coefficients for fully developed land use type), Nonimpervious Area Runoff Coefficients, Impervious Area, Nonimpervious Area and Land Use Area.
The following equation (City Design, 2001) was used for the calculation of the runoff coefficients:

Current Runoff Coefficient (Rc) =

$$\frac{\text{Ultimate Rc} * \text{Impervious Area} + \text{Nonimperviuos Rc} * \text{Nonimperviuos Area}}{\text{Land Use Area}} \qquad (4.4)$$

Table 4.3.3 presents *Ultimate Runoff Coefficients* estimated for each land use type based on typical values reported in the literature (Brown et al 1996; Tonkin & Taylor 1996; Beca Carter Hollings & Ferner 2003) and calculated degree of catchment imperviousness (Brown et al 1996).

Table 4.3.3: Ultimate runoff coefficients and imperviousness percent

Land use type	Ultimate runoff coefficient	Imperviousness percent
Commercial	0.9	48%
Industry	0.9	56%
Open Space	0.3	3%
Quarry Zone	0.3	1%
Residential	0.7	44%
Road	0.66	85%
Rural	0.3	1%

Nonimpervious Runoff Coefficients were assumed to have the same value as an Open Space land use runoff coefficient.

Table 4.3.2: Road land use ultimate runoff coefficient (after Manukau District Plan 2002)

	Road Reserve		**Carriageway**			**Footpath**			**Berm**		
Road category	**Road Reserve Width**	**Runoff Coefficient**	**Carriageway Width**		**Runoff Coefficient**	**Footpath Width**		**Runoff Coefficient**	**Berm Width**		**Runoff Coefficient**
	m		**m**	**%**		**m**	**%**		**m**	**%**	
Local Roads	18.2	0.66	7.8	43%	1.00	1.5	8%	1.00	8.9	49%	0.30
Collector Roads	21.2	0.71	10.8	51%	1.00	1.5	7%	1.00	8.9	42%	0.30
Rural Roads	20.0	0.60	7.0	35%	1.00	1.5	8%	1.00	11.5	58%	0.30
District Arterial	25.0	0.71	13.0	52%	1.00	1.5	6%	1.00	10.5	42%	0.30
Motorway	50.0	0.65	25.0	50%	1.00	0	0%	1.00	25	50%	0.30
Average		**0.66**									

4.4 Creation of GIS model

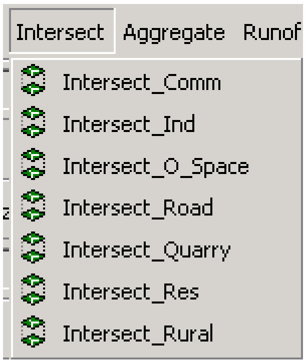
4.4.1. Calculation of Runoff volume in GIS model

The first step in calculating annual runoff volume was to intersect *Puhinui Impervious* feature class and individual land use feature classes in each subcatchment.

Using Visual Basic for Applications (VBA) programming language in ArcInfo 8.3, codes were written to intersect impervious and land use feature classes. VBA intersection codes are shown in *Appendix I: VBA Code*.

The code named *Create Intersect Menu*, also shown in *Appendix I: VBA Code*, was written to create a new menu called *Intersect* on the Main menu bar in ArcMap that incorporated all land use type intersection functions. Figure 4.4.1 shows annual mass loading *Intersect* menu

Figure 4.4.1: Intersect menu



The next step was to aggregate intersected feature classes to be able to calculate impervious area for each land use type.

Using codes shown in *Appendix I: VBA Code* performs the aggregation for all of the land use types. The *Aggregation* menu also includes codes for the calculation of the impervious and catchment areas.

The code named *Create Agg Menu* was written to create a new menu called *Aggregate* on the main menu bar in ArcMap that incorporated all land use type aggregation menus, plus *Impervious* and *Catchment* area calculation menus. Figure 4.4.2 shows annual mass loading *Aggregate* menu.

Figure 4.4.2: Aggregate menu

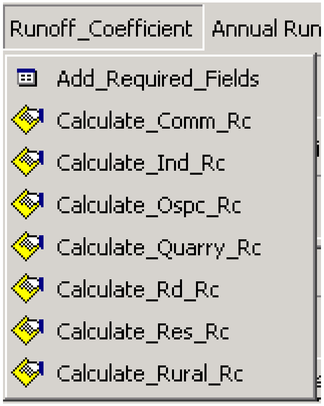
The next step was to calculate runoff coefficients. Firstly the code named *Add_fileds* was written to add all required fields to each land use type feature class. There were eight fields added: *Area* (Specific land use type area), *Imp_Area* (Impervious Area), *NonImp_A* (Nonimpervious Area), *Imp_pc* (Imperviousness percent), *Ctch_Area* (Subcatchment Area), *Current_R* (Current Runoff Coefficient), *Ultimate_R* (Ultimate Runoff Coefficient) and *NonImp_R* (Nonimpervious Runoff Coefficient).

After all the required fields were added *Area* field for each land use type was calculated first. Nonimpervious Area was calculated by subtracting Impervious Area from Land use area. Imperviousness percent was calculated next and *Imp_pc* field was populated with calculated values. Next, the values added to Ultimate Runoff Coefficient and Nonimpervious Runoff Coefficient fields, and finally Current Runoff Coefficient was calculated for every land use type in each Puhinui subcatchment.

A new menu called *Runoff_Coefficient* was created on the Main menu bar in ArcMap by a VBA code that included all land use type runoff coefficient menus.

All *Runoff Coefficient* codes are shown in *Appendix I: VBA Code*. Figure 4.4.3 shows annual mass loading *Runoff Coefficient* menu.

Figure 4.4.3: Runoff Coefficient menu



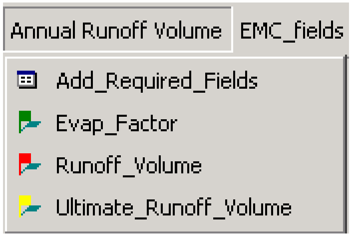
The *Annual Runoff Volume* calculation codes were written that included mean annual rain depth data, calculation of evapotranspiration/evaporation factor, current and ultimate runoff volumes.

Firstly, the code named *Add_f* was written to add all required fields to each land use type feature class. There were five fields added: *Rain_D* (Annual Rainfall Depth), *Evap* (Evapotranspiration), *Evap_f* (Evapotranspiration/evaporation Factor), *RunoffV* (Runoff Volume) and *U_RunoffV* (Ultimate Runoff Volume) fields.

After all the required fields were added, the values were added to Annual Rainfall Depth and Evapotranspiration fields, then Evapotranspiration/Evaporation factor field was calculated (using 4.3 equation), and finally Runoff Volume and Ultimate Runoff Volume fields were calculated (using 4.1 and 4.2 equations). The difference in Runoff Volume and Ultimate Runoff Volume equations was that Current Runoff Coefficient was used in Runoff Volume equation and Ultimate Runoff Coefficient was used in Ultimate Runoff Volume equation.

A new menu called *Annual Runoff Volume* was created on the Main menu bar in ArcMap by a VBA code, which is shown, with the rest of the *Annual Runoff Volume* codes in *Appendix I: VBA Code*. Figure 4.4.4 presents annual mass loading *Annual Runoff Volume* menu.

Figure 4.4.4: Annual Runoff Volume menu

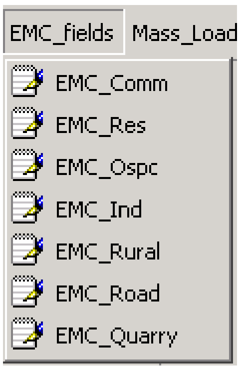


4.4.2. Calculation of median contaminant concentration in GIS model

Median contaminant concentration or expected mean concentration (EMC) data was added to each land use feature class using values as per Table 3.7.1.
Eight median contaminant concentration fields were added to each land use feature class with values typical for a specific land use type: *TSS* (Total Suspended Solids), *BOD* (Biochemical Oxygen Demand), *TPh* (Total Phosphorus), *TCo* (Total Copper), *TL* (Total Lead), *TZ* (Total Zinc), *TKjN* (Total Kjeldahl Nitrogen) and *TPHy* (Total Petroleum Hydrocarbons).

A new menu called *EMC_fields* was created on the Main menu bar in ArcMap by a VBA code, which is shown, with the rest of the median contaminant concentration codes in *Appendix I: VBA Code*. Figure 4.4.5 presents annual mass loading *EMC_fields* menu.

Figure 4.4.5: EMC_fields menu



4.4.3. Calculation of Annual Mass Loading in GIS model

Annual mass loadings were calculated for the current stage of urbanization and ultimate urbanization stage for each land use type. Eight fields were added for annual mass loading of each contaminant for the current stage of urbanization, and eight fields were added for annual mass loading of each contaminant for the ultimate stage of urbanization. The names of added fields are:

ML_TSS	Mass Loading of Total Suspended Solids
ML_BOD	Mass Loading of Biochemical Oxygen Demand
ML_TPh	Mass Loading of Total Phosphorus
ML_Tco	Mass Loading of Total Copper
ML_TL	Mass Loading of Total Lead
ML_TZ	Mass Loading of Total Zinc
ML_TKjN	Mass Loading of Total Kjeldahl Nitrogen
ML_TPHy	Mass Loading of Total Petroleum Hydrocarbons
UML_TSS	Ultimate Mass Loading of Total Suspended Solids
UML_BOD	Ultimate Mass Loading of Biochemical Oxygen Demand
UML_TPh	Ultimate Mass Loading of Total Phosphorus
UML_Tco	Ultimate Mass Loading of Total Copper
UML_TL	Ultimate Mass Loading of Total Lead
UML_TZ	Ultimate Mass Loading of Total Zinc
UML_TKjN	Ultimate Mass Loading of Total Kjeldahl Nitrogen
UML_TPHy	Ultimate Mass Loading of Total Petroleum Hydrocarbons

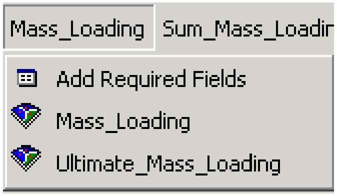
Annual pollutant mass loadings were calculated by multiplying the annual runoff volumes by mean pollutant concentration values for each pollutant. The same process was applied for every land use type.

The following equation (Babich and Lewis, 2001) was used for the calculation of the annual pollutant mass loading:

Mass Pollutant Loading (g/yr) =
*Annual Runoff Volume (m^3/yr) * Mean Pollutant Concentration (g/m^3)*
(4.5)

Finally, a new menu called *Mass Loading* was created on the Main menu bar in ArcMap by a VBA code, which is shown, with the rest of the Annual Mass Loading codes in *Appendix I: VBA Code*. Figure 4.4.6 presents annual mass loading Mass Loading menu.

Figure 4.4.6: Mass loading menu



4.4.4. Calculation of Sum of Annual Mass Loading per subcatchment in GIS model

To calculate the total pollutant load discharged from the subcatchment, the loads of a specific pollutant for all land use types within the subcatchment were summed and divided by the subcatchment area. The same process was applied for each pollutant. These results showed an annual mass contaminant loading in kilograms per hectare per year for each land use of every subcatchment in the Puhinui Catchment.

Two new feature classes were created containing sum values of the total pollutant load discharge for each subcatchment for the current and ultimate urbanization stage for each land use type.

The equation used for the calculation of the annual pollutant mass loading expressed in kilograms per hectare was:

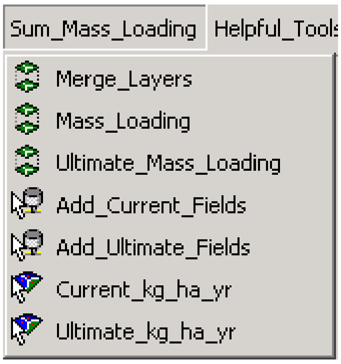
Sum of Annual Mass Loading (kg/ha/yr) =

*Sum of Mass Pollutant Loading (g/yr) / Subcatchment Area (m^2) * 10*

(4.6)

VBA codes used to calculate sums of annual mass loadings are shown in *Appendix I: VBA Code*. Figure 4.4.7 presents *Sum Mass Loading* menu.

Figure 4.4.7: Sum Mass Loading menu



4.4.5. Annual Mass Loading per Land Use

Using previous *Sum Mass Loading* Menu it was possible to calculate sum annual mass contaminant loading for each subcatchment.

To calculate annual loading per land use, the code was written to convert calculated annual contaminant loading per each land use from grams/year to kilograms/hectare/year.

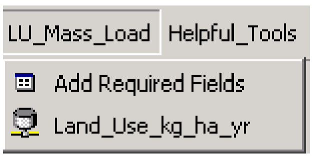
The equation used for the calculation of the annual mass loading per land use expressed in kilograms/hectare/year was:

Annual Mass Loading per Land Use (kg/ha/yr) =

Mass Pollutant Loading (g/yr) / Land Use Area $(m^2) * 10$ (4.7)

VBA codes used to calculate annual mass loadings per land use (kg/ha/yr) are shown in *Appendix I: VBA Code*. Figure 4.4.8 presents annual mass loading per land use *LU Mass Load* menu.

Figure 4.4.8: LU Mass Load menu

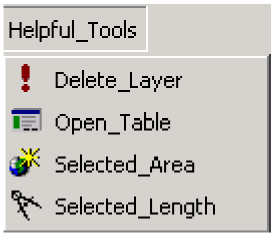


4.4.6. Helpful tools

The codes were written for helpful tools that could be useful while working in ArcMap on annual contaminant loading study: tools for deleting layers, opening tables and calculation of selected areas or lengths.

VBA codes used to create helpful tools are shown in *Appendix I: VBA Code*. Figure 4.4.9 presents annual mass loading *Helpful Tools* menu.

Figure 4.4.9: Helpful Tools menu



Finally, a macro was written to bring all of the above-mentioned menus on the Main menu bar, and it was added as a button named *Mass Loading Menu* on a toolbar.

```
Public Sub Create_menu()
    CreateIntersectMenu
    CreateAggMenu
    MenuCreate_Runoff_C
    MenuRunoffV
    Menu_EMC
    Menu_Mass_Loading
    MenuSum_Mass_Loading
    CreateHelp_ToolMenu
    End Sub
```

Mass Loading Menu in ArcMap is represented by Figure 4.4.10.

Figure 4.4.10: ArcMap Mass Loading Menu

5 Results

The nonpoint source pollution methodology was completed for the eight pollutants listed in Table 3.7.1. The results are presented below:

5.1 Nonpoint source pollution assessment

The main results of this nonpoint source pollution integrated study can be divided into the following:

- Spatial component: annual mass pollutant loading per each subcatchment and per the whole catchment
- Temporal component: current and ultimate annual mass pollutant loading
- Chemical component: annual mass loading for eight pollutants was calculated
- Land use component: annual mass pollutant loading per land use type

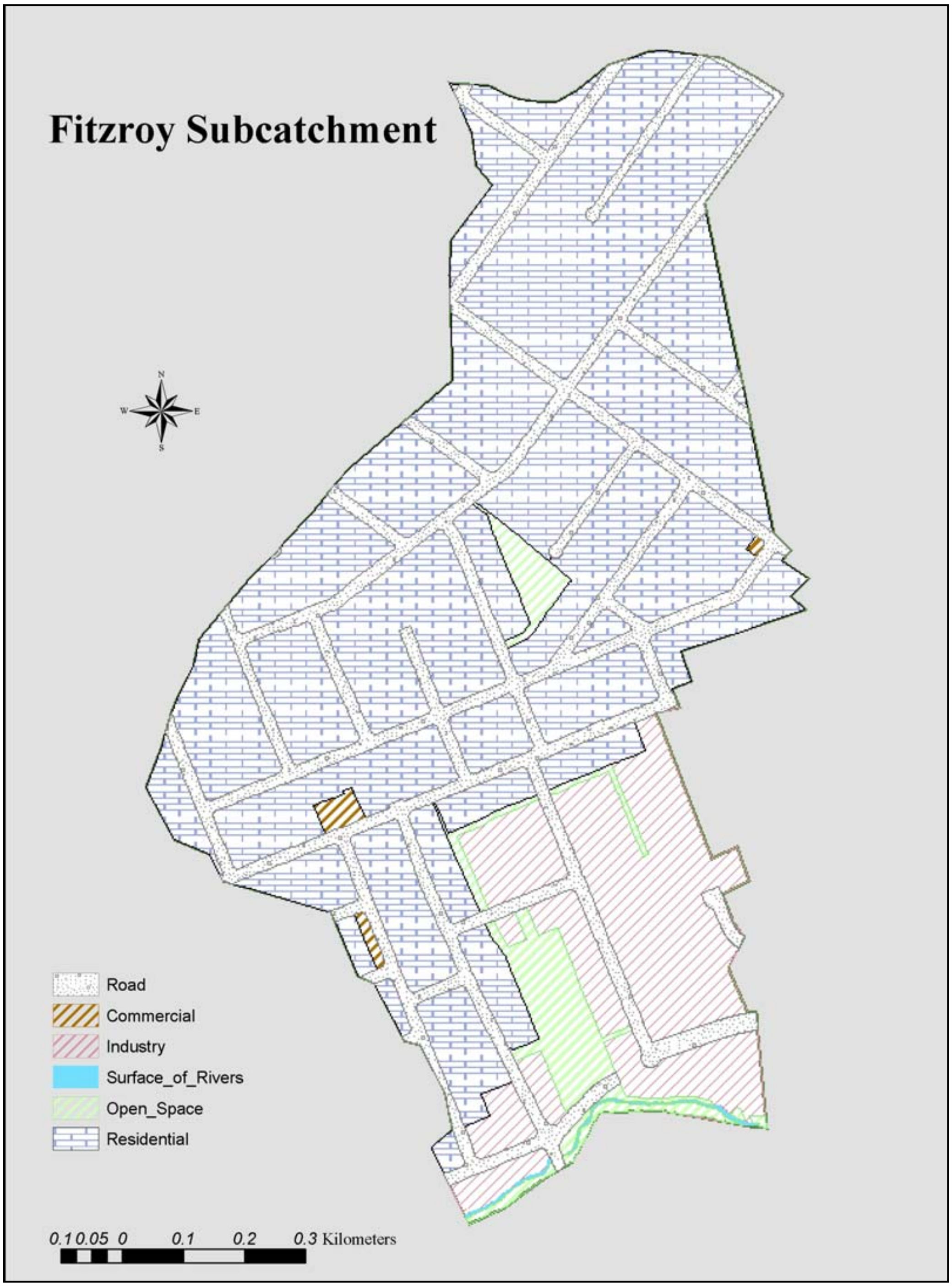
This GIS model has universal character; it can be applied on any urban catchment with minor adjustment. It is user friendly and easy to modify. It is a powerful decision making tool in the stormwater management.

5.2 Fitzroy subcatchment

Spatial distribution of Fitzroy subcatchment land use types and land use areas expressed as percentages of the total Fitzroy subcatchment area are represented in Figure 5.2.1.

Table 5.2.1 shows current and ultimate annual contaminant mass loading for the Fitzroy subcatchment land use types. There is no change in current and ultimate development conditions calculated for Road and Open Space land use types. Annual contaminant mass loadings for Residential, Industry and Commercial land use types showed an increase from current to ultimate development condition.

Figure 5.2.1: Fitzroy subcatchment land use types



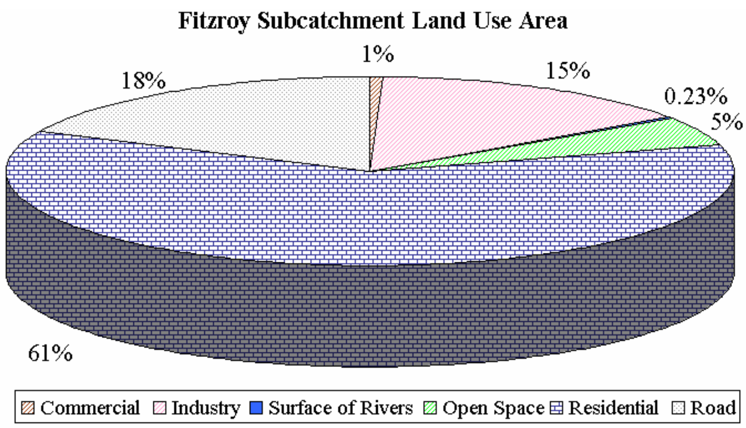


Table 5.2.1: Fitzroy subcatchment annual contaminant mass loading per land use types

Fitzroy									
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons	
Land Use	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	
Road	6.9E+06	5.4E+05	1.6E+04	2.5E+03	2.4E+03	1.2E+04	1.0E+05	6.1E+05	CACML
	6.9E+06	5.4E+05	1.6E+04	2.5E+03	2.4E+03	1.2E+04	1.0E+05	6.1E+05	UACML
Residential	2.0E+07	9.2E+05	4.5E+04	4.6E+03	2.1E+04	3.1E+04	2.2E+05	2.3E+05	CACML
	2.8E+07	1.2E+06	6.1E+04	6.2E+03	2.8E+04	4.3E+04	3.1E+05	3.2E+05	UACML
Open Space	1.7E+05	1.5E+04	9.8E+02	2.1E+01	1.0E+01	3.8E+01	3.1E+03	3.5E+03	CACML
	1.7E+05	1.5E+04	9.8E+02	2.1E+01	1.0E+01	3.8E+01	3.1E+03	3.5E+03	UACML
Industry	7.3E+06	6.8E+05	2.7E+04	2.8E+03	1.2E+04	6.5E+04	9.3E+04	2.6E+05	CACML
	8.3E+06	7.8E+05	3.1E+04	3.2E+03	1.4E+04	7.4E+04	1.1E+05	3.0E+05	UACML
Commercial	7.1E+04	1.1E+04	3.6E+02	6.4E+01	2.0E+02	3.6E+02	3.1E+03	1.8E+03	CACML
	9.8E+04	1.5E+04	4.9E+02	8.8E+01	2.7E+02	4.9E+02	4.3E+03	2.5E+03	UACML
CACML - Current Annual Contaminant Mass Loading									
UACML - Ultimate Annual Contaminant Mass Loading									

Table 5.2.2 shows the sum of annual mass contaminant loading for each pollutant and a percent of loading increase from current to ultimate development condition.

Manukau City Council Operative District Plan was completed in 2002, and, as it was projected that it would take twenty years to achieve the ultimate development as per District Plan, it was possible to calculate the percentage increase from current to ultimate development condition per year.

Normalised total percent increase in Fitzroy subcatchment of annual mass contaminant loading for each pollutant is presented in Figure 5.2.2.

Figure 5.2.2: Fitzroy subcatchment normalised increase of annual mass contaminant loading

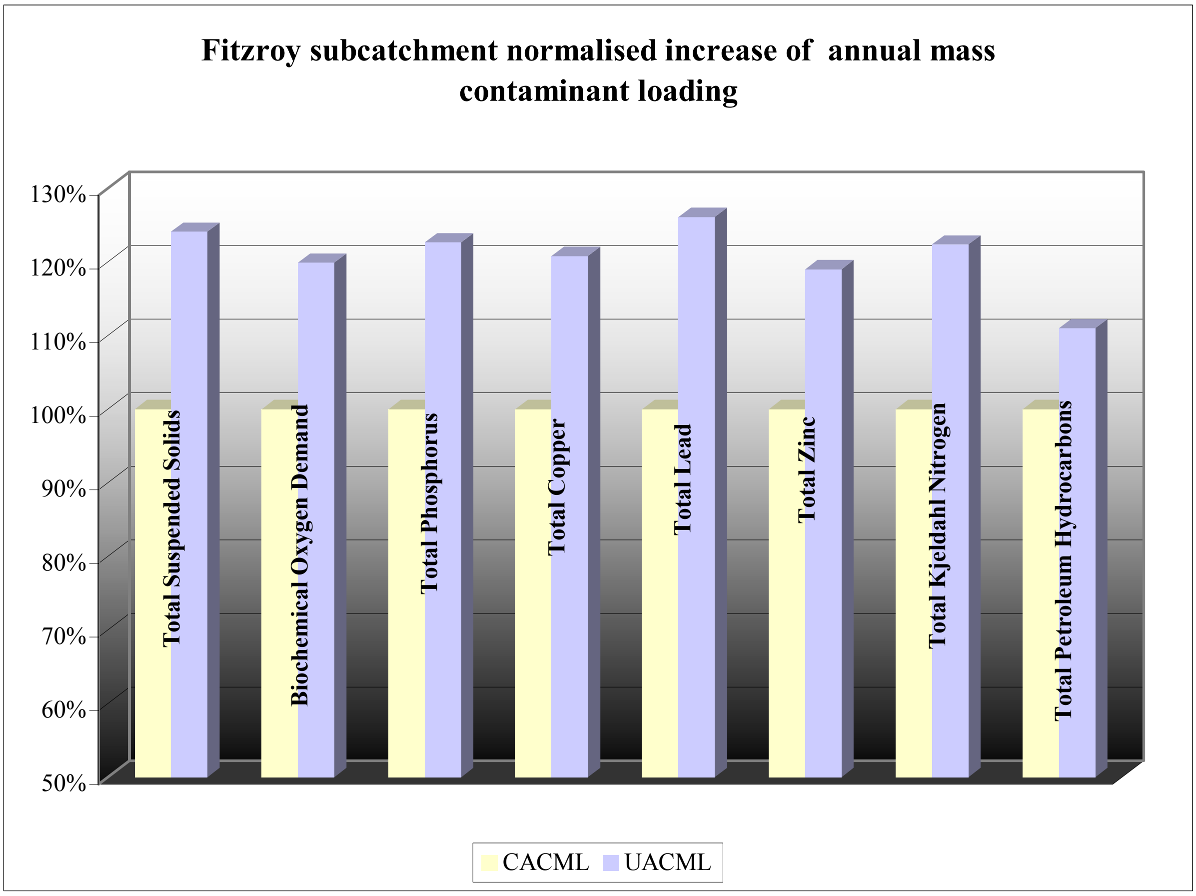


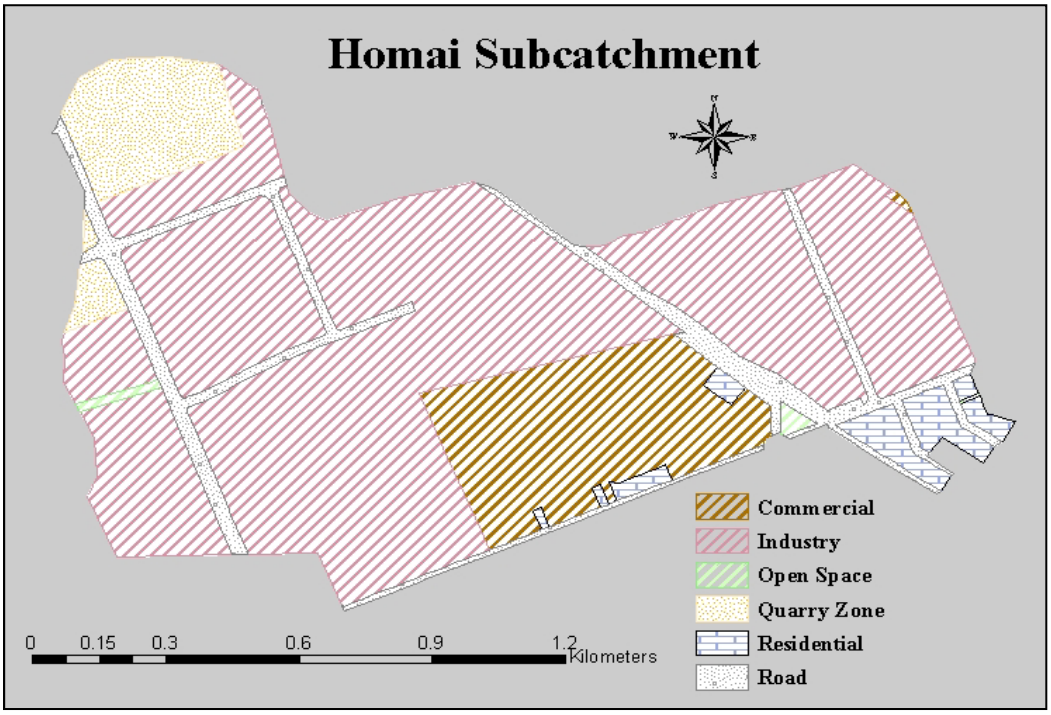
Table 5.2.2: Sum of annual mass contaminant loading per pollutant - Fitzroy

Fitzroy								
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons
	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr
CACML	3.49E+07	2.17E+06	8.85E+04	9.97E+03	3.52E+04	1.09E+05	4.25E+05	1.11E+06
UACML	4.33E+07	2.60E+06	1.09E+05	1.20E+04	4.44E+04	1.30E+05	5.20E+05	1.23E+06
Total Percent Increase	24%	20%	23%	21%	26%	19%	22%	11%
Percent Increase per year	1.27%	1.05%	1.19%	1.09%	1.37%	1.00%	1.18%	0.58%
CACML - Current Annual Contaminant Mass Loading								
UACML - Ultimate Annual Contaminant Mass Loading								

5.3 Homai subcatchment

Homai subcatchment covers 162 hectares and has six different land use types: Commercial, Industry, Open Space, Quarry Zone, Residential and Road. Spatial distribution of Homai subcatchment land use types and percentages of land use areas are represented in Figure 5.3.1.

Figure 5.3.1: Homai subcatchment land use types



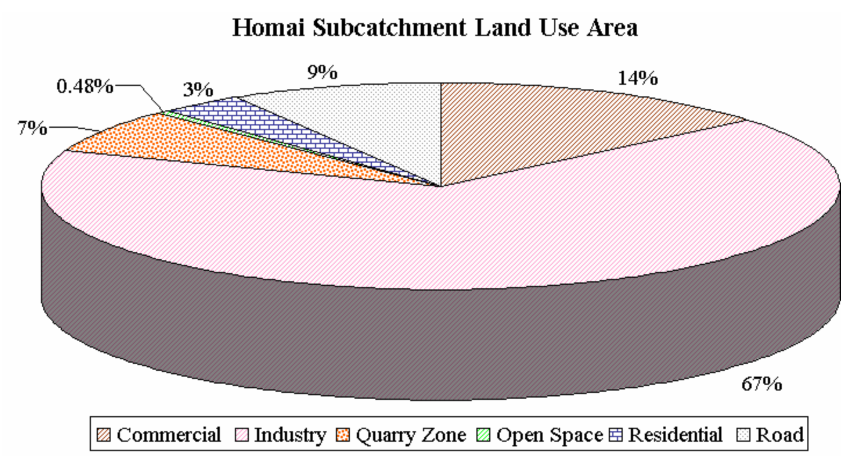


Table 5.3.1 shows current and ultimate annual contaminant mass loading for the Homai subcatchment land use types. There is no change in current and ultimate development conditions calculated for Quarry Zone and Open Space land use types. Annual contaminant mass loadings for Road, Residential, Industry and Commercial land use types showed increase from current to ultimate development condition.

Table 5.3.1: Homai subcatchment annual contaminant mass loading per land use types

Homai									
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons	
Land Use	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	
Road	1.4E+06	1.1E+05	3.1E+03	5.0E+02	4.9E+02	2.4E+03	2.0E+04	1.2E+05	CACML
	4.1E+06	3.2E+05	9.2E+03	1.5E+03	1.4E+03	7.2E+03	6.0E+04	3.6E+05	UACML
Residential	1.4E+06	6.3E+04	3.1E+03	3.2E+02	1.4E+03	2.2E+03	1.5E+04	1.6E+04	CACML
	2.0E+06	9.0E+04	4.4E+03	4.5E+02	2.0E+03	3.1E+03	2.2E+04	2.3E+04	UACML
Open Space	2.2E+04	2.0E+03	1.3E+02	2.7E+00	1.4E+00	5.0E+00	4.1E+02	4.6E+02	CACML
	2.2E+04	2.0E+03	1.3E+02	2.7E+00	1.4E+00	5.0E+00	4.1E+02	4.6E+02	UACML
Quarry Zone	1.6E+05	7.1E+04	5.5E+02	2.9E+02	1.2E+03	6.8E+03	2.2E+04	2.8E+04	CACML
	1.6E+05	7.1E+04	5.5E+02	2.9E+02	1.2E+03	6.8E+03	2.2E+04	2.8E+04	UACML
Industry	2.5E+07	2.3E+06	9.2E+04	9.6E+03	4.1E+04	2.2E+05	3.2E+05	9.1E+05	CACML
	3.9E+07	3.7E+06	1.5E+05	1.5E+04	6.5E+04	3.5E+05	5.0E+05	1.4E+06	UACML
Commercial	1.0E+06	1.6E+05	5.0E+03	9.0E+02	2.8E+03	5.0E+03	4.4E+04	2.5E+04	CACML
	2.3E+06	3.6E+05	1.2E+04	2.1E+03	6.4E+03	1.2E+04	1.0E+05	5.9E+04	UACML
CACML - Current Annual Contaminant Mass Loading									
UACML - Ultimate Annual Contaminant Mass Loading									

Table 5.3.2 shows sum of annual mass contaminant loading for each pollutant and a percent of loading increase from current to ultimate development condition. Homai subcatchment showed the highest mass contaminant loading increase in the Puhinui catchment.

Normalised total percent increase in Homai subcatchment of annual mass contaminant loading for each pollutant is shown in Figure 5.3.2.

Figure 5.3.2: Homai subcatchment normalised increase of annual mass contaminant loading.

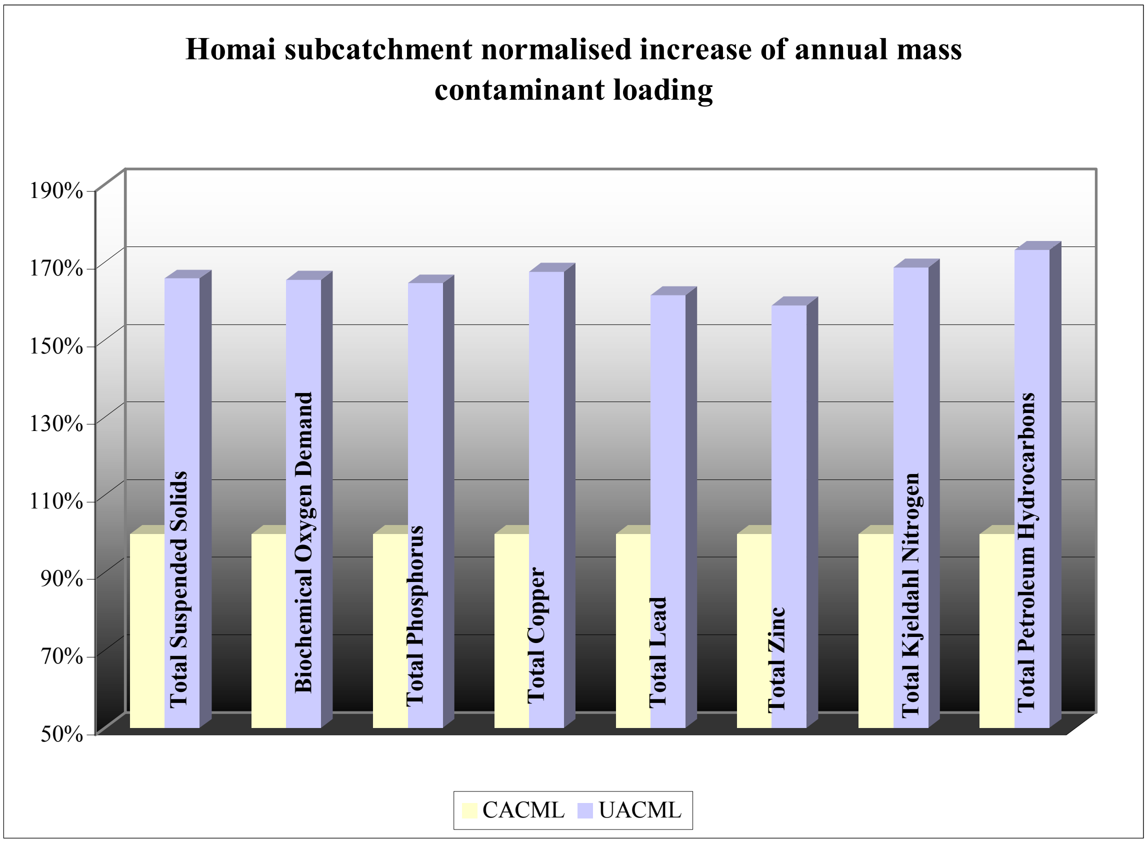


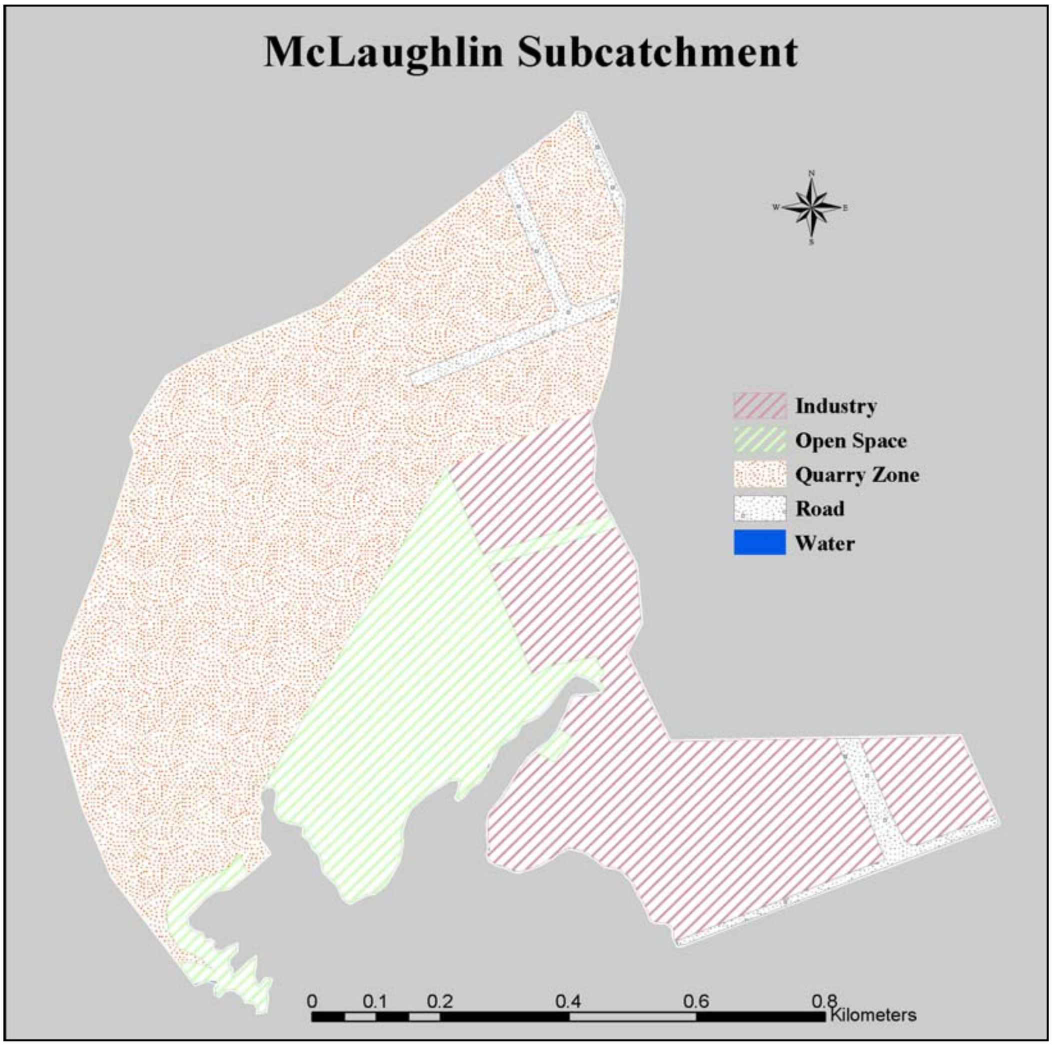
Table 5.3.2: Sum of annual mass contaminant loading per pollutant – Homai

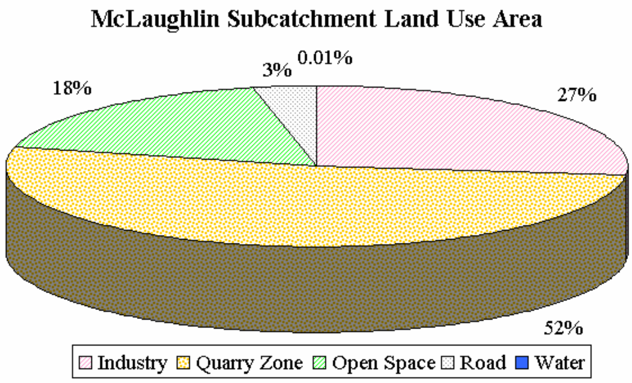
Homai								
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons
	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr
CACML	2.90E+07	2.74E+06	1.04E+05	1.16E+04	4.69E+04	2.39E+05	4.19E+05	1.10E+06
UACML	4.81E+07	4.53E+06	1.71E+05	1.95E+04	7.58E+04	3.80E+05	7.06E+05	1.90E+06
Total Percent Increase	66%	66%	65%	68%	62%	59%	69%	73%
Percent Increase per year	3%	3%	3%	4%	3%	3%	4%	4%
CACML - Current Annual Contaminant Mass Loading								
UACML - Ultimate Annual Contaminant Mass Loading								

5.4 McLaughlin subcatchment

McLaughlin subcatchment covers 90 hectares and has five different land use types: Industry, Open Space, Quarry Zone, Road and Water. Spatial distribution of McLaughlin subcatchment land use types and land use area percentages are represented in Figure 5.4.1.

Figure 5.4.1: McLaughlin subcatchment land use types





Normalised total percent increase in McLaughlin subcatchment of annual mass contaminant loading for each pollutant is presented in Figure 5.4.2.

Table 5.4.1 shows current and ultimate annual contaminant mass loading for the McLaughlin subcatchment land use types. There is no change in current and ultimate development conditions calculated for Road, Quarry Zone and Open Space land use types. Annual contaminant mass loadings for Industry land use type showed increase from current to ultimate development condition.

Table 5.4.2 shows sum of annual mass contaminant loading for each pollutant and a percent of loading increase from current to ultimate development condition.

Figure 5.4.2: McLaughlin subcatchment normalised increase of annual mass contaminant loading

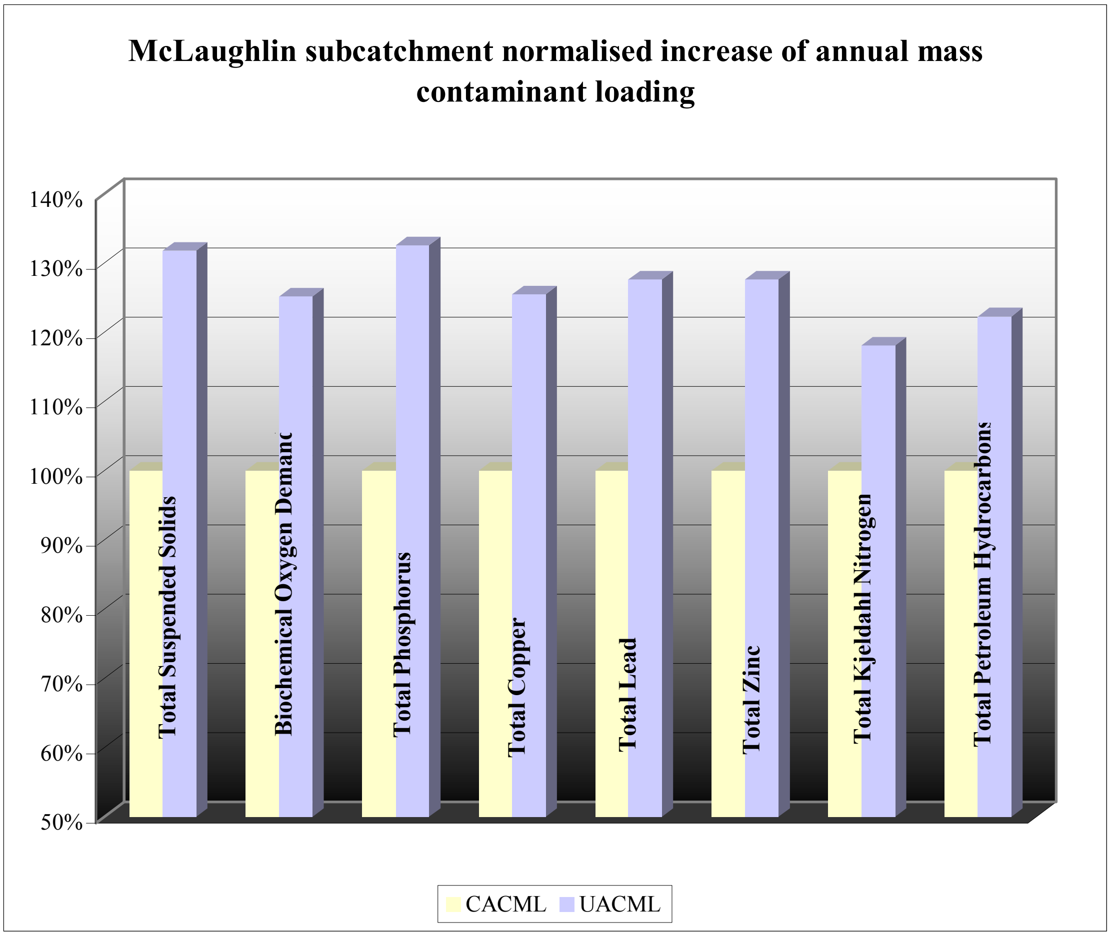


Table 5.4.1: McLaughlin subcatchment annual contaminant mass loading per land use types

McLaughlin									
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons	CACML
Land Use	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	UACML
Industry	6.9E+06	6.5E+05	2.6E+04	2.7E+03	1.1E+04	6.2E+04	8.8E+04	2.5E+05	CACML
	9.8E+06	9.2E+05	3.6E+04	3.8E+03	1.6E+04	8.7E+04	1.2E+05	3.5E+05	UACML
Quarry Zone	6.6E+05	3.0E+05	2.3E+03	1.2E+03	5.2E+03	2.9E+04	9.1E+04	1.2E+05	CACML
	6.6E+05	3.0E+05	2.3E+03	1.2E+03	5.2E+03	2.9E+04	9.1E+04	1.2E+05	UACML
Open Space	3.8E+05	3.4E+04	2.2E+03	4.7E+01	2.4E+01	8.7E+01	7.1E+03	7.9E+03	CACML
	3.8E+05	3.4E+04	2.2E+03	4.7E+01	2.4E+01	8.7E+01	7.1E+03	7.9E+03	UACML
Road	1.0E+06	8.0E+04	2.3E+03	3.7E+02	3.6E+02	1.8E+03	1.5E+04	9.0E+04	CACML
	1.0E+06	8.0E+04	2.3E+03	3.7E+02	3.6E+02	1.8E+03	1.5E+04	9.0E+04	UACML
CACML - Current Annual Contaminant Mass Loading									
UACML - Ultimate Annual Contaminant Mass Loading									

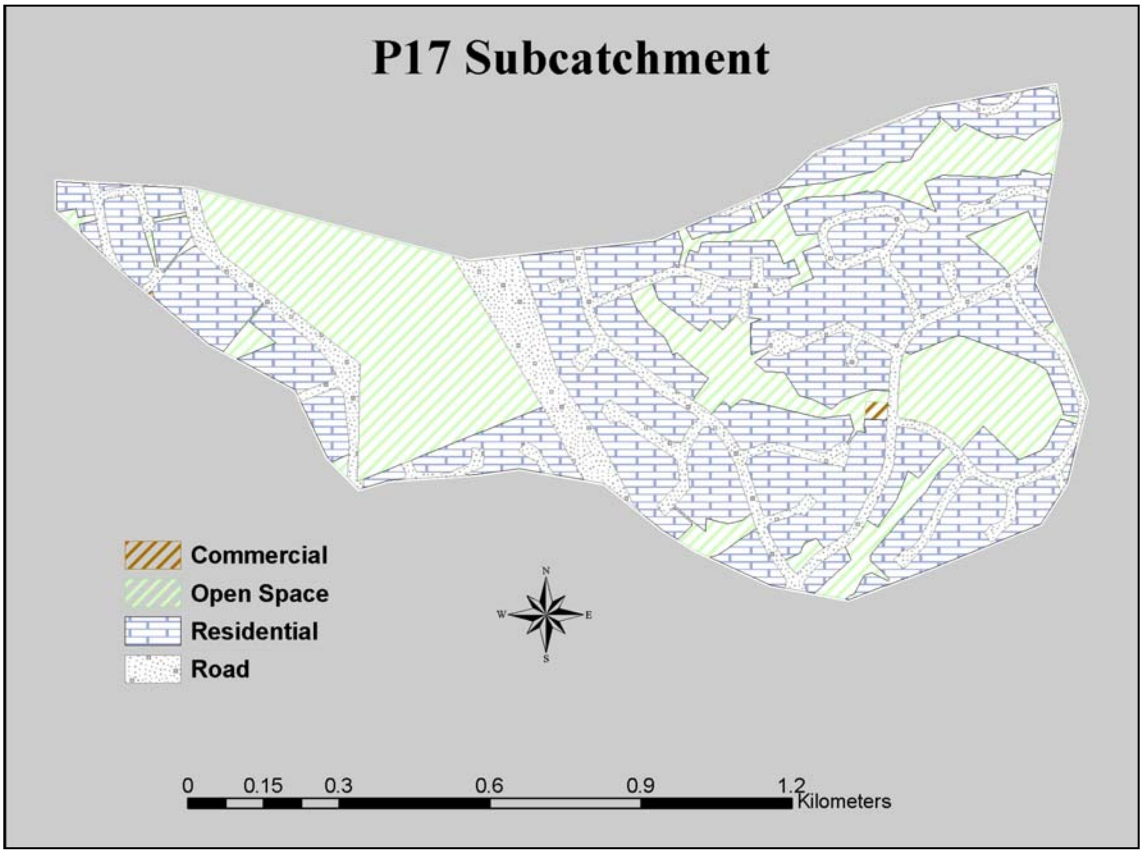
Table 5.4.2: Sum of annual mass contaminant loading per pollutant – McLaughlin

McLaughlin								
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons
	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr
CACML	9.0E+06	1.1E+06	3.2E+04	4.3E+03	1.7E+04	9.2E+04	2.0E+05	4.7E+05
UACML	1.2E+07	1.3E+06	4.3E+04	5.4E+03	2.2E+04	1.2E+05	2.4E+05	5.7E+05
Total Percent Increase	32%	25%	33%	25%	28%	28%	18%	22%
Percent Increase per year	2%	1%	2%	1%	1%	1%	1%	1%
CACML - Current Annual Contaminant Mass Loading								
UACML - Ultimate Annual Contaminant Mass Loading								

5.5 P17 subcatchment

P17 subcatchment covers 110 hectares and has four different land use types: Commercial, Open Space, Residential and Road. Spatial distribution of P17 subcatchment land use types and percentages of land use types are represented in Figure 5.5.1.

Figure 5.5.1: P17 subcatchment land use types



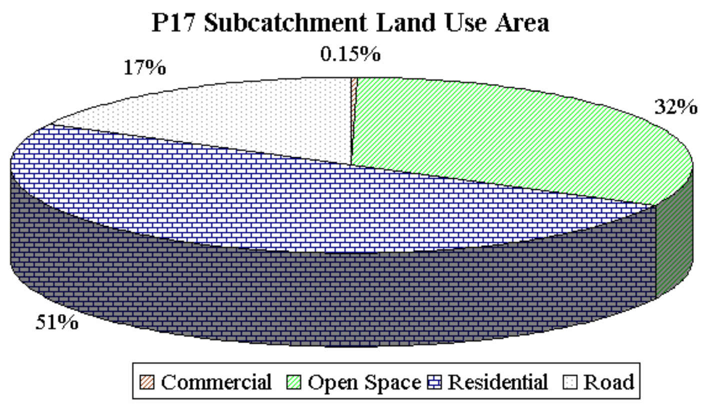


Figure 5.5.2 presents nomalised total percent increase in P17 subcatchment of annual mass contaminant loading for each pollutant.

Table 5.5.1 shows current and ultimate annual contaminant mass loading for the P17 subcatchment land use types. There is no change in current and ultimate development conditions calculated for Open Space land use type. Annual contaminant mass loadings for Commercial, Residential and Road land use types showed increase from current to ultimate development condition.

Table 5.5.2 shows sum of annual mass contaminant loading for each pollutant and a percent of loading increase from current to ultimate development condition.

Figure 5.5.2: P17 subcatchment normalised increase of annual mass contaminant loading

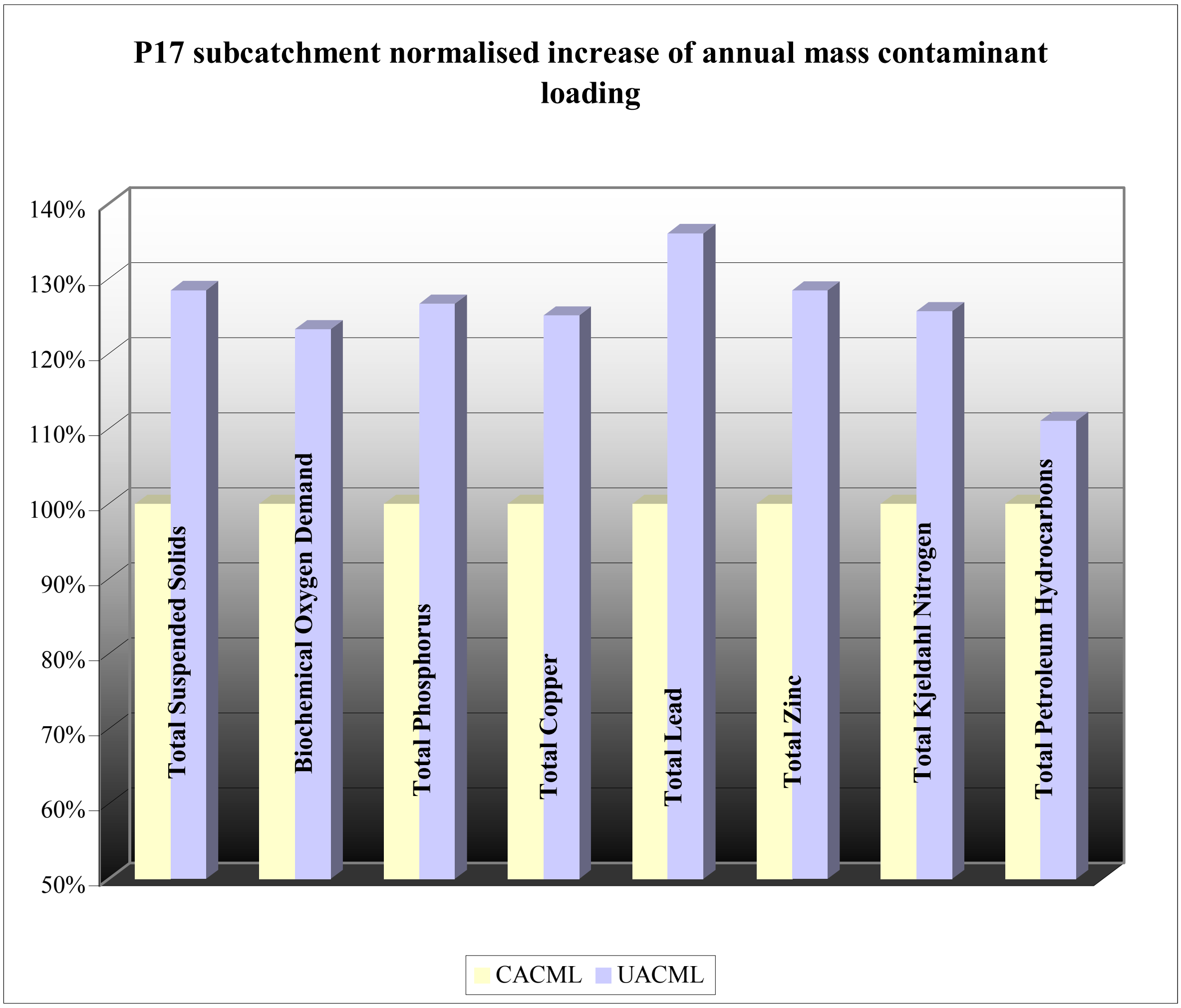


Table 5.5.1: P17 subcatchment annual contaminant mass loading per land use types

P17									
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons	
Land Use	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	
Commercial	5.2E+03	8.1E+02	2.6E+01	4.6E+00	1.4E+01	2.6E+01	2.3E+02	1.3E+02	CACML
	1.4E+04	2.2E+03	7.2E+01	1.3E+01	4.0E+01	7.1E+01	6.3E+02	3.6E+02	UACML
Open Space	8.4E+05	7.6E+04	4.9E+03	1.0E+02	5.2E+01	1.9E+02	1.6E+04	1.7E+04	CACML
	8.4E+05	7.6E+04	4.9E+03	1.0E+02	5.2E+01	1.9E+02	1.6E+04	1.7E+04	UACML
Residential	1.5E+07	6.7E+05	3.3E+04	3.4E+03	1.5E+04	2.3E+04	1.6E+05	1.7E+05	CACML
	2.1E+07	9.5E+05	4.6E+04	4.7E+03	2.1E+04	3.2E+04	2.3E+05	2.4E+05	UACML
Road	6.2E+06	4.8E+05	1.4E+04	2.2E+03	2.2E+03	1.1E+04	9.0E+04	5.4E+05	CACML
	6.3E+06	4.9E+05	1.4E+04	2.3E+03	2.2E+03	1.1E+04	9.2E+04	5.5E+05	UACML
CACML - Current Annual Contaminant Mass Loading									
UACML - Ultimate Annual Contaminant Mass Loading									

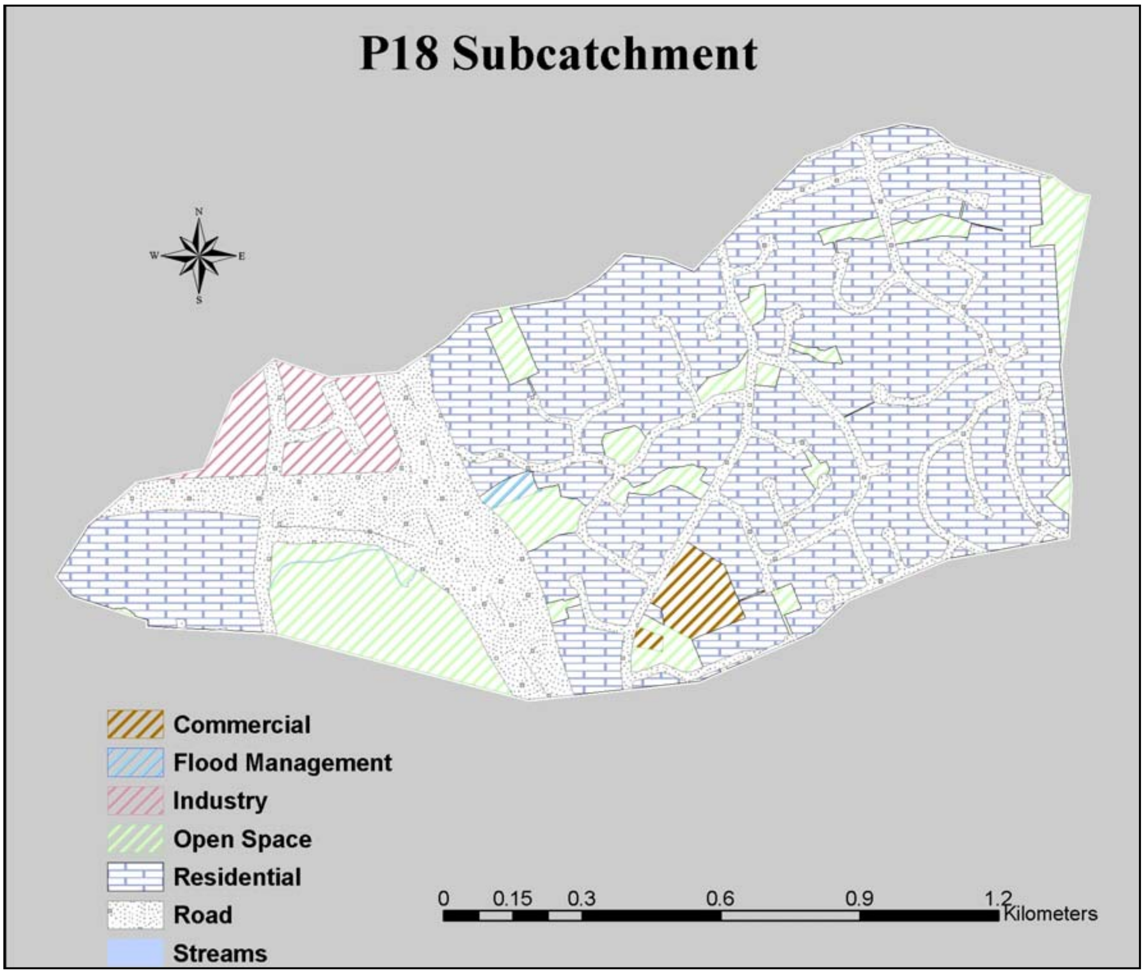
Table 5.5.2: Sum of annual mass contaminant loading per pollutant – P17

P17								
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons
	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr
CACML	2.2E+07	1.2E+06	5.2E+04	5.7E+03	1.7E+04	3.4E+04	2.7E+05	7.3E+05
UACML	2.8E+07	1.5E+06	6.5E+04	7.1E+03	2.4E+04	4.4E+04	3.4E+05	8.1E+05
Total Percent Increase	28%	23%	27%	25%	36%	28%	26%	11%
Percent Increase per year	1%	1%	1%	1%	2%	1%	1%	1%
CACML - Current Annual Contaminant Mass Loading								
UACML - Ultimate Annual Contaminant Mass Loading								

5.6 P18 subcatchment

P18 subcatchment covers 110 hectares and has seven different land use types: Commercial, Flood Management, Industry, Open Space, Residential, Road and Streams. Spatial distribution of P18 subcatchment land use types and land use area percentages are represented in Figure 5.6.1.

Figure 5.6.1: P18 subcatchment land use types



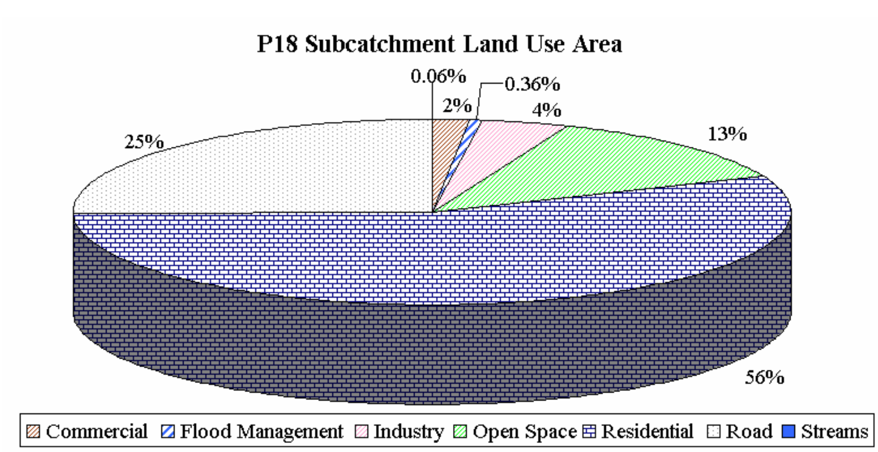


Figure 5.6.2 presents normalised total percent increase in P18 subcatchment of annual mass contaminant loading for each pollutant.

Table 5.6.1 shows current and ultimate annual contaminant mass loading for the P18 subcatchment land use types. There is no change in current and ultimate development conditions calculated for Open Space land use type. Annual contaminant mass loadings for Commercial, Industry, Residential and Road land use types showed an increase from current to ultimate development condition.

Table 5.6.2 shows sum of annual mass contaminant loading for each pollutant and a percent of loading increase from current to ultimate development condition.

Figure 5.6.2: P18 subcatchment normalised increase of annual mass contaminant loading

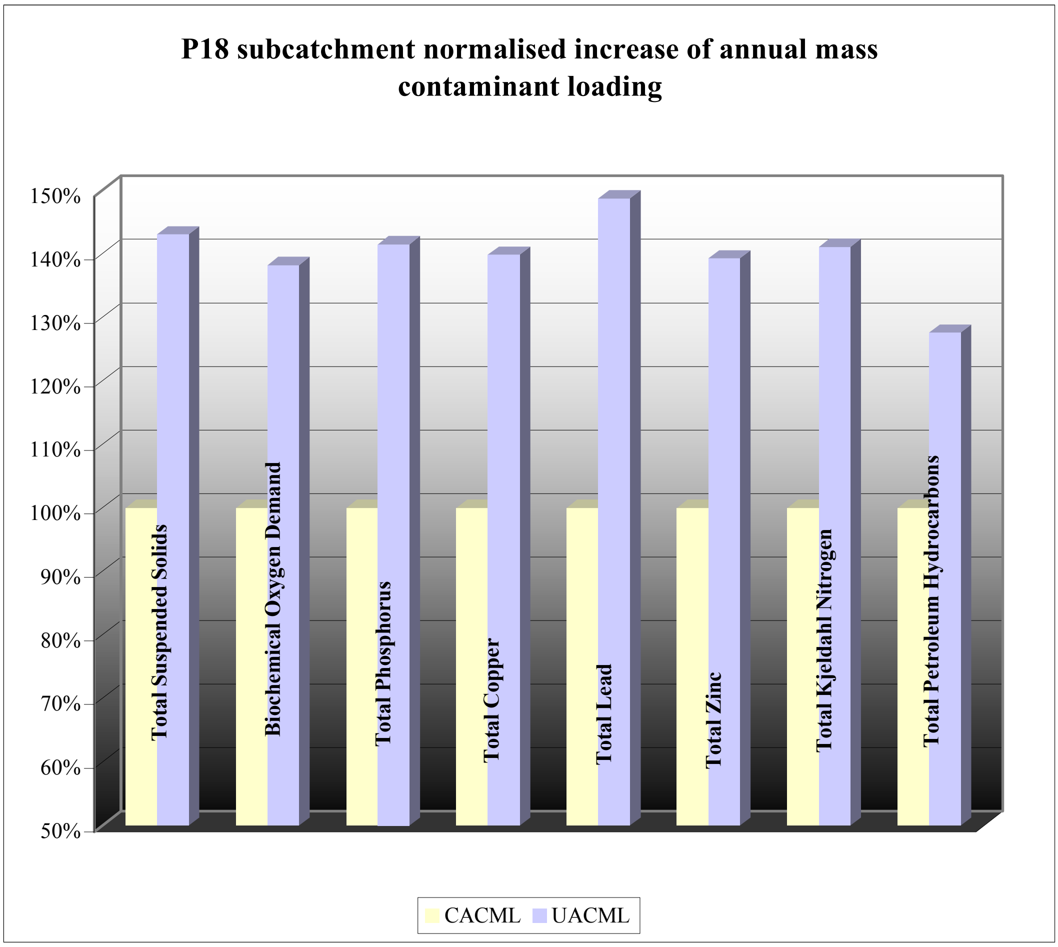


Table 5.6.1: P18 subcatchment annual contaminant mass loading per land use types

P18									
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons	
Land Use	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	
Commercial	2.2E+05	3.4E+04	1.1E+03	2.0E+02	6.0E+02	1.1E+03	9.6E+03	5.5E+03	CACML
	3.8E+05	5.9E+04	1.9E+03	3.4E+02	1.0E+03	1.9E+03	1.7E+04	9.5E+03	UACML
Industry	2.2E+06	2.0E+05	8.1E+03	8.4E+02	3.6E+03	2.0E+04	2.8E+04	7.9E+04	CACML
	2.8E+06	2.6E+05	1.0E+04	1.1E+03	4.6E+03	2.5E+04	3.5E+04	1.0E+05	UACML
Open Space	4.8E+05	4.3E+04	2.8E+03	6.0E+01	3.0E+01	1.1E+02	8.9E+03	1.0E+04	CACML
	4.8E+05	4.3E+04	2.8E+03	6.0E+01	3.0E+01	1.1E+02	8.9E+03	1.0E+04	UACML
Residential	1.9E+07	8.5E+05	4.2E+04	4.3E+03	1.9E+04	2.9E+04	2.1E+05	2.2E+05	CACML
	3.0E+07	1.3E+06	6.5E+04	6.7E+03	3.0E+04	4.6E+04	3.3E+05	3.4E+05	UACML
Road	9.2E+06	7.2E+05	2.1E+04	3.3E+03	3.2E+03	1.6E+04	1.3E+05	8.1E+05	CACML
	1.1E+07	8.6E+05	2.5E+04	4.0E+03	3.9E+03	1.9E+04	1.6E+05	9.6E+05	UACML
CACML - Current Annual Contaminant Mass Loading									
UACML - Ultimate Annual Contaminant Mass Loading									

Table 5.6.2: Sum of annual mass contaminant loading per pollutant – P18

P18								
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons
	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr
CACML	3.1E+07	1.9E+06	7.4E+04	8.7E+03	2.7E+04	6.6E+04	3.9E+05	1.1E+06
UACML	4.4E+07	2.6E+06	1.0E+05	1.2E+04	4.0E+04	9.2E+04	5.5E+05	1.4E+06
Total Percent Increase	43%	38%	41%	40%	49%	39%	41%	28%
Percent Increase per year	2%	2%	2%	2%	3%	2%	2%	1%
CACML - Current Annual Contaminant Mass Loading								
UACML - Ultimate Annual Contaminant Mass Loading								

5.7 Puhinui Coast subcatchment

Puhinui Coast subcatchment covers 87 hectares and has two different land use types: Open Space and Water. Spatial distribution of Puhinui Coast subcatchment land use types is represented in Figure 5.7.1.

Figure 5.7.1: Puhinui Coast subcatchment land use types

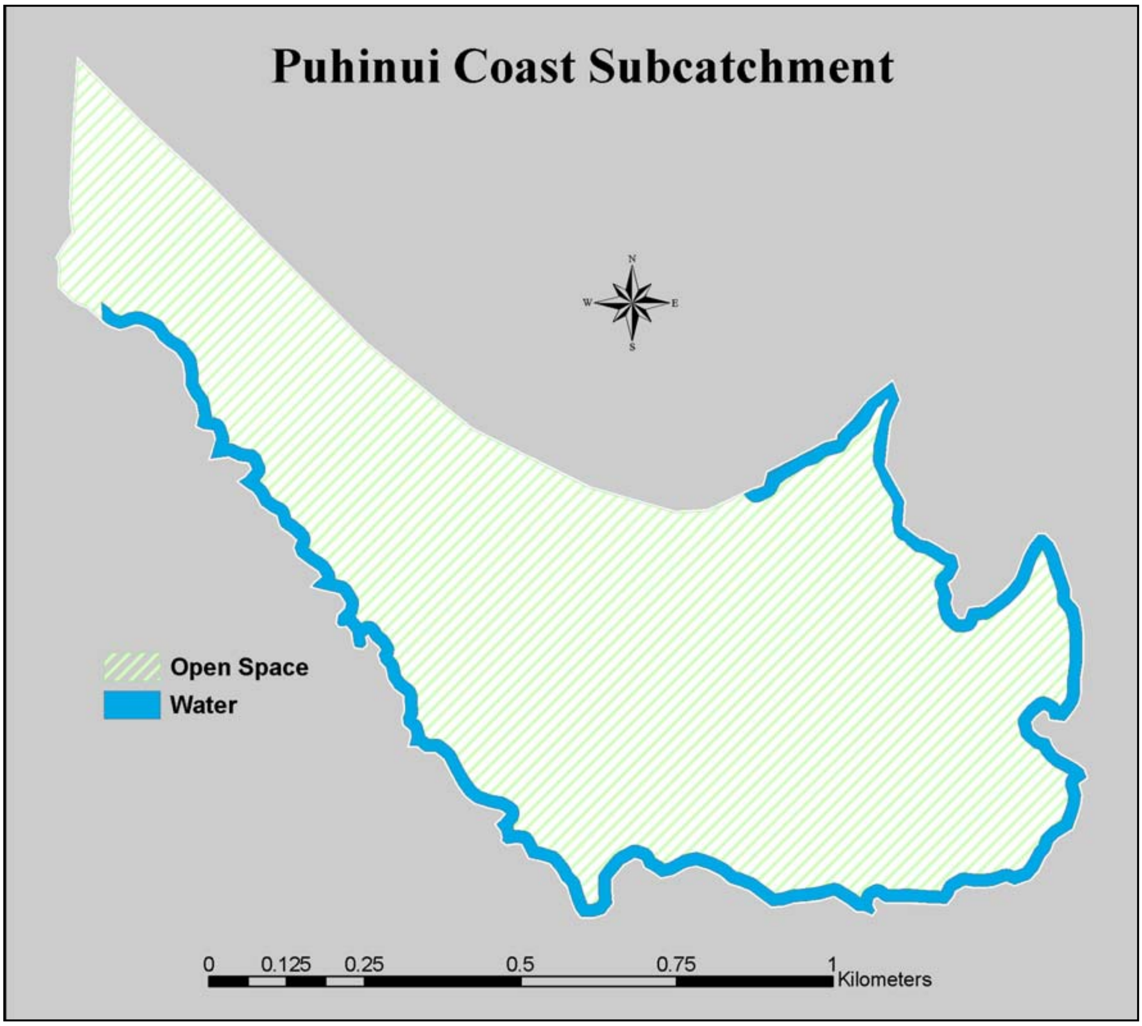


Table 5.7.1 shows current and ultimate annual contaminant mass loading for the Puhinui Coast subcatchment land use types. There is no change in current and ultimate development conditions calculated for Open Space land use type.

Puhinui Coast subcatchment is the only Puhinui subcatchment which did not show any changes from current to ultimate development conditions, as there is no planned urbanisation or industrialisation of this subcatchment.

Table 5.7.1: Puhinui Coast subcatchment annual contaminant mass loading per land use types

Puhinui Coast									
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons	
Land Use	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	
Open Space	1.9E+06	1.7E+05	1.1E+04	2.3E+02	1.2E+02	4.2E+02	3.5E+04	3.9E+04	CACML
	1.9E+06	1.7E+05	1.1E+04	2.3E+02	1.2E+02	4.2E+02	3.5E+04	3.9E+04	UACML
CACML - Current Annual Contaminant Mass Loading									
UACML - Ultimate Annual Contaminant Mass Loading									

5.8 Puhinui Stream subcatchment

Puhinui Stream subcatchment covers 1623 hectares and has eleven different land use types: Commercial, Flood Management, Industry, Open Space, Quarry Zone, Residential, Road, Rural, Streams, Surface of Rivers and Water. This is the largest subcatchment in the Puhinui catchment and the most diverse in terms of present land use types. Manukau City Centre is situated in the Puhinui Stream subcatchment. Puhinui Stream is the only subcatchment in the Puhinui catchment with Rural land use type.

Puhinui Stream subcatchment discharges into Manukau Harbour, next to the Auckland International Airport.

The Puhinui stream has undergone extensive alteration and in a number of locations has been channelled and lined in concrete. This caused loss of ecological, recreational and amenity values. Further modification to the Puhinui stream is anticipated with the future construction of State Highway 20 across several sections of the stream (D.J. Scott Associates Ltd, 2002).

Normalised total percent increase in Puhinui Stream subcatchment of annual mass contaminant loading for each pollutant is presented in Figure 5.8.2.

Table 5.8.1 shows current and ultimate annual contaminant mass loading for the Puhinui Stream subcatchment land use types. There is no change in current and ultimate development conditions calculated for Open Space, Quarry Zone and Rural land use types. Annual contaminant mass loadings for Commercial, Industry, Residential and Road land use types showed an increase from current to ultimate development condition.

Table 5.8.2 shows the sum of annual mass contaminant loading for each pollutant and a percent of loading increase from current to ultimate development condition.

Spatial distribution of Puhinui Stream subcatchment land use types and percentages of land use types are represented in Figure 5.8.1.

Figure 5.8.1: Puhinui Stream subcatchment land use types

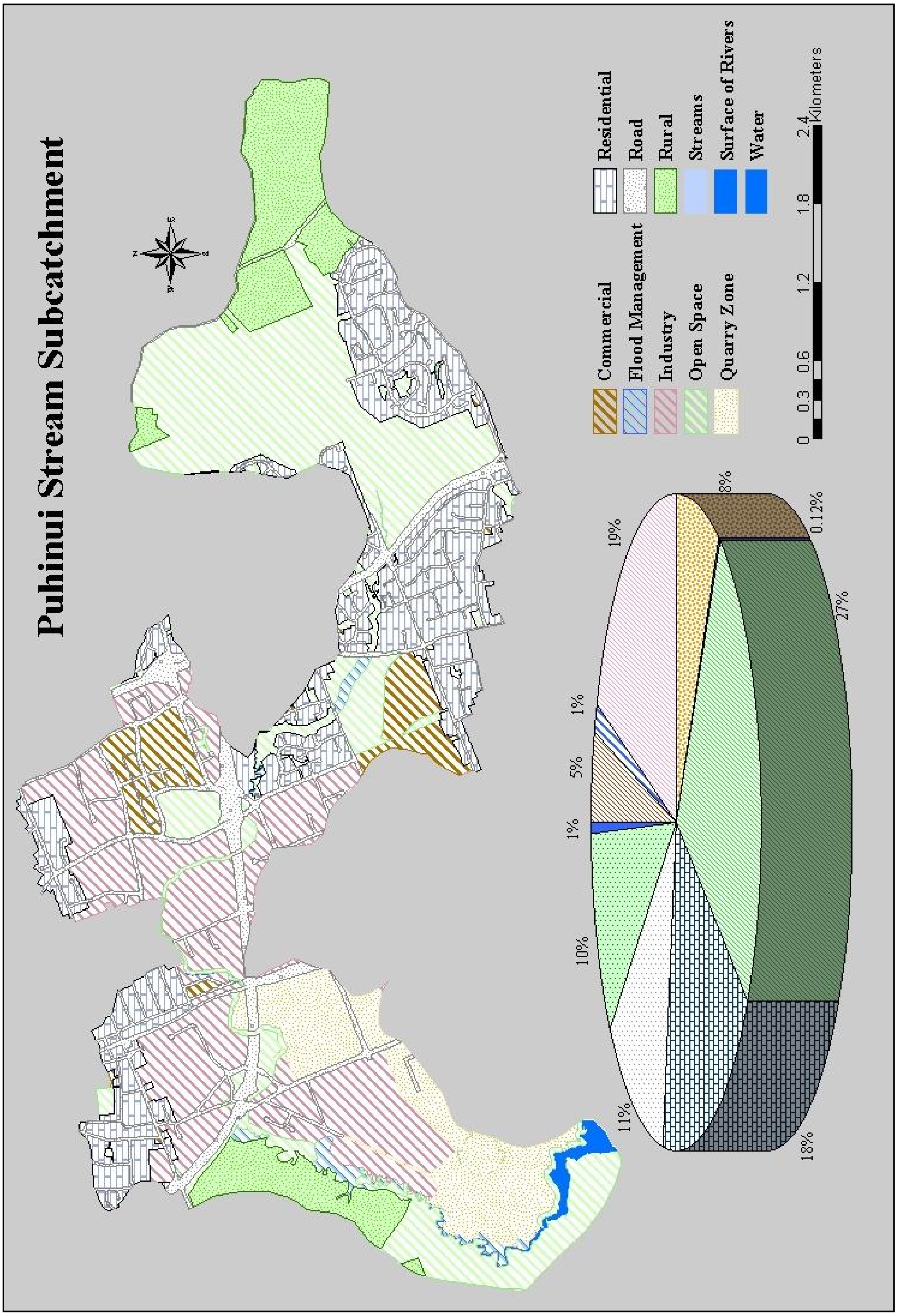


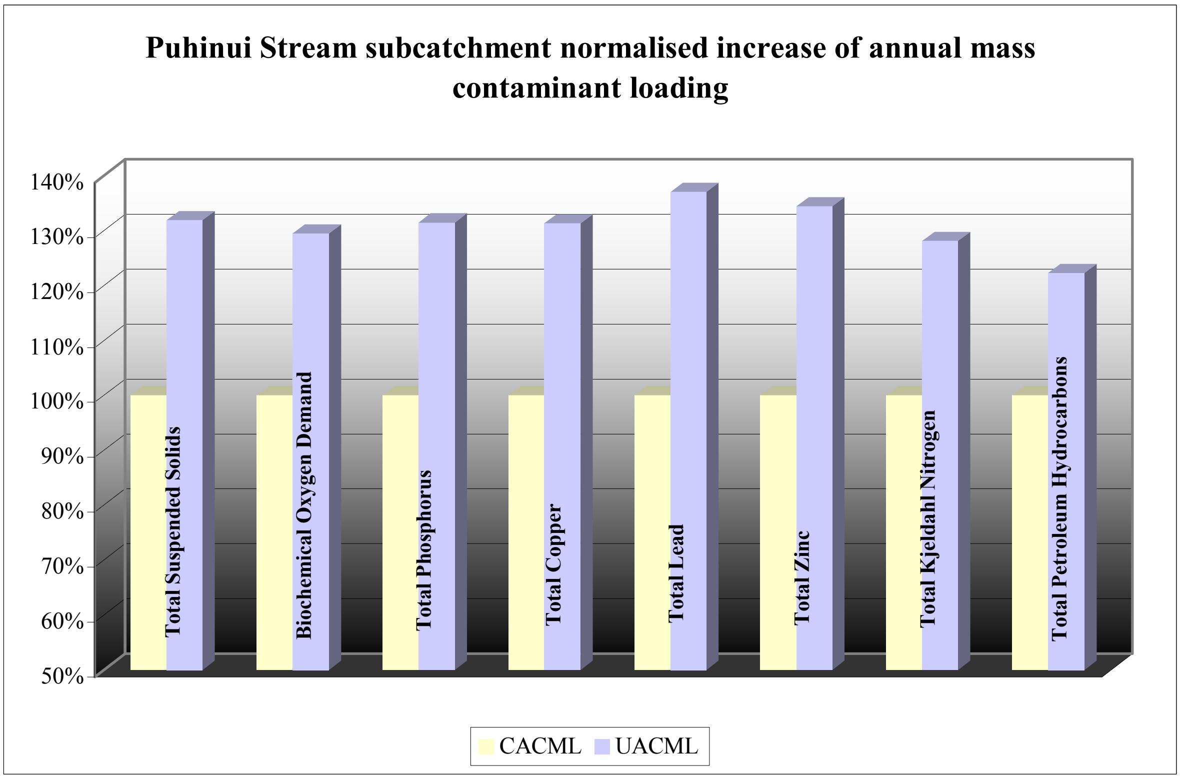
Table 5.8.1: Puhinui Stream subcatchment annual contaminant mass loading per land use types

Puhinui Stream									
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons	
Land Use	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	
	8.9E+06	1.4E+06	4.5E+04	8.0E+03	2.5E+04	4.4E+04	3.9E+05	2.3E+05	CACML
Commercial	1.2E+07	1.9E+06	6.2E+04	1.1E+04	3.4E+04	6.1E+04	5.4E+05	3.1E+05	UACML
	9.3E+07	8.7E+06	3.4E+05	3.6E+04	1.5E+05	8.3E+05	1.2E+06	3.4E+06	CACML
Industry	1.3E+08	1.2E+07	4.8E+05	5.0E+04	2.1E+05	1.2E+06	1.6E+06	4.7E+06	UACML
	1.9E+06	8.6E+05	6.6E+03	3.5E+03	1.5E+04	8.2E+04	2.6E+05	3.3E+05	CACML
Quarry Zone	1.9E+06	8.6E+05	6.7E+03	3.5E+03	1.5E+04	8.2E+04	2.6E+05	3.3E+05	UACML
	1.0E+07	9.5E+05	6.1E+04	1.3E+03	6.5E+02	2.4E+03	1.9E+05	2.2E+05	CACML
Open Space	1.0E+07	9.5E+05	6.1E+04	1.3E+03	6.5E+02	2.4E+03	1.9E+05	2.2E+05	UACML
	7.2E+07	3.2E+06	1.6E+05	1.6E+04	7.3E+04	1.1E+05	7.9E+05	8.2E+05	CACML
Residential	1.1E+08	4.8E+06	2.3E+05	2.4E+04	1.1E+05	1.6E+05	1.2E+06	1.2E+06	UACML
	5.4E+07	4.2E+06	1.2E+05	1.9E+04	1.9E+04	9.4E+04	7.9E+05	4.7E+06	CACML
Road	5.8E+07	4.5E+06	1.3E+05	2.1E+04	2.0E+04	1.0E+05	8.5E+05	5.1E+06	UACML
	7.9E+06	4.5E+05	2.1E+04	2.5E+02	1.2E+03	4.5E+03	1.6E+05	8.3E+04	CACML
Rural	7.9E+06	4.5E+05	2.1E+04	2.5E+02	1.2E+03	4.5E+03	1.6E+05	8.3E+04	UACML
CACML - Current Annual Contaminant Mass Loading									
UACML - Ultimate Annual Contaminant Mass Loading									

Table 5.8.2: Sum of annual mass contaminant loading per pollutant – Puhinui Stream

Puhinui Stream								
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons
CACML	2.5E+08	2.0E+07	7.5E+05	8.4E+04	2.9E+05	1.2E+06	3.8E+06	9.8E+06
UACML	3.3E+08	2.6E+07	9.9E+05	1.1E+05	3.9E+05	1.6E+06	4.8E+06	1.2E+07
Total Percent Increase	32%	29%	31%	31%	37%	34%	28%	22%
Percent Increase per year	2%	2%	2%	2%	2%	2%	1%	1%
CACML - Current Annual Contaminant Mass Loading								
UACML - Ultimate Annual Contaminant Mass Loading								

Figure 5.8.2: Puhinui Stream subcatchment normalised increase of annual mass contaminant loading



5.9 Wiri subcatchment

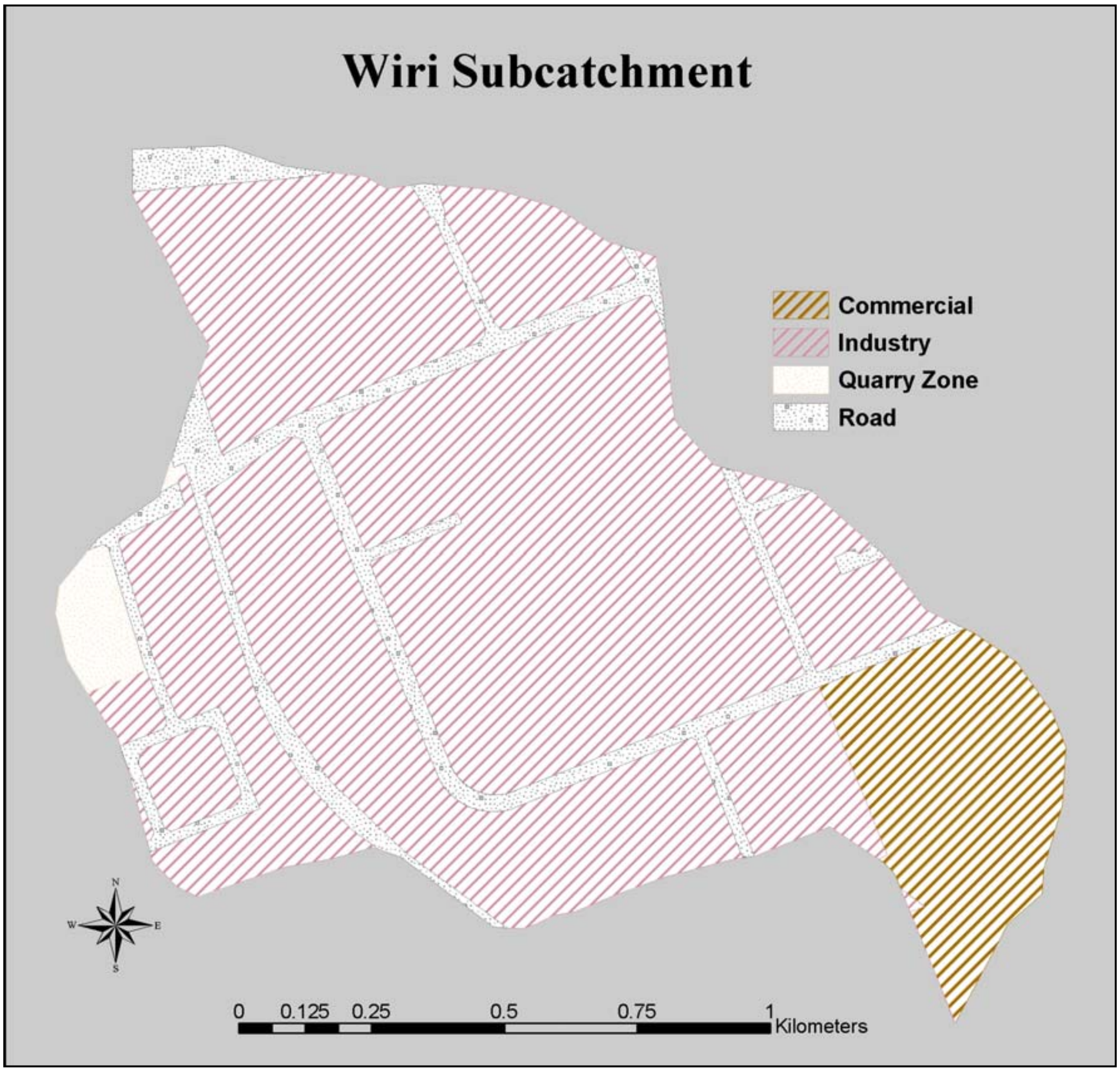
Wiri subcatchment covers 178 hectares and has four different land use types: Commercial, Industry, Quarry Zone, and Road. Spatial distribution of Wiri subcatchment land use types and percentages of land use types are represented in Figure 5.9.1.

Table 5.9.1 shows current and ultimate annual contaminant mass loading for the Wiri subcatchment land use types. There is no change in current and ultimate development conditions calculated for Quarry Zone land use type. Annual contaminant mass loadings for Commercial, Industry, and Road land use types showed increase from current to ultimate development condition.

Table 5.9.2 shows sum of annual mass contaminant loading for each pollutant and a percent of loading increase from current to ultimate development condition.

Figure 5.9.2 presents normalised total percent increase in Puhinui Stream subcatchment of annual mass contaminant loading for each pollutant.

Figure 5.9.1: Wiri subcatchment land use types



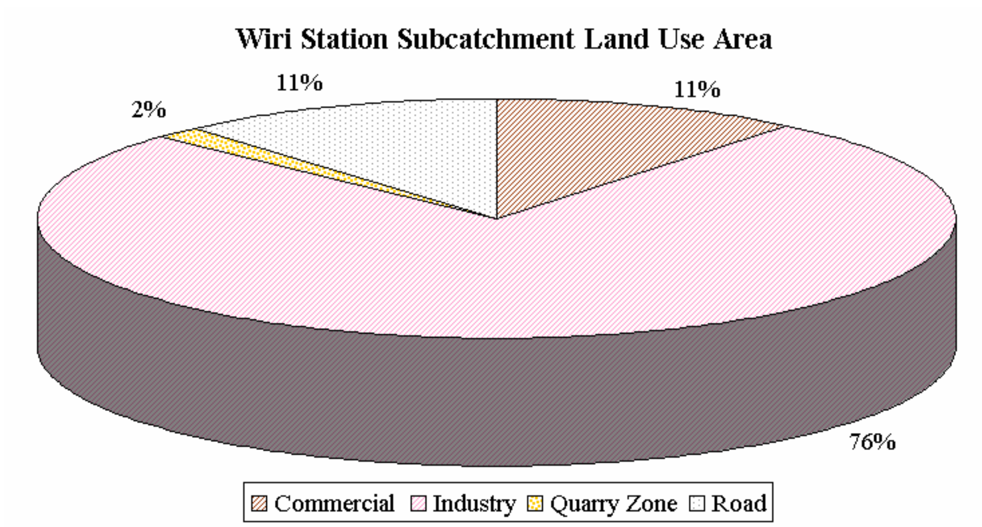


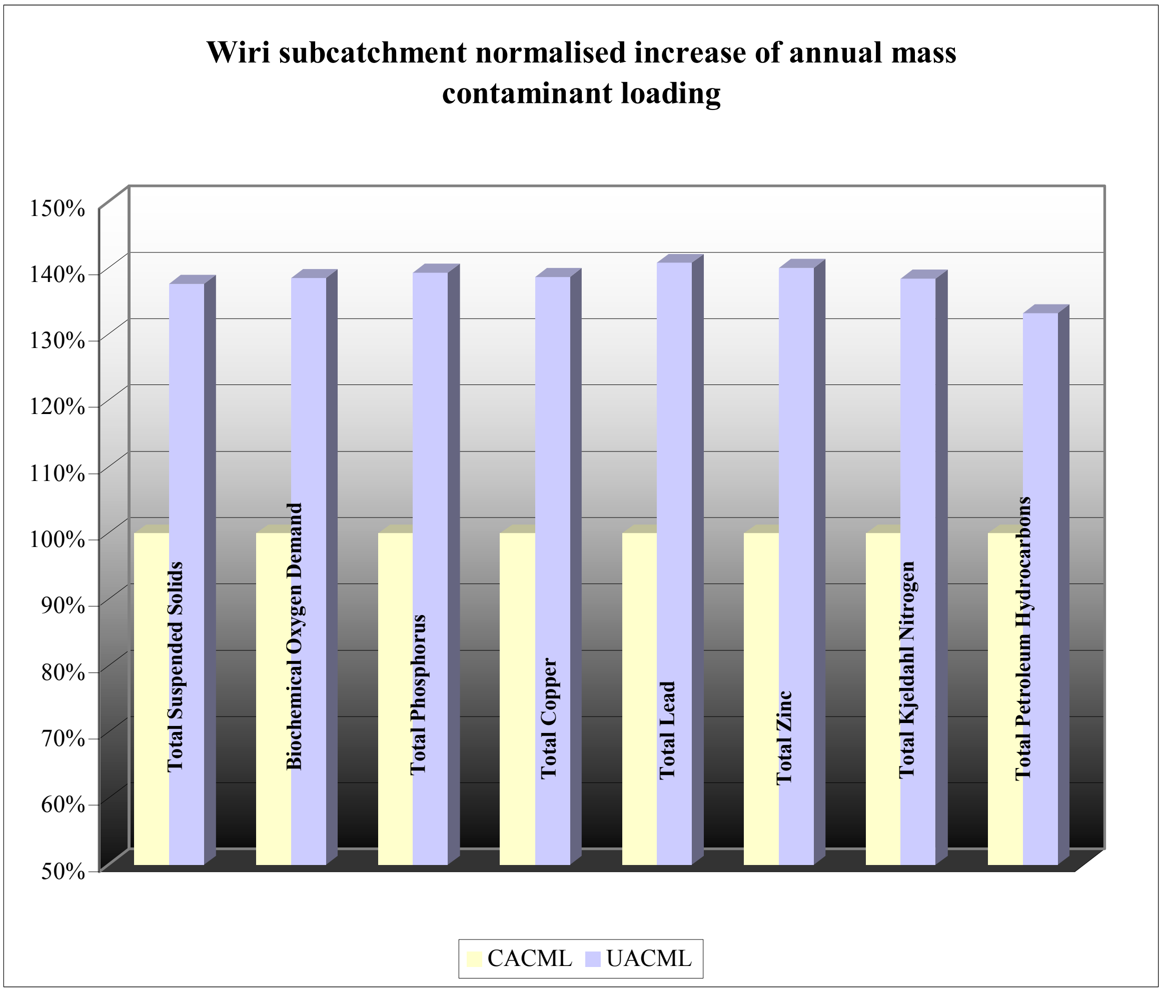
Table 5.9.1: Wiri subcatchment annual contaminant mass loading per land use types

Wiri									
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons	
Land Use	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	
Commercial	1.8E+06	2.8E+05	9.1E+03	1.6E+03	5.0E+03	9.0E+03	7.9E+04	4.6E+04	CACML
	2.8E+06	4.4E+05	1.4E+04	2.6E+03	7.9E+03	1.4E+04	1.3E+05	7.2E+04	UACML
Industry	3.9E+07	3.7E+06	1.4E+05	1.5E+04	6.4E+04	3.5E+05	5.0E+05	1.4E+06	CACML
	5.5E+07	5.1E+06	2.0E+05	2.1E+04	9.0E+04	4.9E+05	7.0E+05	2.0E+06	UACML
Quarry Zone	6.5E+04	2.9E+04	2.3E+02	1.2E+02	5.1E+02	2.8E+03	8.9E+03	1.1E+04	CACML
	6.5E+04	2.9E+04	2.3E+02	1.2E+02	5.1E+02	2.8E+03	8.9E+03	1.1E+04	UACML
Road	5.6E+06	4.3E+05	1.2E+04	2.0E+03	2.0E+03	9.7E+03	8.2E+04	4.9E+05	CACML
	6.12E+06	4.8E+05	1.4E+04	2.2E+03	2.1E+03	1.1E+04	9.0E+04	5.4E+05	UACML
CACML - Current Annual Contaminant Mass Loading									
UACML - Ultimate Annual Contaminant Mass Loading									

Table 5.9.2: Sum of annual mass contaminant loading per pollutant – Wiri

Wiri								
	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Total Copper	Total Lead	Total Zinc	Total Kjeldahl Nitrogen	Total Petroleum Hydrocarbons
	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr	g/yr
CACML	4.7E+07	4.4E+06	1.7E+05	1.9E+04	7.2E+04	3.7E+05	6.7E+05	2.0E+06
UACML	6.4E+07	6.1E+06	2.3E+05	2.6E+04	1.0E+05	5.2E+05	9.2E+05	2.6E+06
Total Percent Increase	38%	38%	39%	39%	41%	40%	38%	33%
Percent Increase per year	2%	2%	2%	2%	2%	2%	2%	2%
CACML - Current Annual Contaminant Mass Loading								
UACML - Ultimate Annual Contaminant Mass Loading								

Figure 5.9.2: Wiri subcatchment normalised increase of annual mass contaminant loading

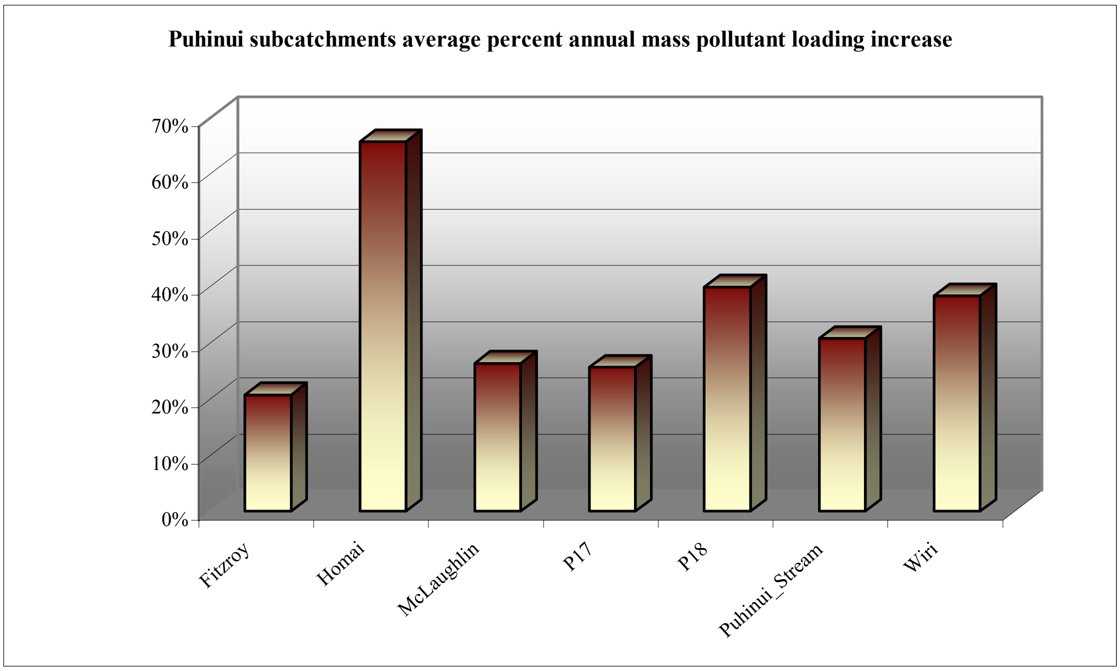


5.10 Puhinui catchment

Although Wiri subcatchment showed the highest annual mass loadings for each calculated pollutant except Total Suspended Solids, the highest average increase in total mass pollutant loading was recorded in Homai subcatchment while there was no recorded increase in Puhinui Coast subcatchment.

Homai subcatchment largely consists of industrial land use which covers 67% of the overall subcatchment area. Puhinui Coast subcatchment consists of Open Space land use type, and as there was no residential or business development planned in this area, increase in total pollutant loading was non-existent. The rest of the subcatchments showed average increase in total mass pollutant loading for the ultimate land use development between 20 and 40 percent. Figure 5.10.1 presents average percent annual mass pollutant loading increase in the Puhinui catchment per each subcatchment.

Figure 5.10.1: Puhinui subcatchments average percent annual mass pollutant loading increase

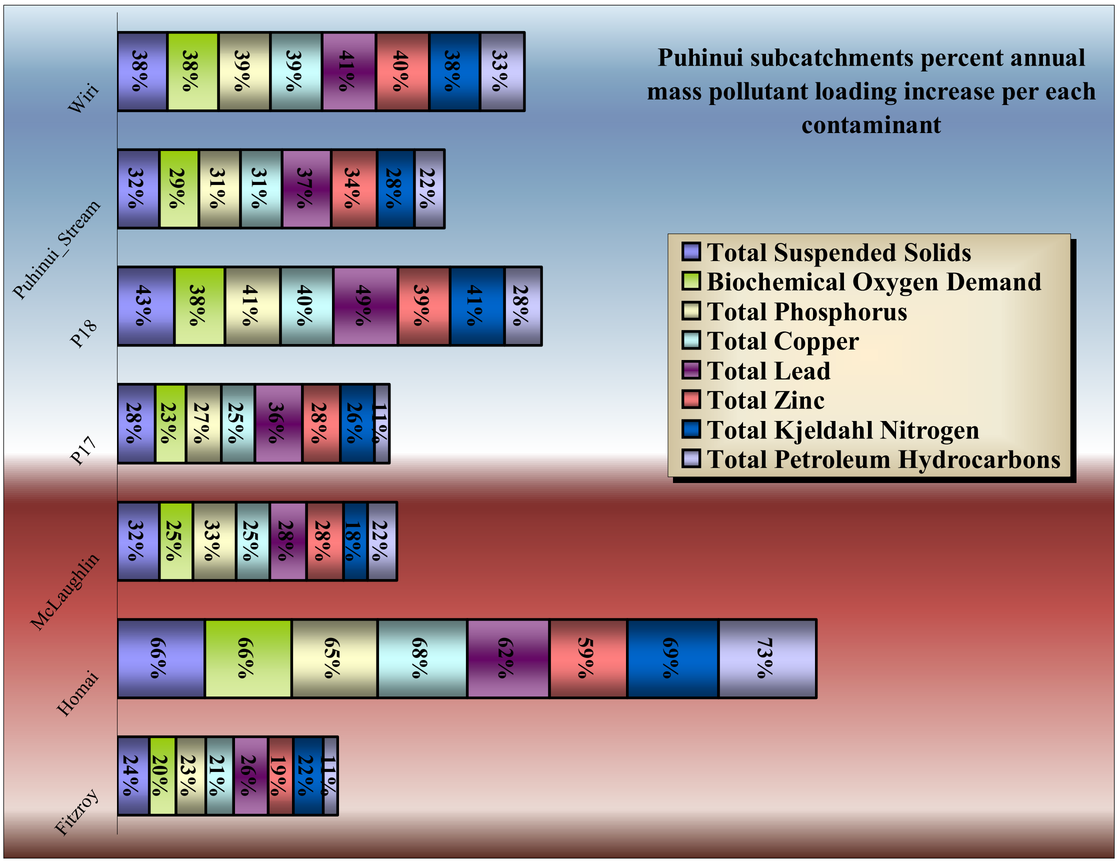


The highest average total loading increase for the ultimate land use development was recorded for Lead, 35%, and Total Petroleum Hydrocarbons showed the lowest increase of 25%. Figure 5.10.2 presents total average percent annual mass pollutant loading increase in the Puhinui catchment per each pollutant.

Total Petroleum Hydrocarbons average mass loading was mostly lower then the other contaminants loadings except in the Homai subcatchment where it showed higher increase then the rest of the contaminants. Again the reason for this is the land use types present in the Homai subcatchment: Industry 67%, Commercial 14%, Road 9%, Quarry Zone 7%, Residential 3% and Open Space 0.48%. Industry, Road, Quarry Zone, Commercial and Residential land use types have the highest median contaminant concentration values for Petroleum Hydrocarbons.

Total Lead showed the highest increase in the average mass pollutant loading in relation to other contaminants for every subcatchment except the Homai and McLaughlin subcatchments, and even in the McLaughlin subcatchment it showed the third highest increase in the average mass pollutant loading.

Figure 5.10.2: Puhinui subcatchments percent annual mass pollutant loading increase per each contaminant



Total Suspended Solids, Total Phosphorus, Total Copper and Total Zinc showed the highest increase in the average mass pollutant loading after Lead.

Figure 5.10.3 presents Puhinui subcatchments average percent annual mass pollutant loading increase visualised in 3D format available in ArcScene, where each subcatchment is extruded by the value of increase percentage.

The highest average annual mass contaminant loading percent increase was recorded for Commercial land use type 49%, then Residential land use type 47%, Industry 41%, Road 11% and Quarry Zone 0.21%. There was no increase in annual mass contaminant loading recorded for Rural and Open Space land use types.

Figure 5.10.4 presents Puhinui catchment average annual mass contaminant loading percent increase per land use visualised in 3D format where each land use is extruded by the value of the increase percentage.

Figure 5.10.3: Puhinui subcatchments average percent annual mass pollutant loading increase, 3D

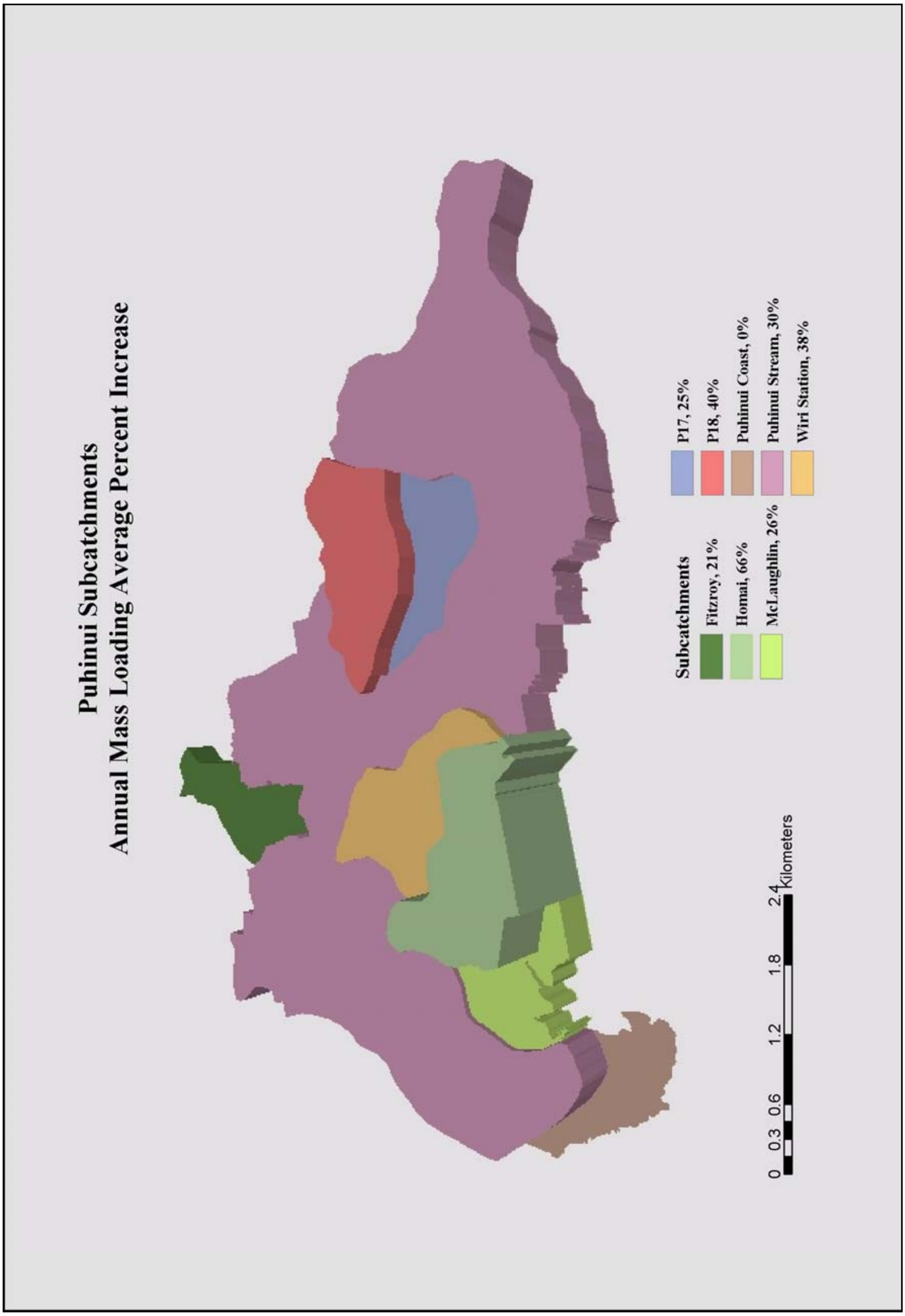
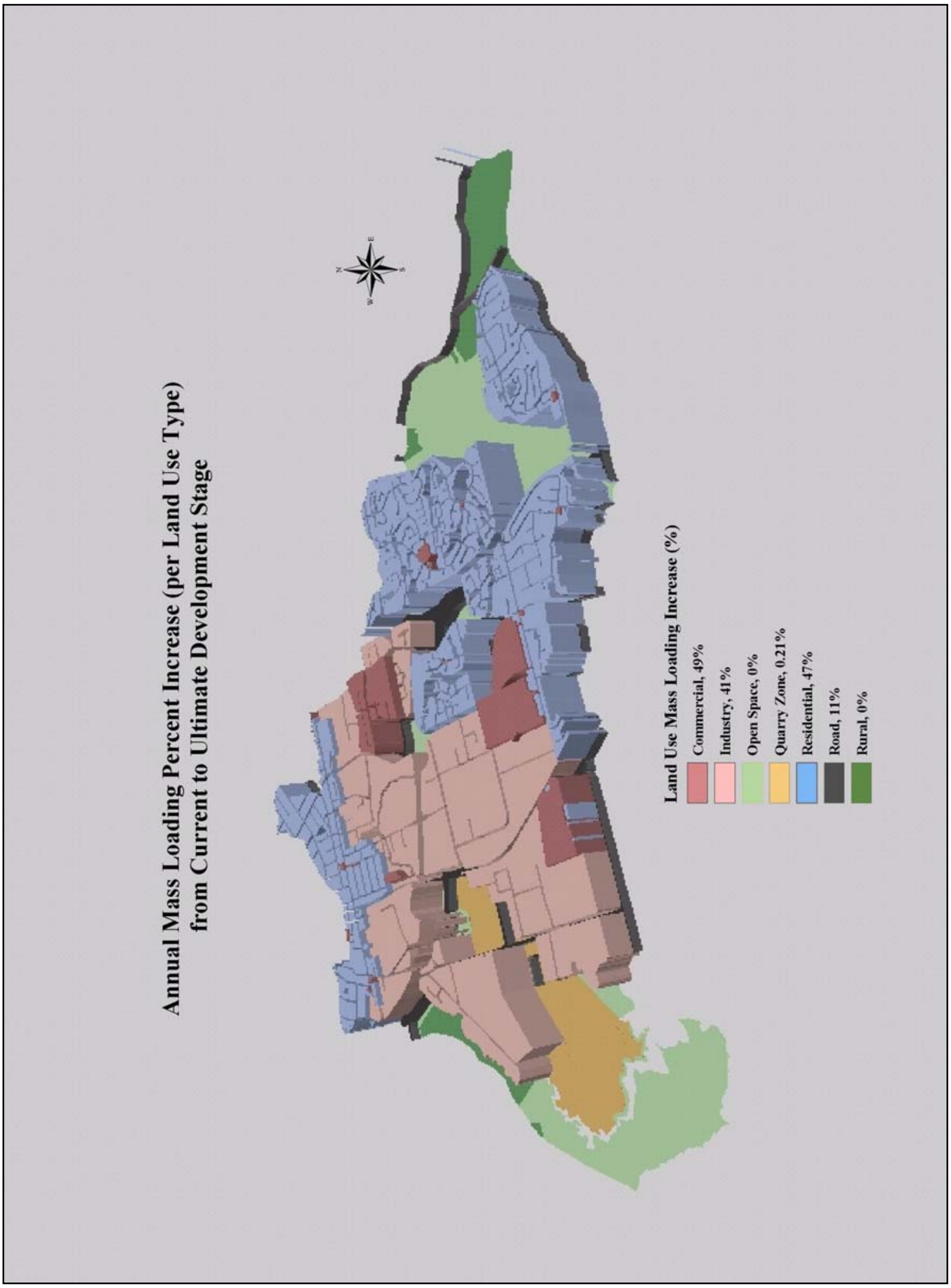
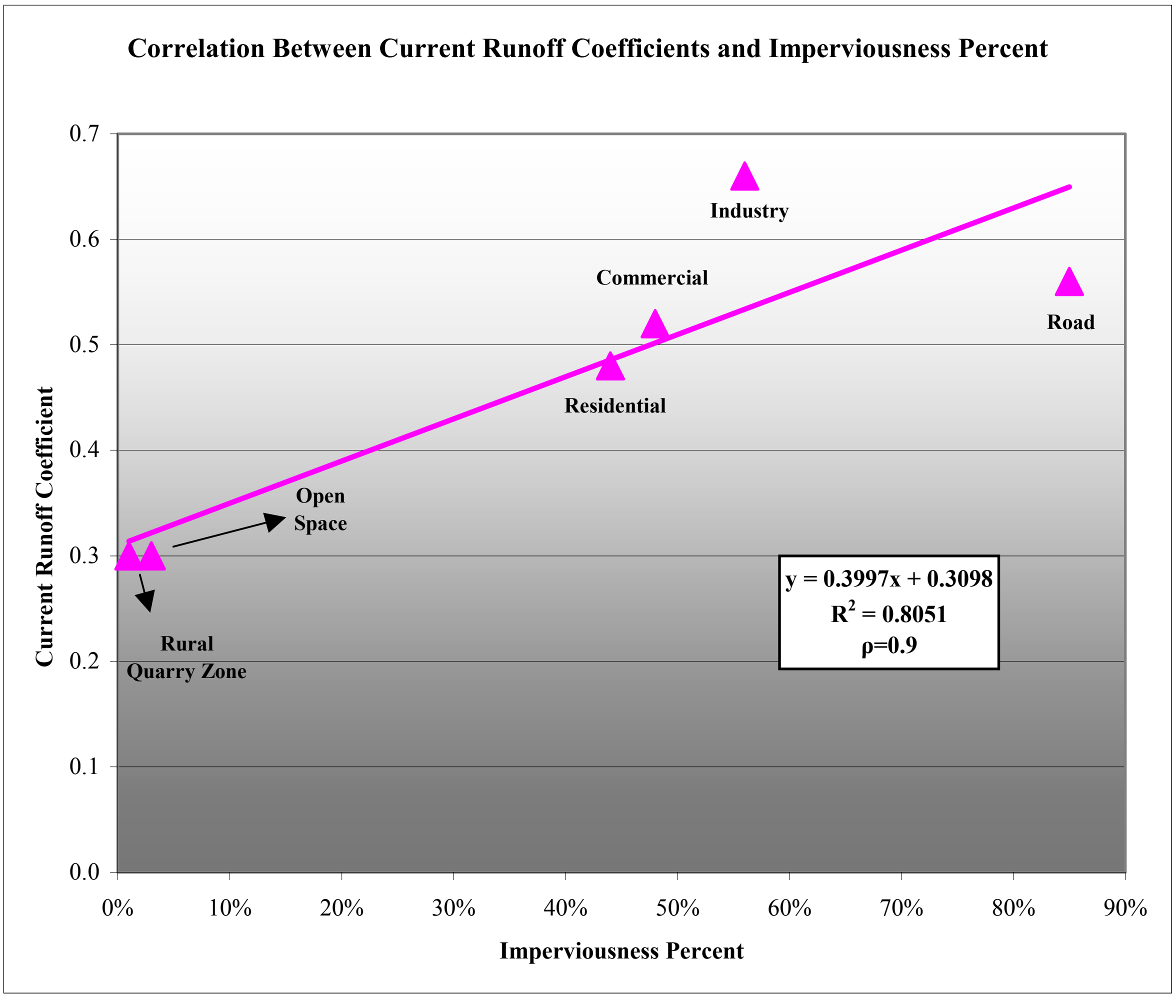


Figure 5.10.4: Puhinui catchment average annual mass pollutant loading increase per land use, 3D



A very strong correlation exists between imperviousness and runoff coefficients in the Puhinui catchment (Figure 5.10.5). Large values of runoff coefficients data set are associated with large values of the imperviousness percent data set resulting in a high correlation coefficient ρ=0.9.

Figure 5.10.5: Puhinui catchment runoff coefficients and imperviousness percent correlation



Maps are generated showing annual mass contaminant loadings per subcatchment in the Puhinui catchment for each pollutant showing current and ultimate loading values in kilograms per hectare per year.

Figures 5.10.6 to 5.10.13 present annual mass contaminant loadings per subcatchment in the Puhinui catchment.

Figure 5.10.6: Total Suspended Solids annual mass loading (kg/ha/yr) per subcatchment

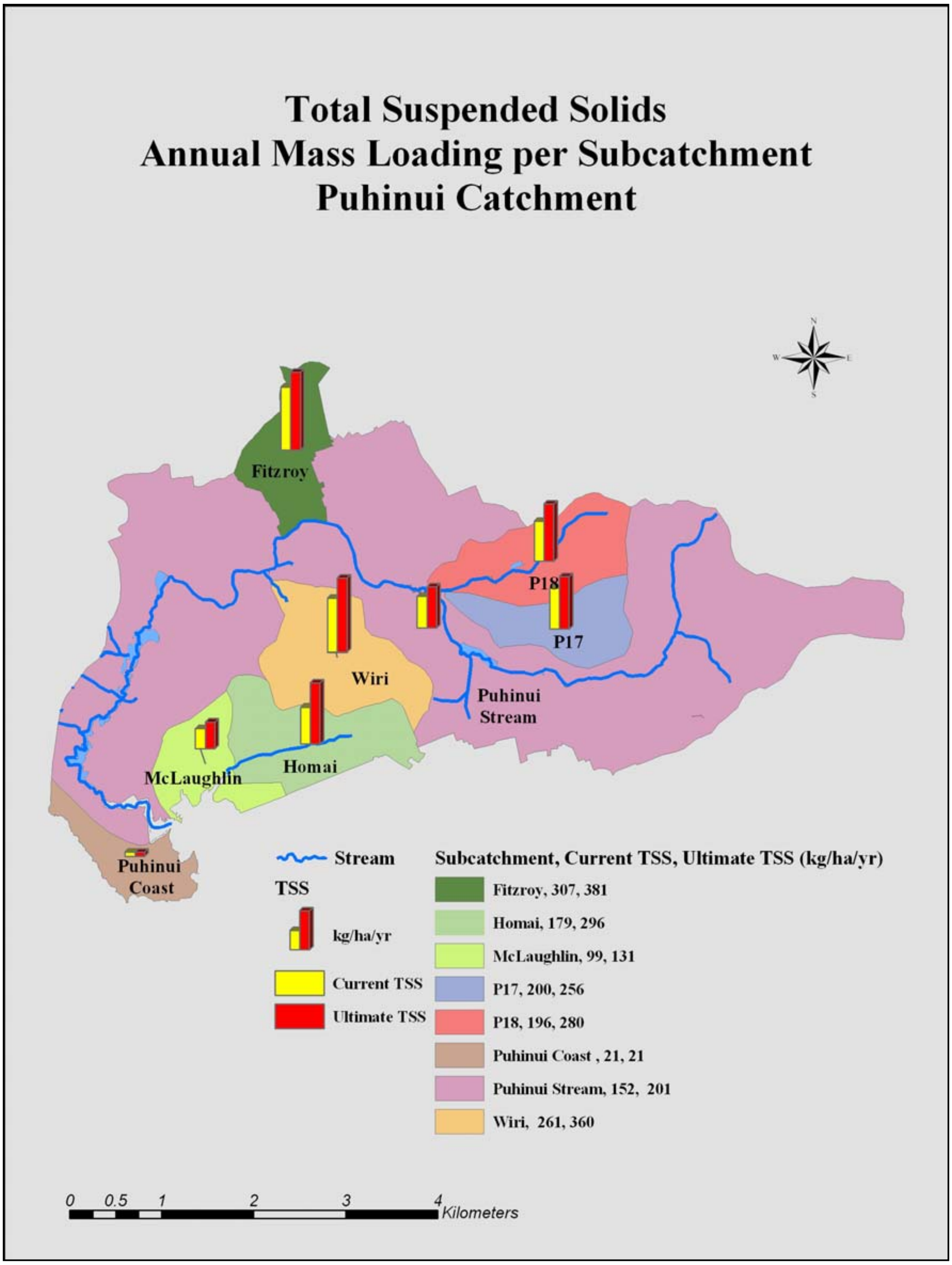


Figure 5.10.7: Biochemical Oxygen Demand annual mass loading (kg/ha/yr) per subcatchment

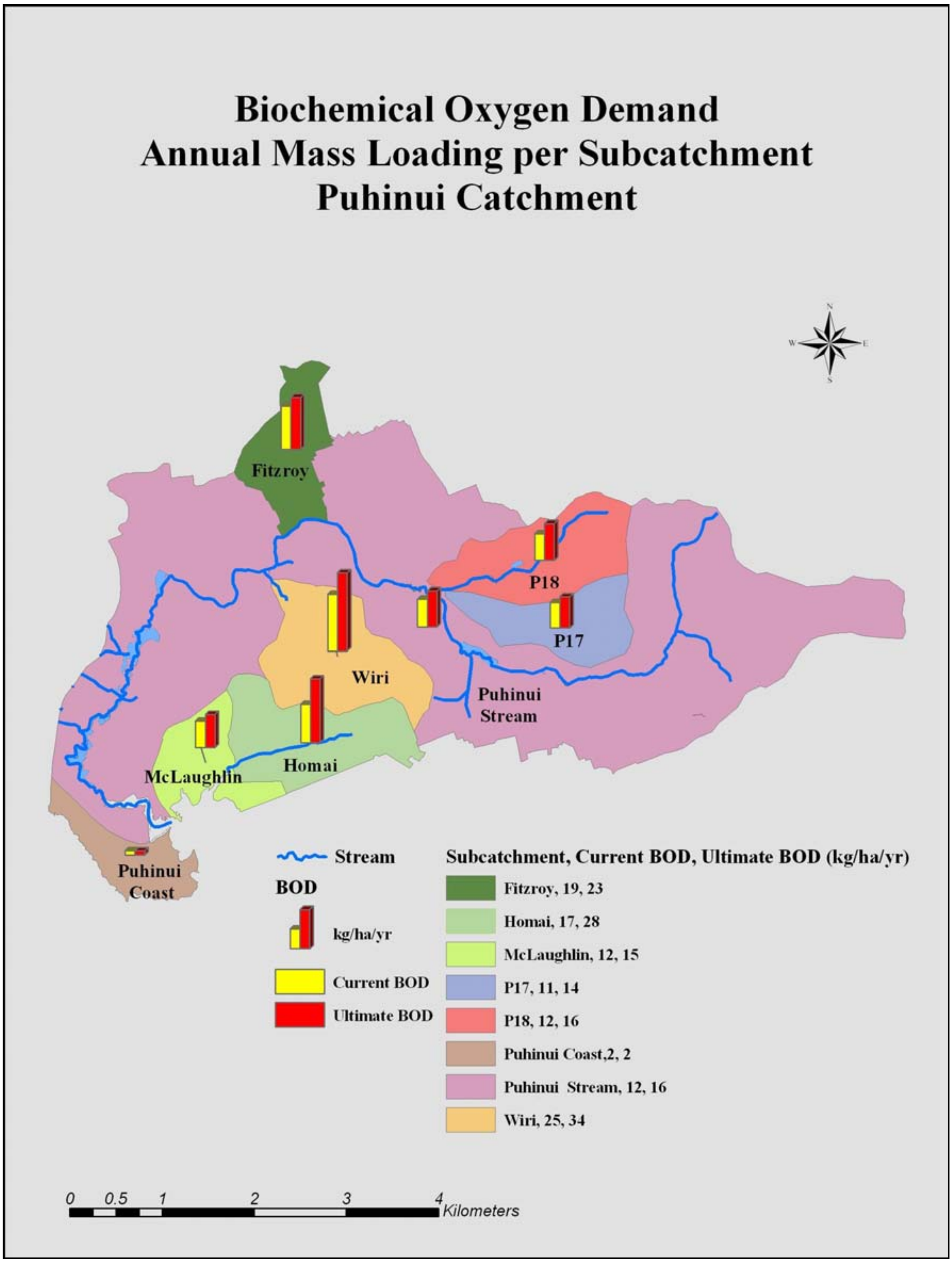


Figure 5.10.8: Total Phosphorus annual mass loading (kg/ha/yr) per subcatchment

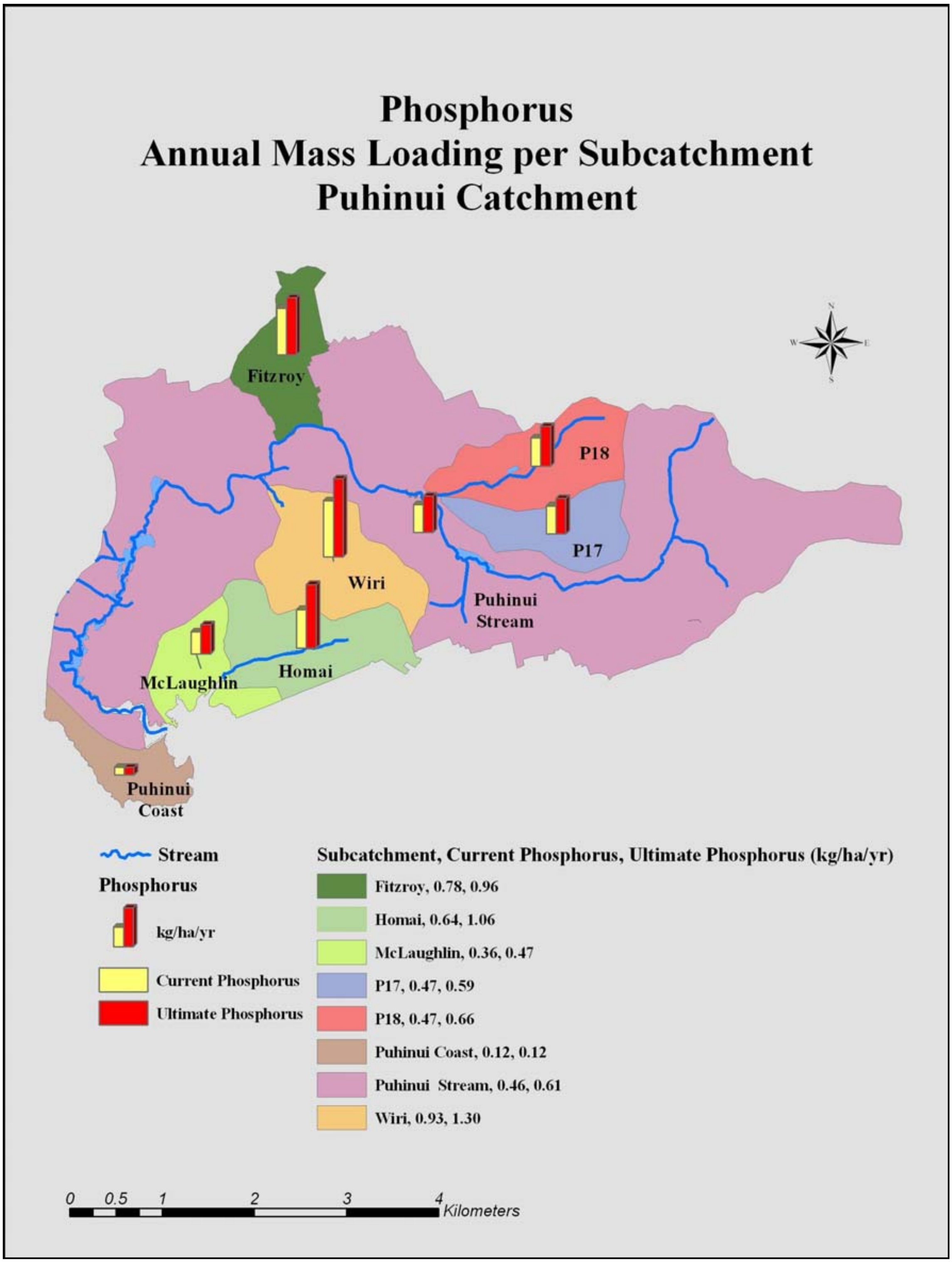


Figure 5.10.9: Total Copper annual mass loading (kg/ha/yr) per subcatchment

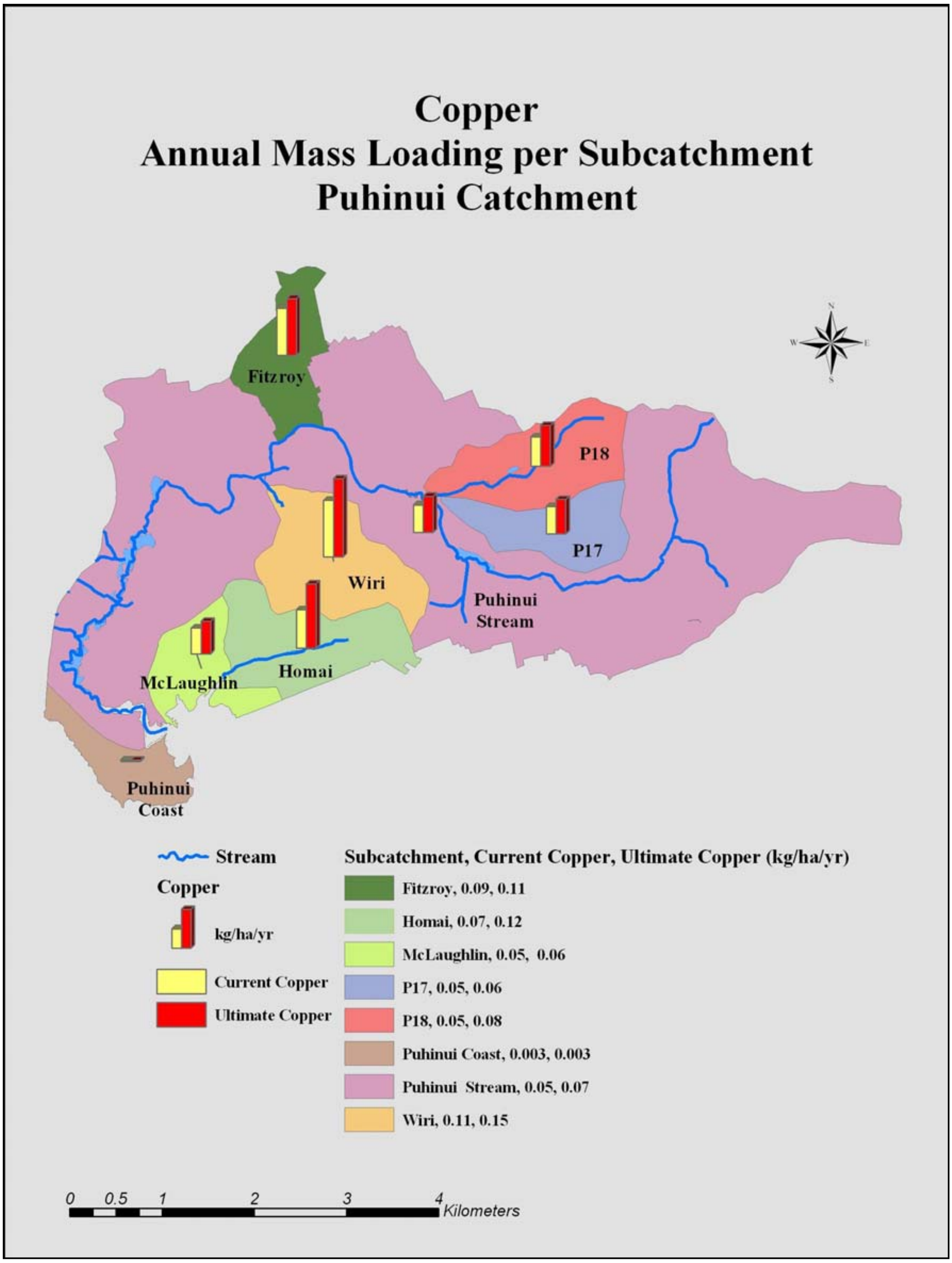


Figure 5.10.10: Total Lead annual mass loading (kg/ha/yr) per subcatchment

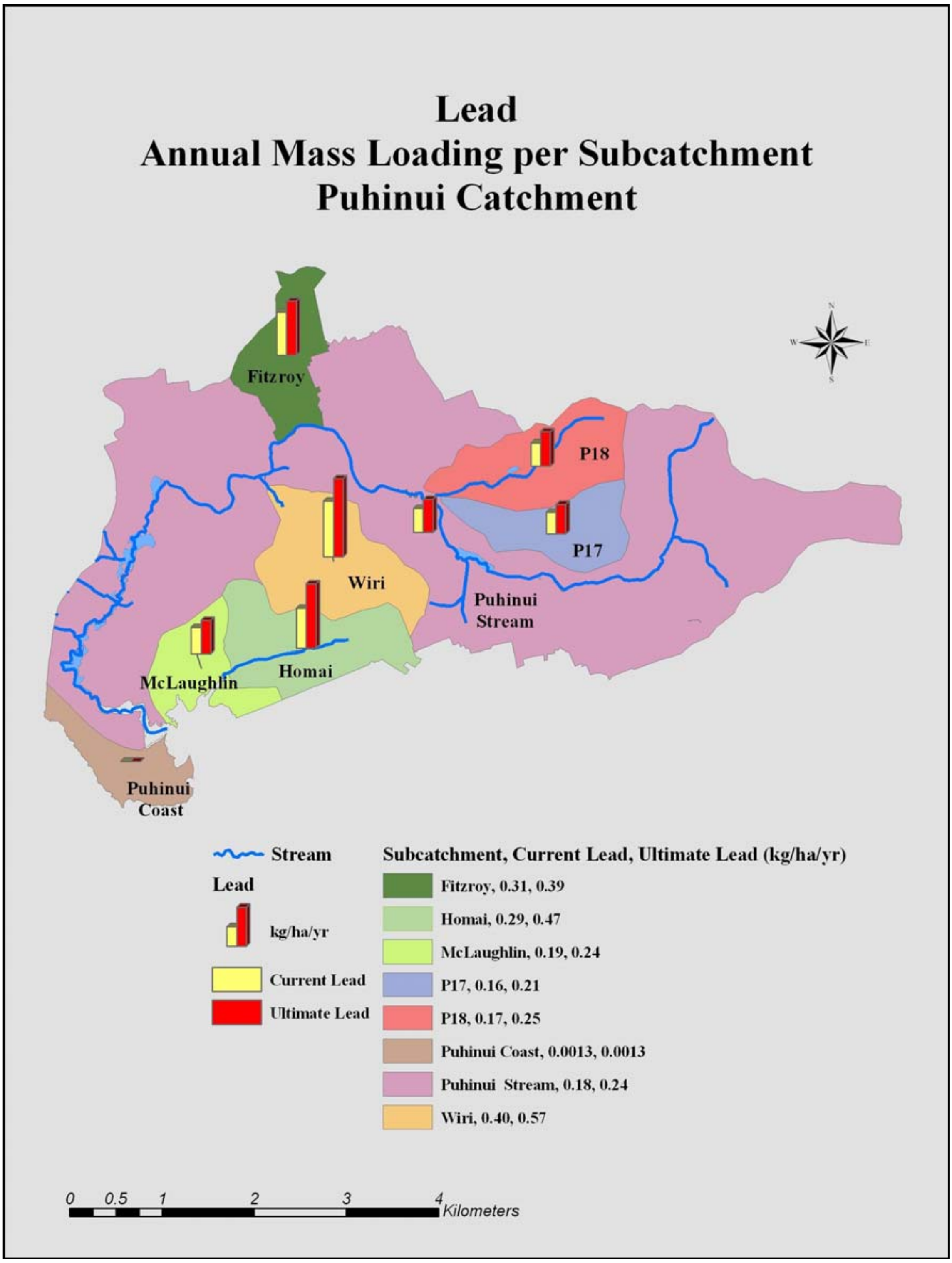


Figure 5.10.11: Total Zinc annual mass loading (kg/ha/yr) per subcatchment

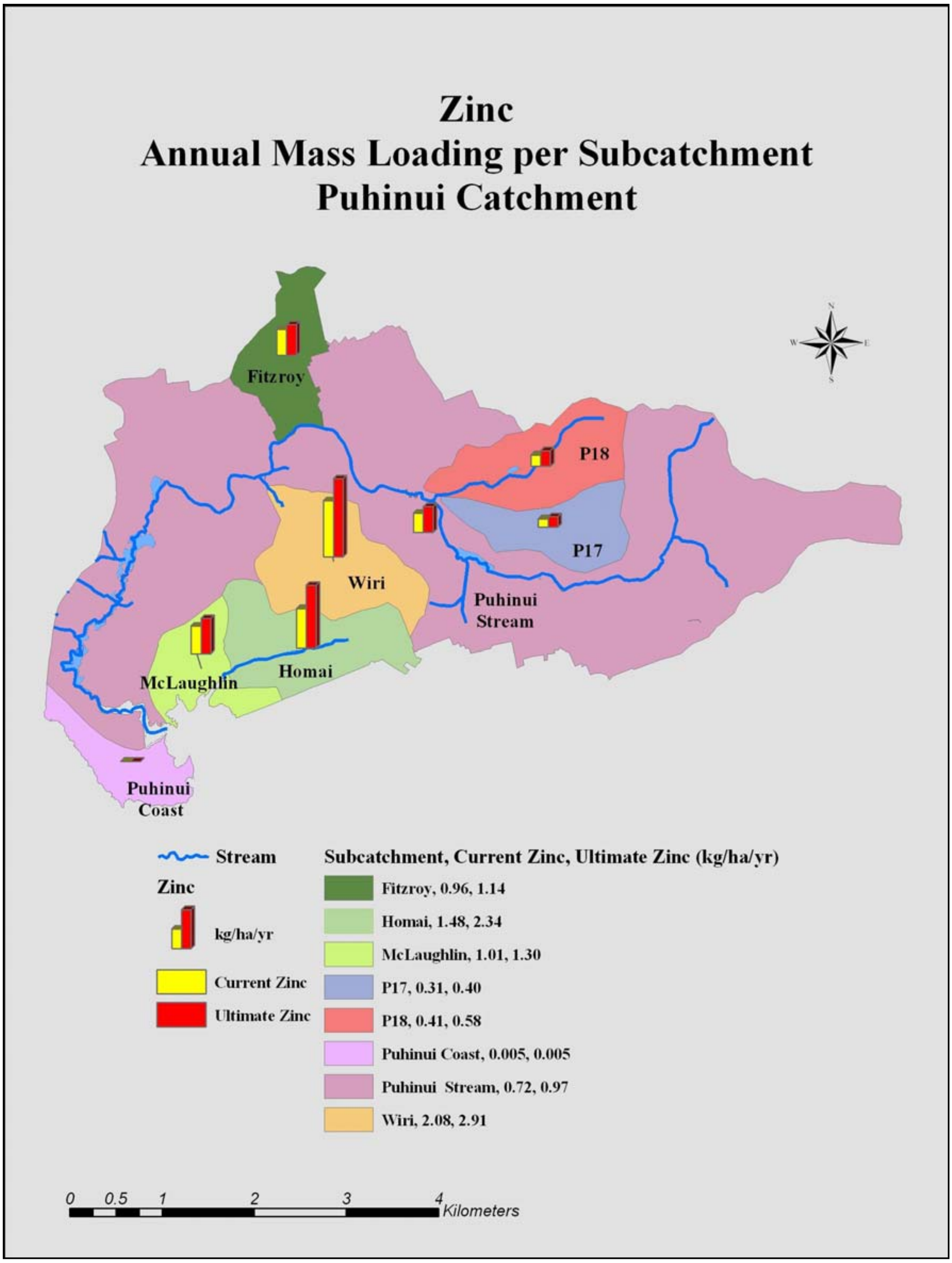


Figure 5.10.12: Total Kjeldahl Nitrogen annual mass loading (kg/ha/yr) per subcatchment

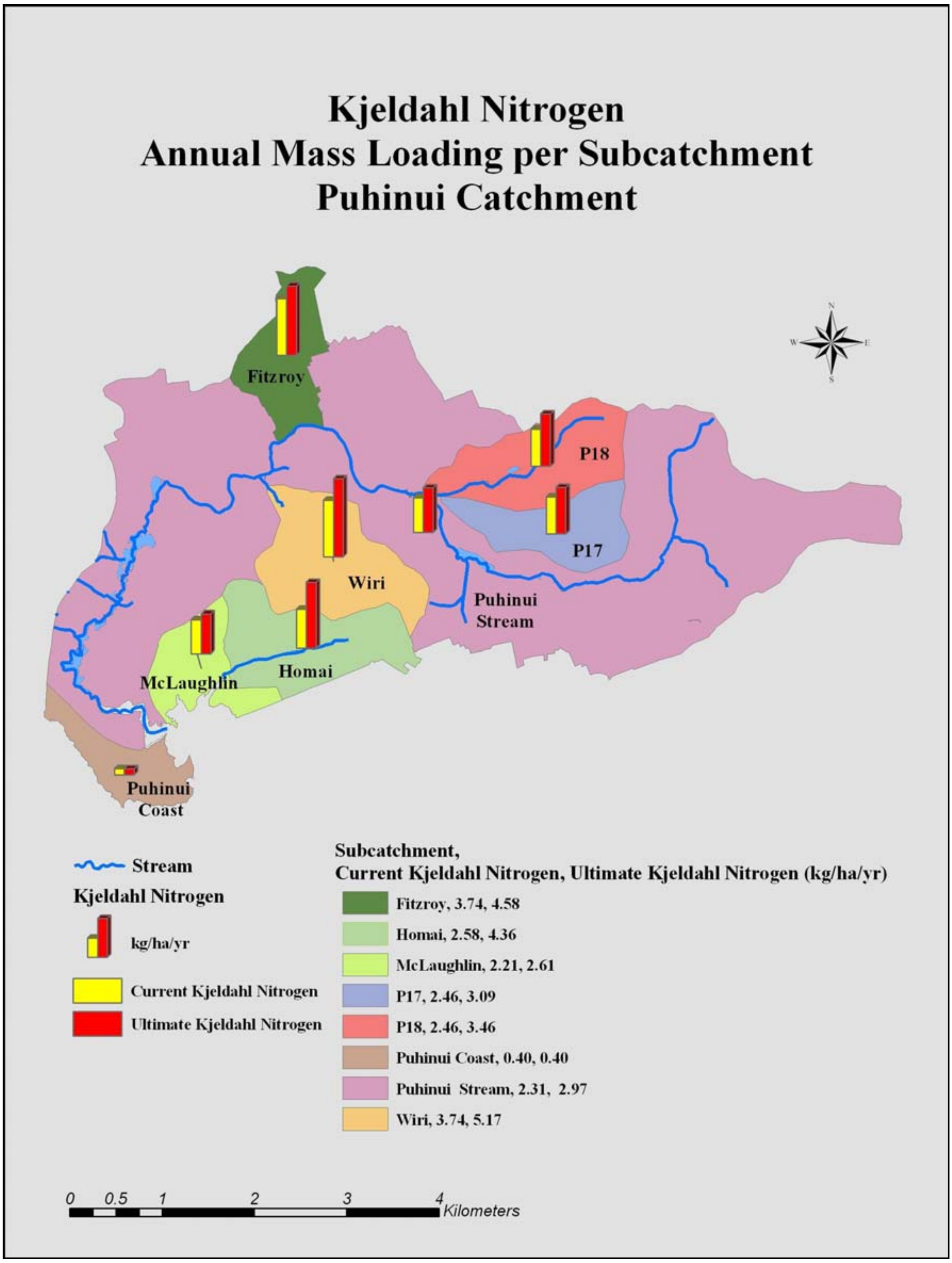


Figure 5.10.13: Total Petroleum Hydrocarbons annual mass loading (kg/ha/yr) per subcatchment

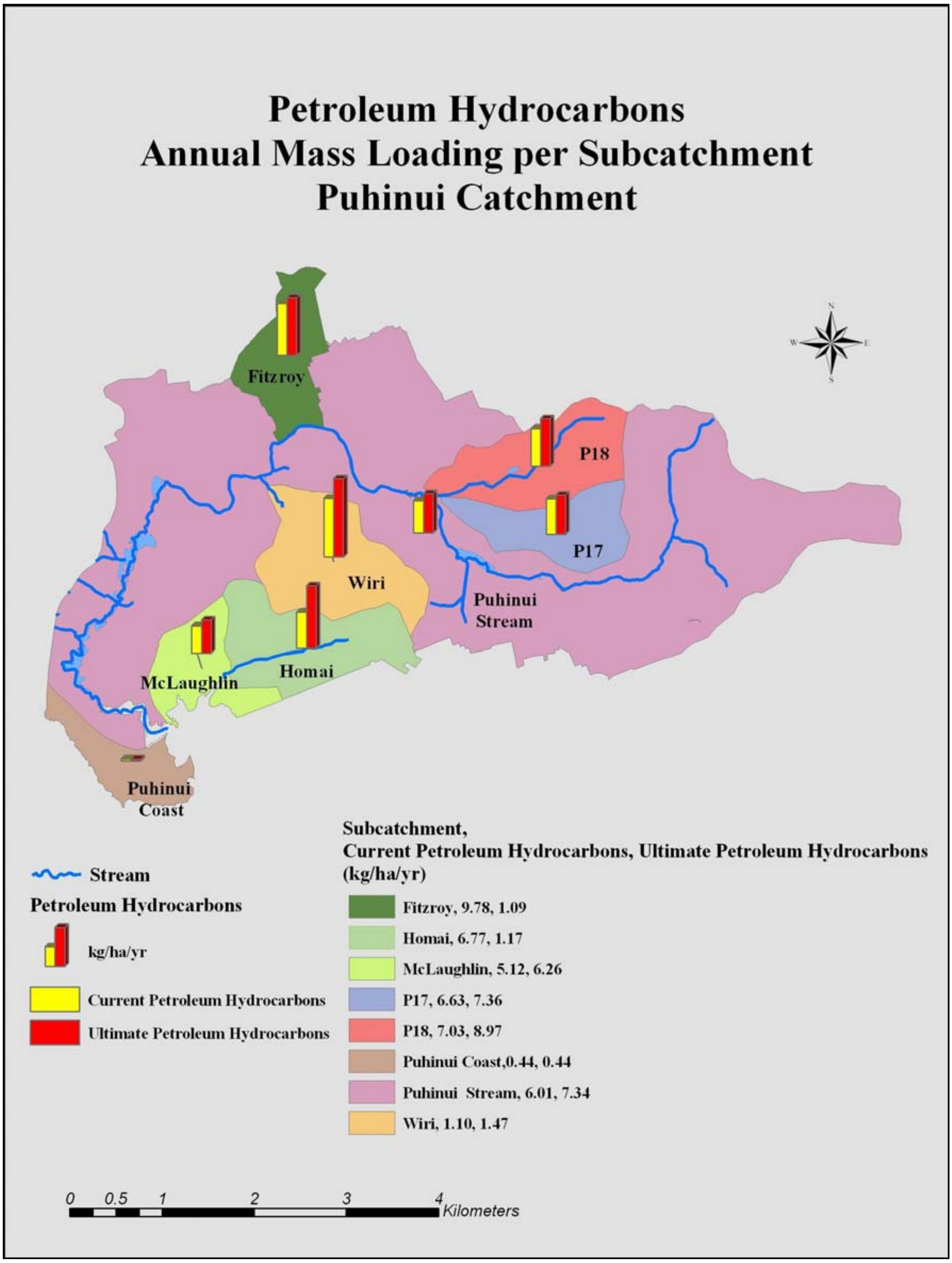


Table 5.10.1 shows current and ultimate annual contaminant mass loading for the Puhinui catchment land use types. There is no change in current and ultimate development conditions calculated for Quarry Zone, Rural and Open Space land use types. Annual contaminant mass loadings for Commercial, Industry, Residential and Road land use types showed increase from current to ultimate development condition.

Table 5.10.1: Puhinui catchment annual contaminant mass loading per land use types

Puhinui catchment	**Total Suspended Solids**	**Biochemical Oxygen Demand**	**Total Phosphorus**	**Total Copper**	**Total Lead**	**Total Zinc**	**Total Kjeldahl Nitrogen**	**Total Petroleum Hydrocarbons**	
Land Use	kg/yr								
Commercial	11,974	1,874	60	11	33	60	528	304	CACML
Commercial	17,876	2,797	90	16	50	89	788	453	UACML
Industry	173,569	16,225	640	67	284	1,547	2,201	6,289	CACML
Industry	244,728	22,877	903	94	401	2,181	3,103	8,867	UACML
Open Space	14,180	1,285	83	2	1	3	264	295	CACML
Open Space	14,180	1,285	83	2	1	3	264	295	UACML
Quarry Zone	2,789	1,258	10	5	22	120	380	488	CACML
Quarry Zone	2,795	1,261	10	5	22	120	381	489	UACML
Residential	127,529	5,732	279	29	129	196	1,404	1,454	CACML
Residential	187,436	8,424	411	42	190	287	2,064	2,138	UACML
Road	83,951	6,554	188	30	29	147	1,230	7,364	CACML
Road	93,411	7,293	209	34	33	163	1,368	8,194	UACML
Rural	7,886	448	21	0.2	1	4	158	83	CACML
Rural	7,886	448	21	0.2	1	4	158	83	UACML
CACML - Current Annual Contaminant Mass Loading									
UACML - Ultimate Annual Contaminant Mass Loading									

Maps are generated showing annual mass contaminant loadings per land use in the Puhinui catchment for each pollutant showing current and ultimate loading values in kilograms per year.

Figures 5.10.14 to 5.10.21 present annual mass contaminant loadings per land use in the Puhinui catchment. Appendix II contains maps of each Puhinui subcatchment showing annual mass contaminant loadings per land use.

Figure 5.10.14: Total Suspended Solids annual mass loading (kg/yr) per land use

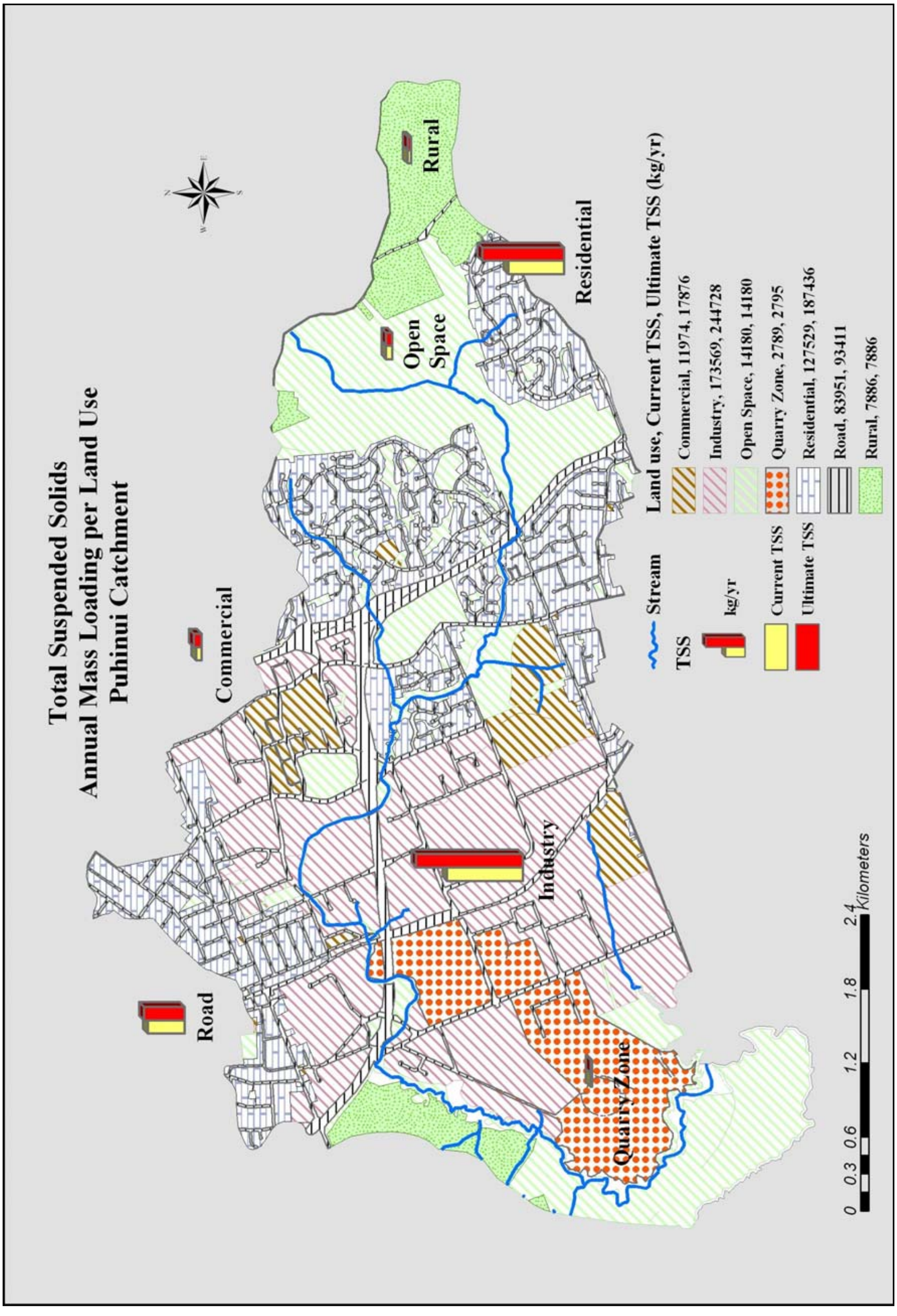


Figure 5.10.15: Biochemical Oxygen Demand annual mass loading (kg/yr) per land use

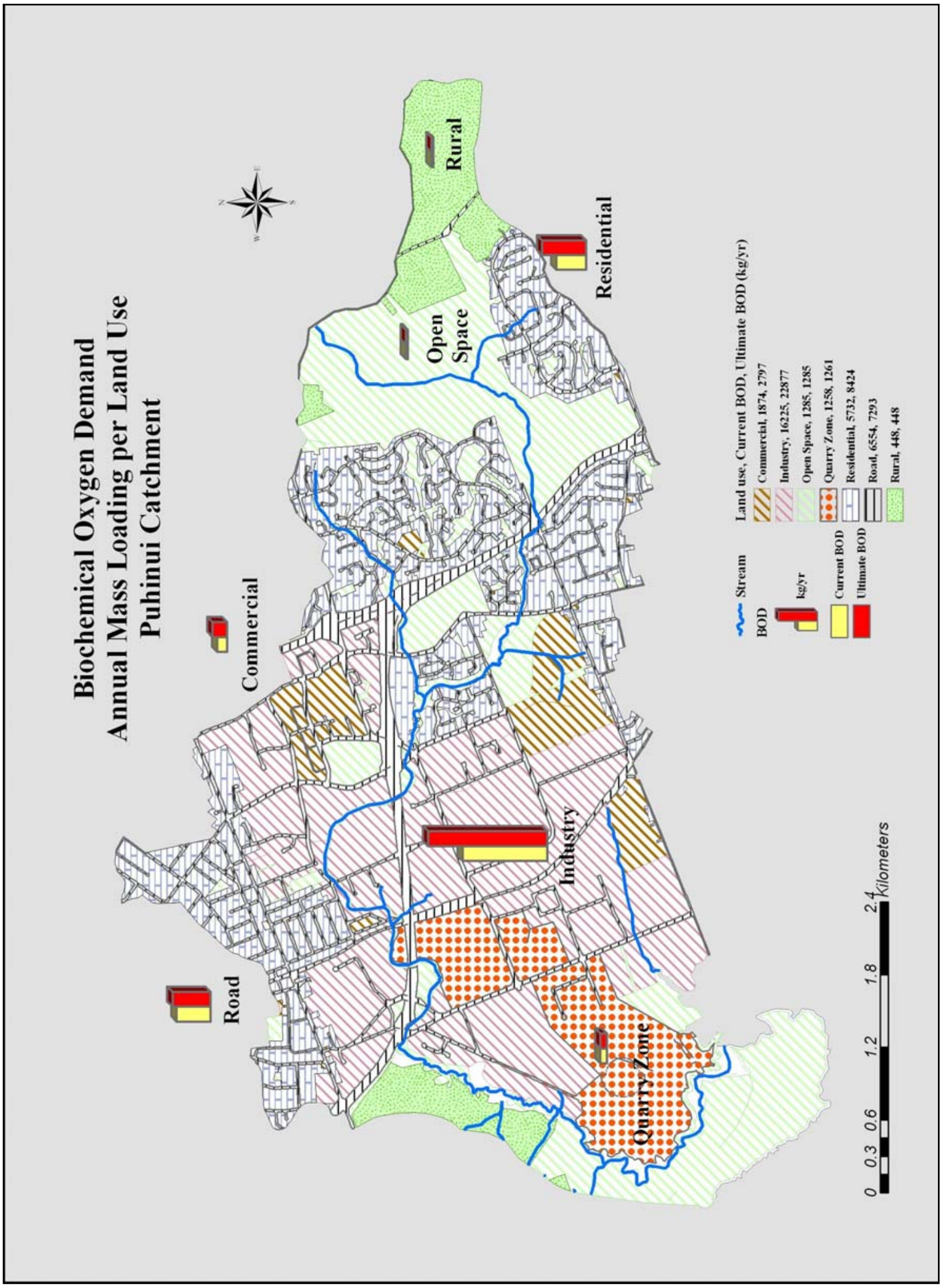


Figure 5.10.16: Total Phosphorus annual mass loading (kg/yr) per land use

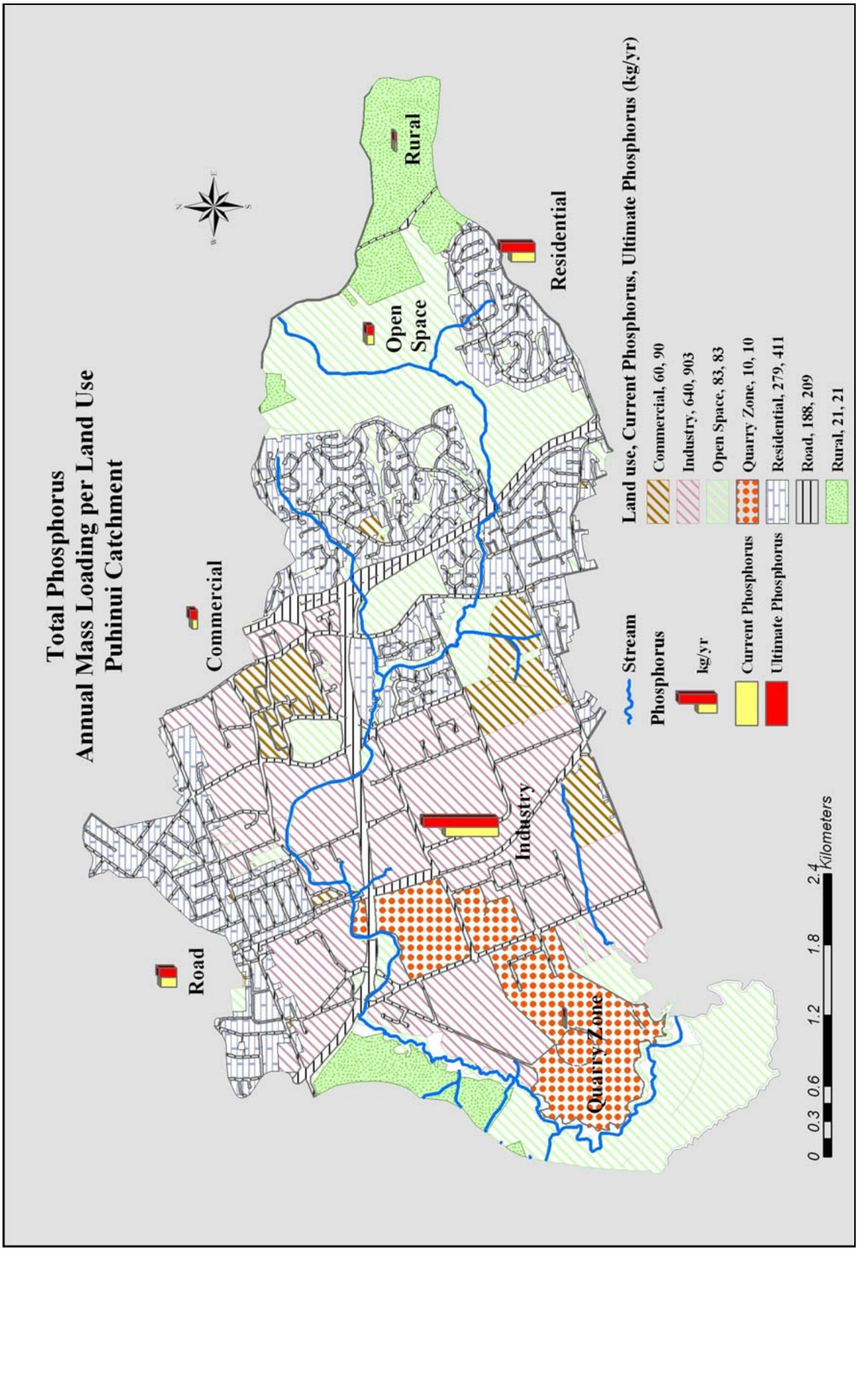


Figure 5.10.17: Total Copper annual mass loading (kg/yr) per land use

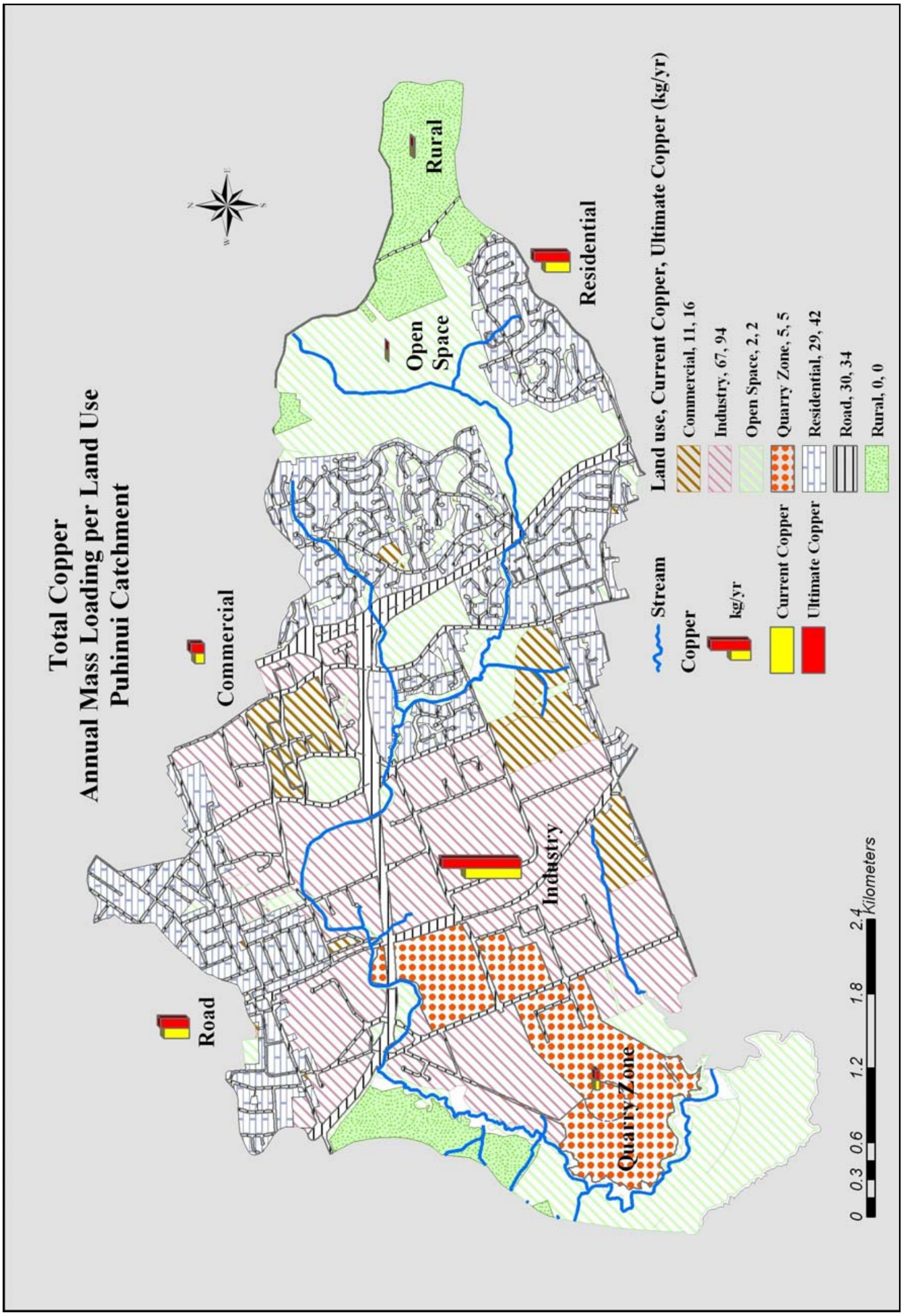


Figure 5.10.18: Total Lead annual mass loading (kg/yr) per land use

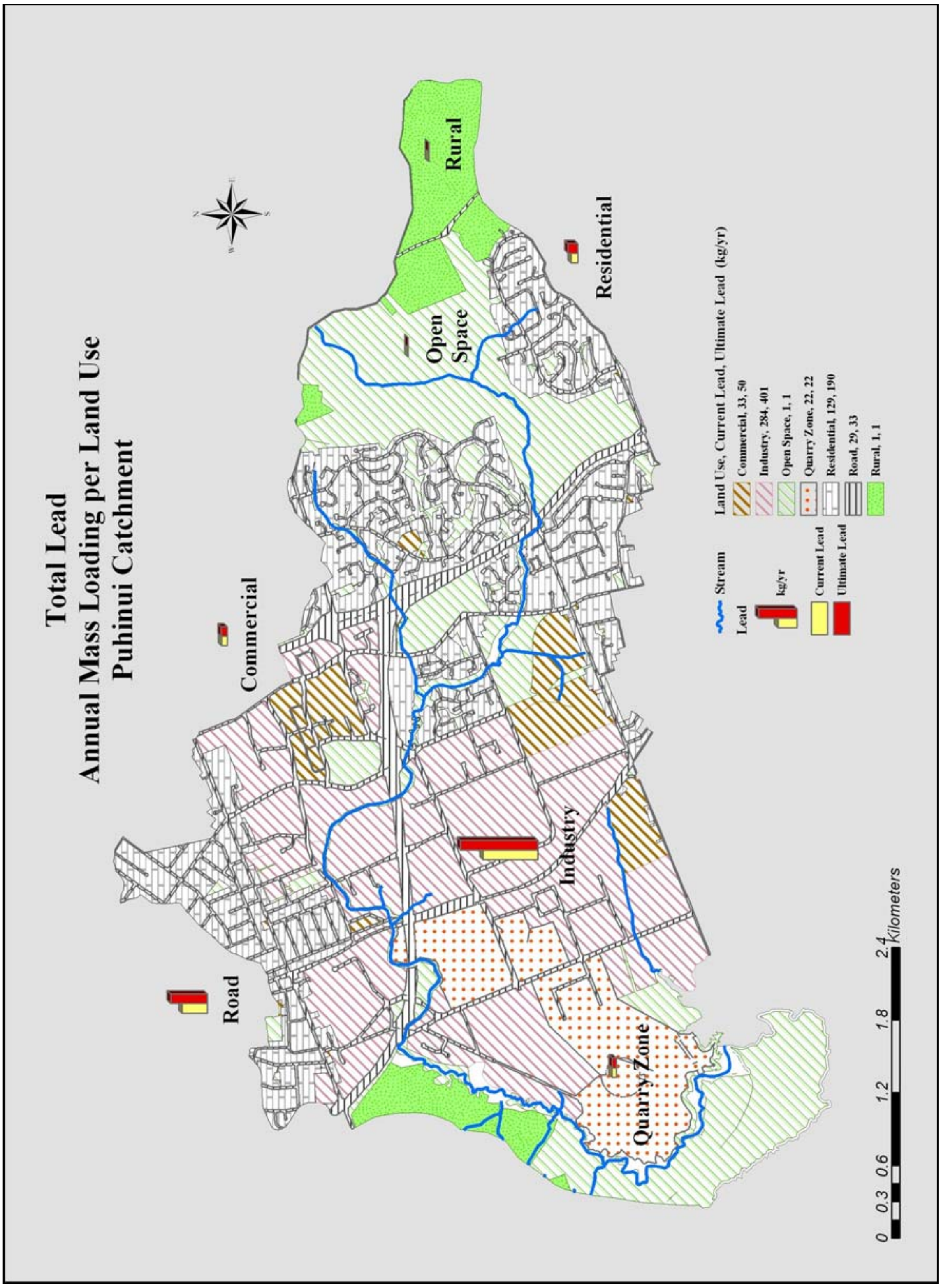


Figure 5.10.19: Total Zinc annual mass loading (kg/yr) per land use

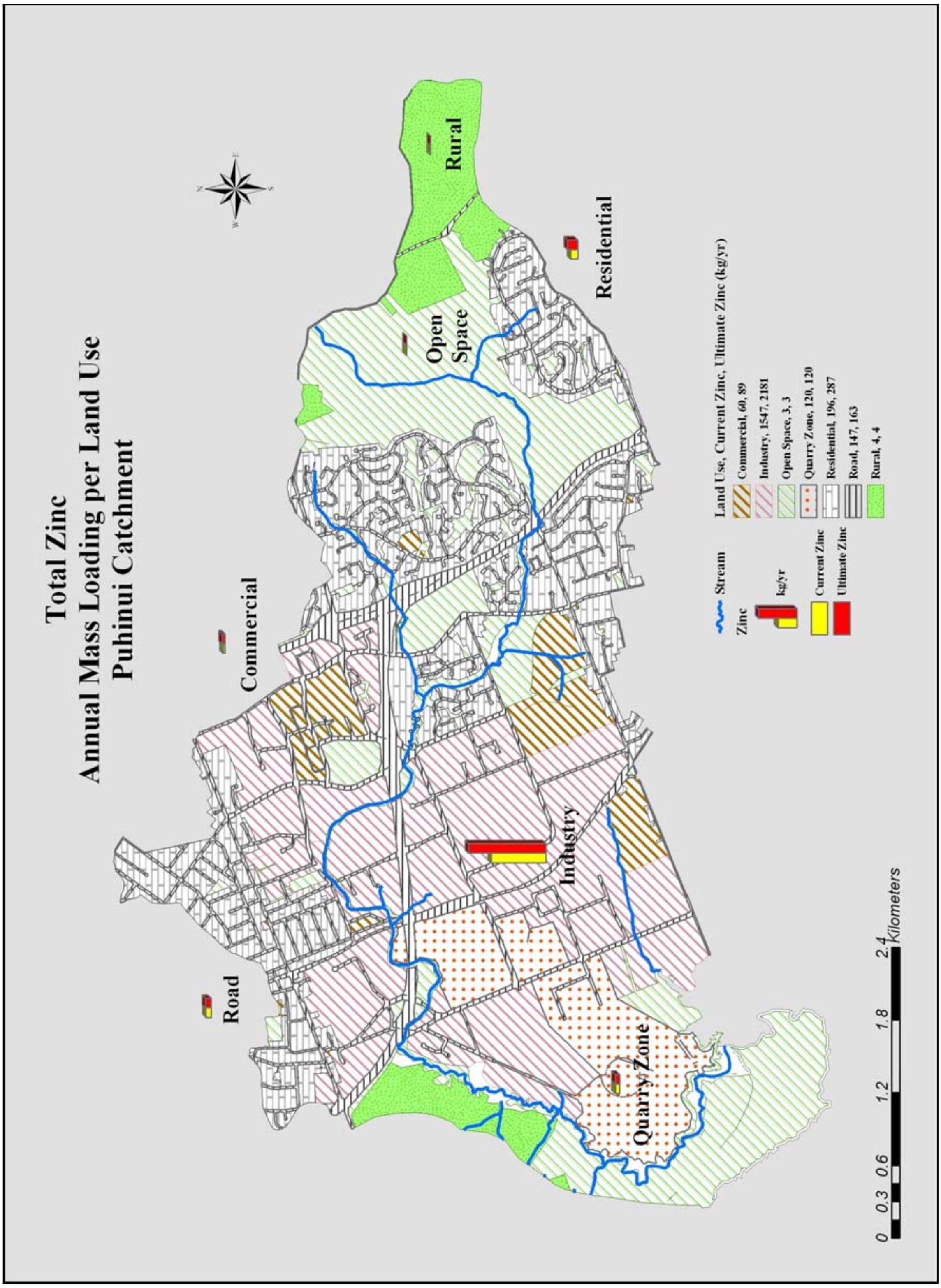


Figure 5.10.20: Total Kjeldahl Nitrogen annual mass loading (kg/yr) per land use

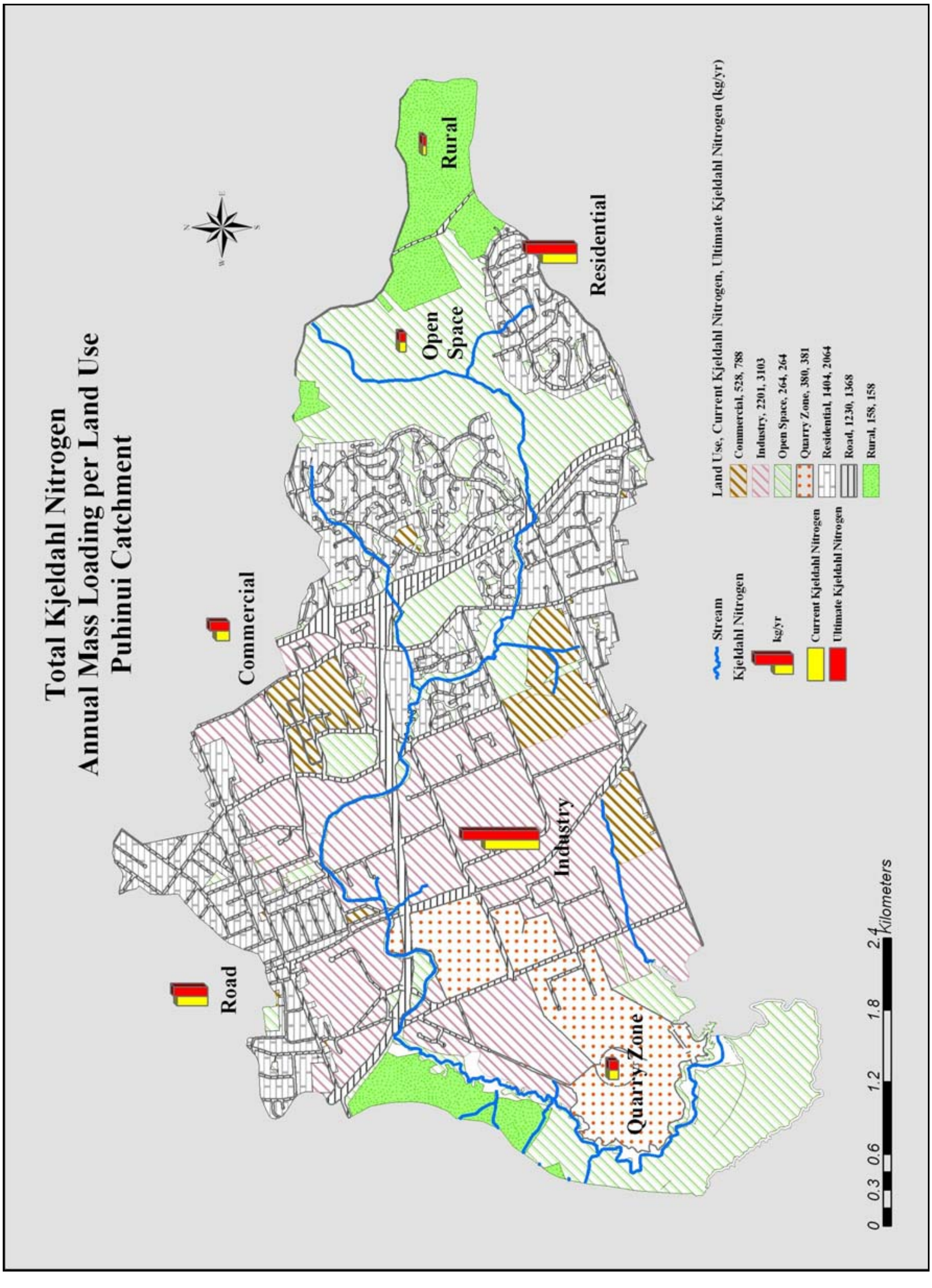
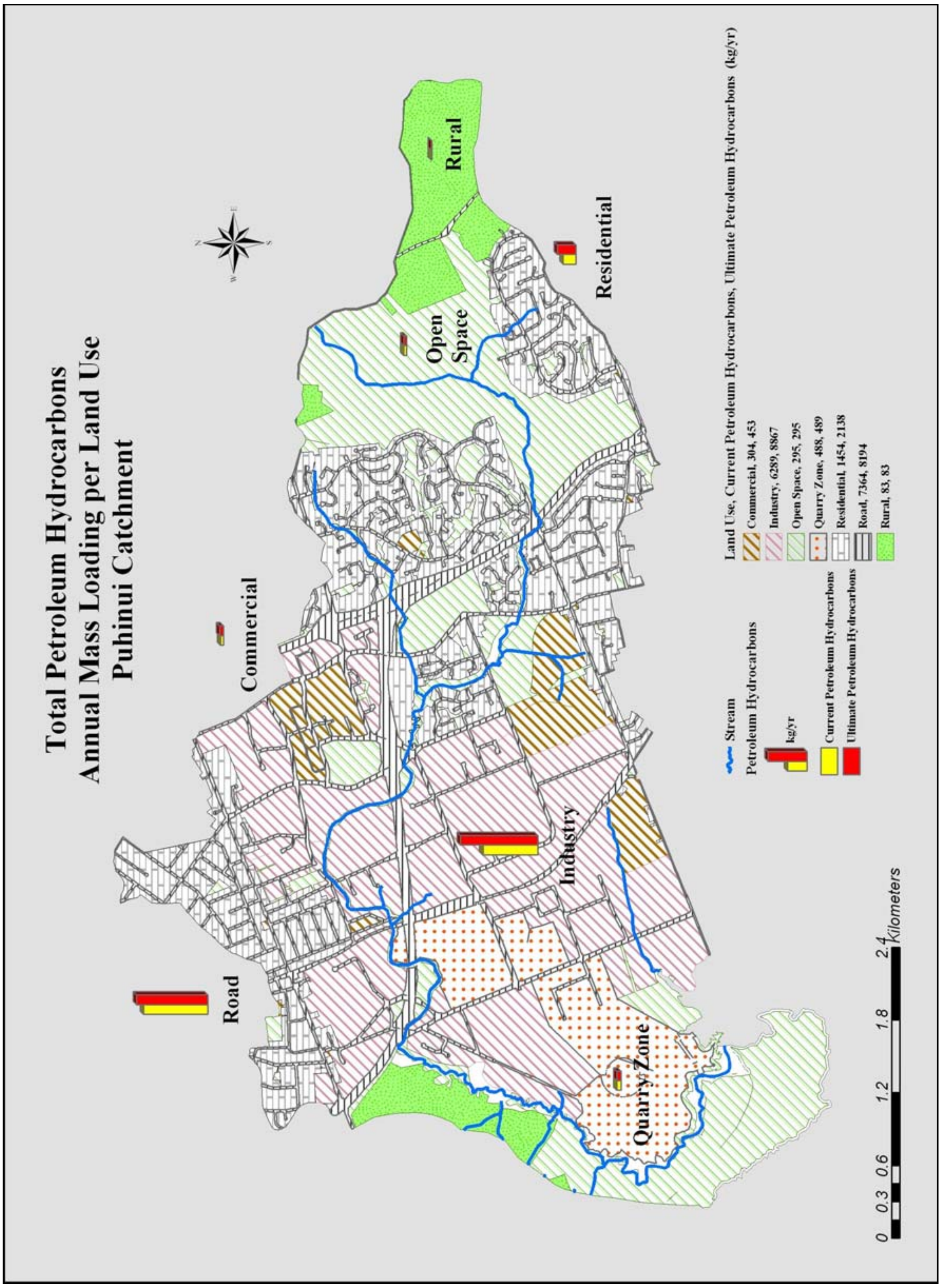


Figure 5.10.21: Total Petroleum Hydrocarbons annual mass loading (kg/yr) per land use



6 Discussion and Recommendations

The GIS model developed to estimate the annual mass of pollutants in stormwater runoff of the Puhinui Stream for current and ultimate stages of urbanization discussed in the preceding chapters represents a viable technique for assessment of the land use effects on the stormwater runoff.

Wiri subcatchment showed the highest annual mass loadings for all calculated pollutants except for Total Suspended Solids. The highest annual mass loading for Total Suspended Solids was calculated in Fitzroy subcatchment. The highest average increase in total mass pollutant loading was recorded in Homai subcatchment while there was no recorded increase in Puhinui Coast subcatchment. Wiri and Homai subcatchments largely consist of industrial land which covers 79% of Wiri subcatchment and 67% of Homai subcatchment. This contributes to the very high annual mass pollutant loadings. Fitzroy subcatchment has the highest percentage of Residential land use type, 61%, while Puhinui Coast subcatchment consists of only Open Space and Water land use types, and as there was no residential or business development planned in this area, increase in total pollutant loading was non-existent. The rest of the subcatchments showed average increase in total mass pollutant loading for the ultimate land use development between 20 and 40 percent. Average percent annual mass pollutant loading increase in the Puhinui catchment per each subcatchment is presented in Figure 5.10.1.

The highest average total loading increase for the ultimate land use development was recorded for Lead, 35%, while Total Petroleum Hydrocarbons showed the lowest increase of 25%. Total average percent annual mass pollutant loading increase in the Puhinui catchment per each pollutant is presented in Figure 5.10.2. Current and ultimate annual contaminant mass loading for the Puhinui catchment land use types are shown in Table 5.10.1. There is no change in current and ultimate development conditions calculated for Quarry Zone, Rural and Open Space land use types. Annual contaminant mass loadings for Commercial, Industry, Residential and Road land use types showed increase from current to ultimate development condition.

Condition and use of the land from which the runoff originated will determine contaminants present in stormwater runoff. Commercial, industrial and residential land use types are main sources of Total Suspended Solids and heavy metals in Puhinui catchment. Rural and Open Space land use types contribute the least to contaminant loads in stormwater runoff. Runoff from roads generates high levels of Petroleum Hydrocarbons. Historically, roads runoff used to generate high levels of Lead, but the introduction of unleaded petrol in New Zealand within last ten years helped in reduction of Lead in roads stormwater runoff which proved true in this study as well.

This project follows the basic guidelines and mass loading equations set up in Waitakere City Contaminant Loading Study (Babich and Lewis, 2001). Waitakere study did not use GIS, and it used literature values for runoff coefficients and imperviousness percentages for different land use types. As it was the only study done to estimate the annual mass of pollutants in stormwater runoff in Auckland region, the results from the Waitakere study were compared to the results obtained in this GIS project. Massey catchment (Waitakere City) was used for comparison, as it was the catchment with similar land use types present as in the Puhinui catchment. Most of the catchments in Waitakere City contain large areas of bush, rural and open space land use types and they were not suitable for comparison. Table 6.1 represents the contaminant mass loading values of Puhinui and Massey catchments.

Table 6.1: Puhinui and Massey catchments total annual contaminant mass loadings

		Total Suspended Solids	**Biochemical Oxygen Demand**	**Total Phosphorus**	**Total Copper**	**Total Lead**	**Total Zinc**	**Total Kjeldahl Nitrogen**	**Total Petroleum Hydrocarbons**
		kg/ha/yr							
Puhinui	Current	177	13.75	0.53	0.06	0.21	0.87	2.49	6.55
	Ultimate	241	18.50	0.72	0.08	0.30	1.21	3.33	8.26
Massey		385	19.40	0.88	0.09	0.49	0.62	4.49	7.71

We can see from Table 6.1 that the results show the same order of magnitude of pollutant loads for both catchments. However, Massey catchment has higher mass contaminant loading values then Puhinui catchment for each contaminant except for Zinc. This could be due to several factors:

Massey catchment has higher annual rainfall depth – 1300 mm/yr compared to Puhinui's 1127 mm/yr. Residential land use covers more then 70 percent of Massey catchment (compared to 21 percent in Puhinui catchment) and residential median contaminant concentration values are amongst the highest ones. Waitakere study used literature values for runoff coefficients and imperviousness percentages of different land use types. Puhinui study used calculated values for runoff coefficients and imperviousness percentages based on the present data in the catchment.

The advantages of the GIS model developed here are summarized below:

- The model establishes the connection of typical pollutant concentrations with land uses present in the catchment and offers an accurate characterisation of nonpoint source pollution in that catchment.
- Incorporating the simple method for estimation of stormwater runoff pollutant loads in the GIS model requires data sources (e.g. the subcatchment drainage area and impervious cover, stormwater runoff pollutant concentrations, annual rainfall) which were already available in a digital format and easily extractable from the Manukau City Council GIS database.
- With this model it was easy to break up land use into specific areas, such as residential, commercial, industrial, road, open space, quarry zone and rural and calculate annual pollutant loads for each type of land.
- The model uses different impervious cover values for separate land uses within a subcatchment and it calculates runoff coefficients based on the present data in the catchment.
- The model provides a proficient way to identify specific subcatchments or land use types where high levels of pollutants concentrations may be expected. In particular this study has shown that the Homai Stream subcatchment showed the highest average increase in mass pollutant loading although the highest sum of annual mass loading was recorded in the Puhinui Stream subcatchment. The study also showed the highest pollutant loading for the Industry land use type, followed by the Residential and Road land use types.
- Use of the GIS model has logistical advantages that allow for adaptation to other study areas. Another advantage of this GIS model is that is easily adaptable to any changes in the data or geographical area with minor adjustments in programming scripts.
- This model helps to provide first cut answers and directly supports decision making processes.
- This GIS model offers variety of ways to visualize calculated results. Outputs of the GIS model are maps, charts and tables that are easy to understand and interpret.

The GIS model for estimation of the annual mass of pollutants in stormwater runoff provides reasonable estimates of changes in pollutant export resulting from development activities. However, several limitations should be kept in mind when applying this method.

- The model provides estimates of storm pollutant export that are possibly close to the "true" but unknown value for a development site or a subcatchment but it is very important not to over emphasise the precision of the results obtained.
- This model provides a general planning estimate of likely storm pollutant loadings from areas at the scale of a subcatchment or catchment site. More sophisticated modeling should be applied to analyse larger and more complex catchments.
- The runoff calculations rely on an annual rainfall estimate of 1127 mm; a more accurate model would account for seasonal or yearly fluctuations in rainfall.
- The literature based expected mean concentrations assume constant values related to each land use and are not considered to vary from event to event or between different land use subcategories. This could be improved by introducing constituent event mean concentrations instead of expected mean concentrations.
- Transport of pollutants is assumed to be conservative throughout of this study with no loss or decay of pollutants considered. This limitation could be addressed through use of water quality simulation models.
- The model does not consider the removal efficiencies of various SMP (Stormwater Management Policy) practices already present in the catchment area. In the future, this limitation could be easily dealt with by introducing estimates of the average pollutant removal efficiency of the SMP categories in calculation of the final annual pollutant load (Centre for Watershed Protection, 2001).
- The model results could be further improved by applying this model on the subcatchments delineated for each stormwater outlet. The results of this calculation could provide more in-depth information for the environmental management as it would identify parts of stormwater network that are in need of immediate attention.

The GIS model developed for estimation of the annual pollutant mass in stormwater runoff is a useable, reliable and repeatable means of establishing nonpoint source pollution estimates in stormwater runoff. Consideration of the above limitations for future applications of the model will provide for a more comprehensive analysis.

Appendix I: VBA Code

Appendix I is submitted in the digital format because of its size and can be found on a CD named Appendix I.

Appendix II: Annual Mass Contaminant Loading per Land Use – Puhinui Subcatchments Maps

Figure A II.1: Total Suspended Solids annual mass loading (kg/ha/yr) per land use – Fitzroy subcatchment

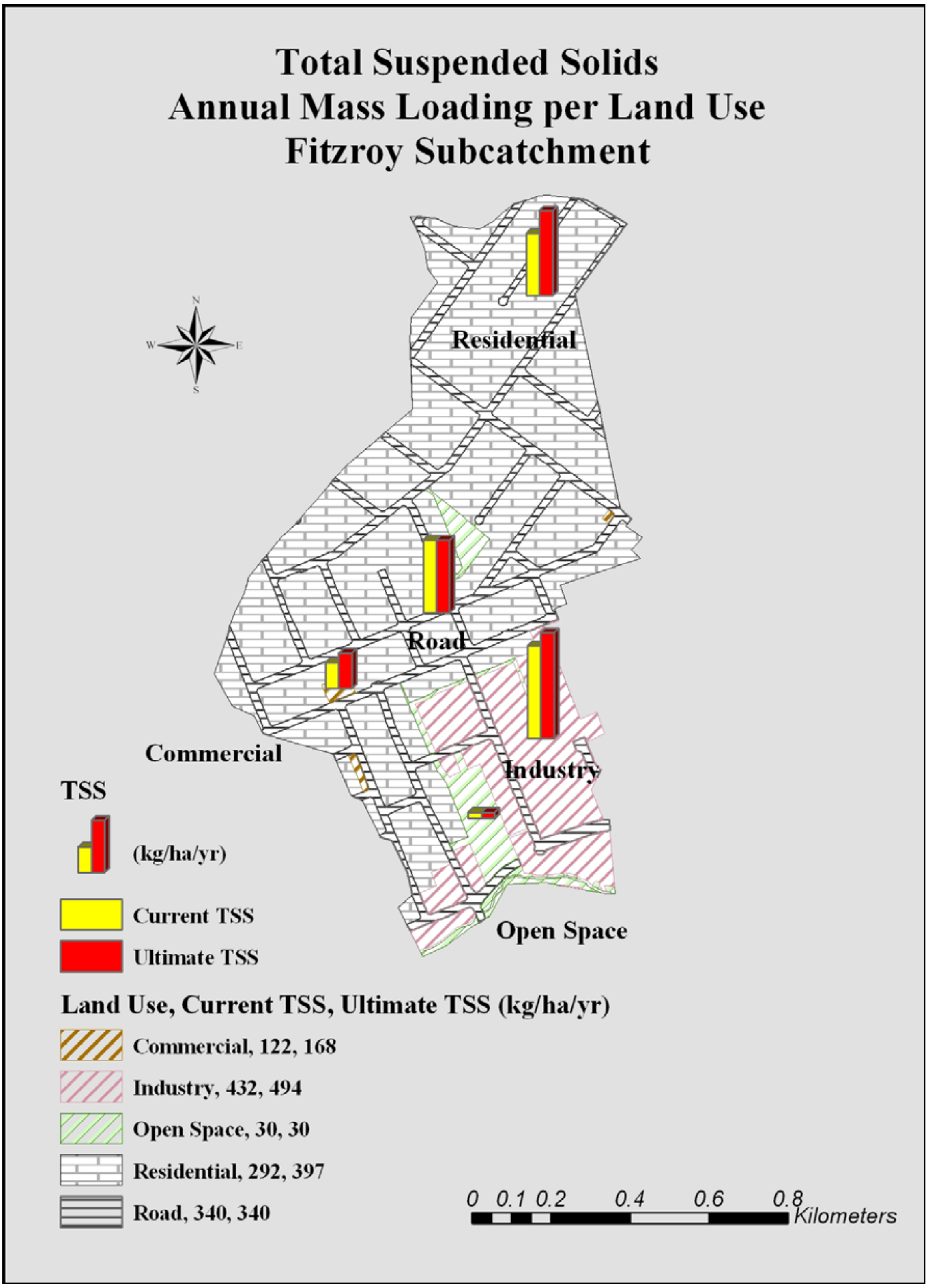


Figure A II.2: Biochemical Oxygen Demand annual mass loading (kg/ha/yr) per land use – Fitzroy subcatchment

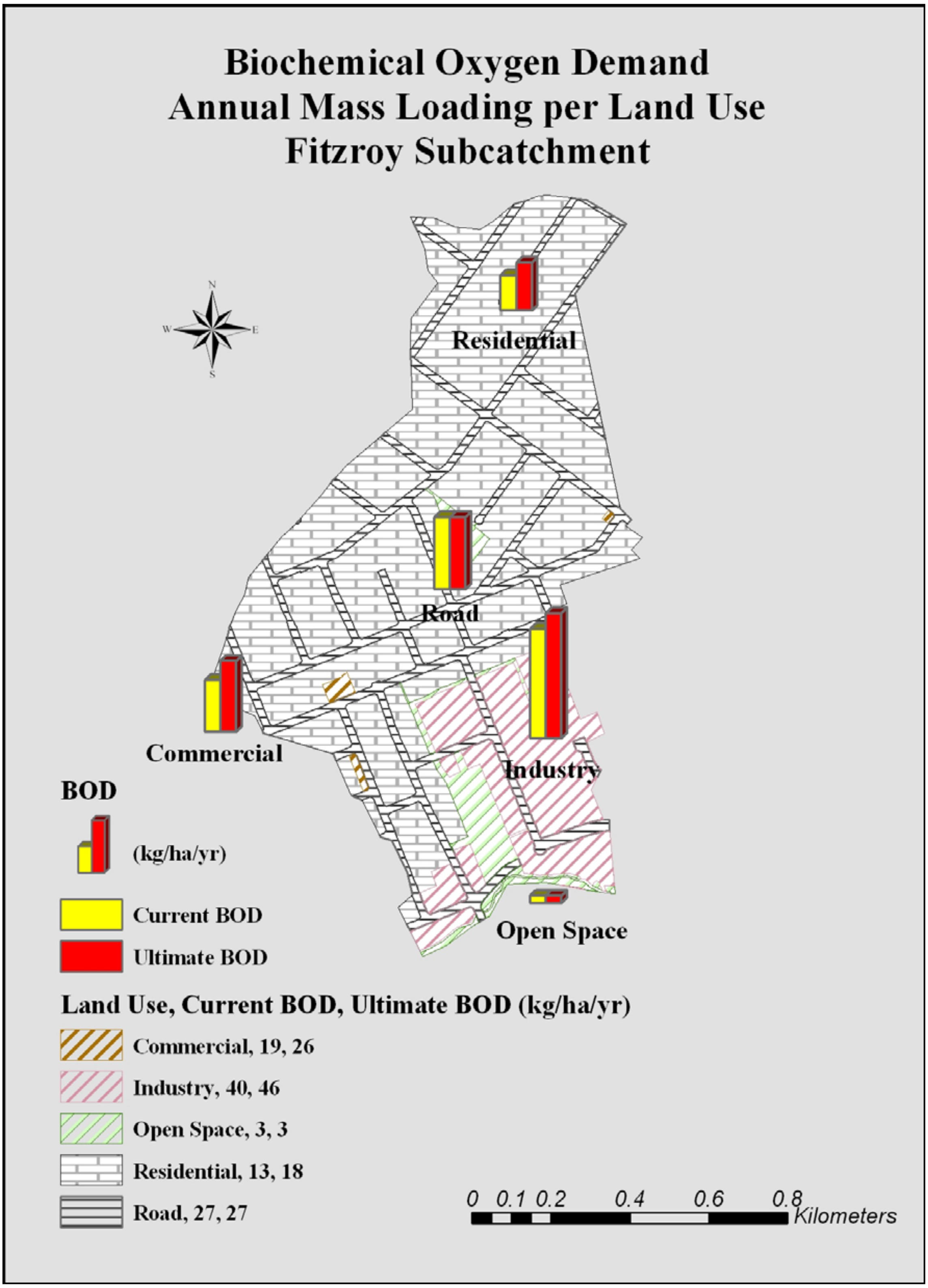


Figure A II.3: Total Phosphorus annual mass loading (kg/ha/yr)
per land use – Fitzroy subcatchment

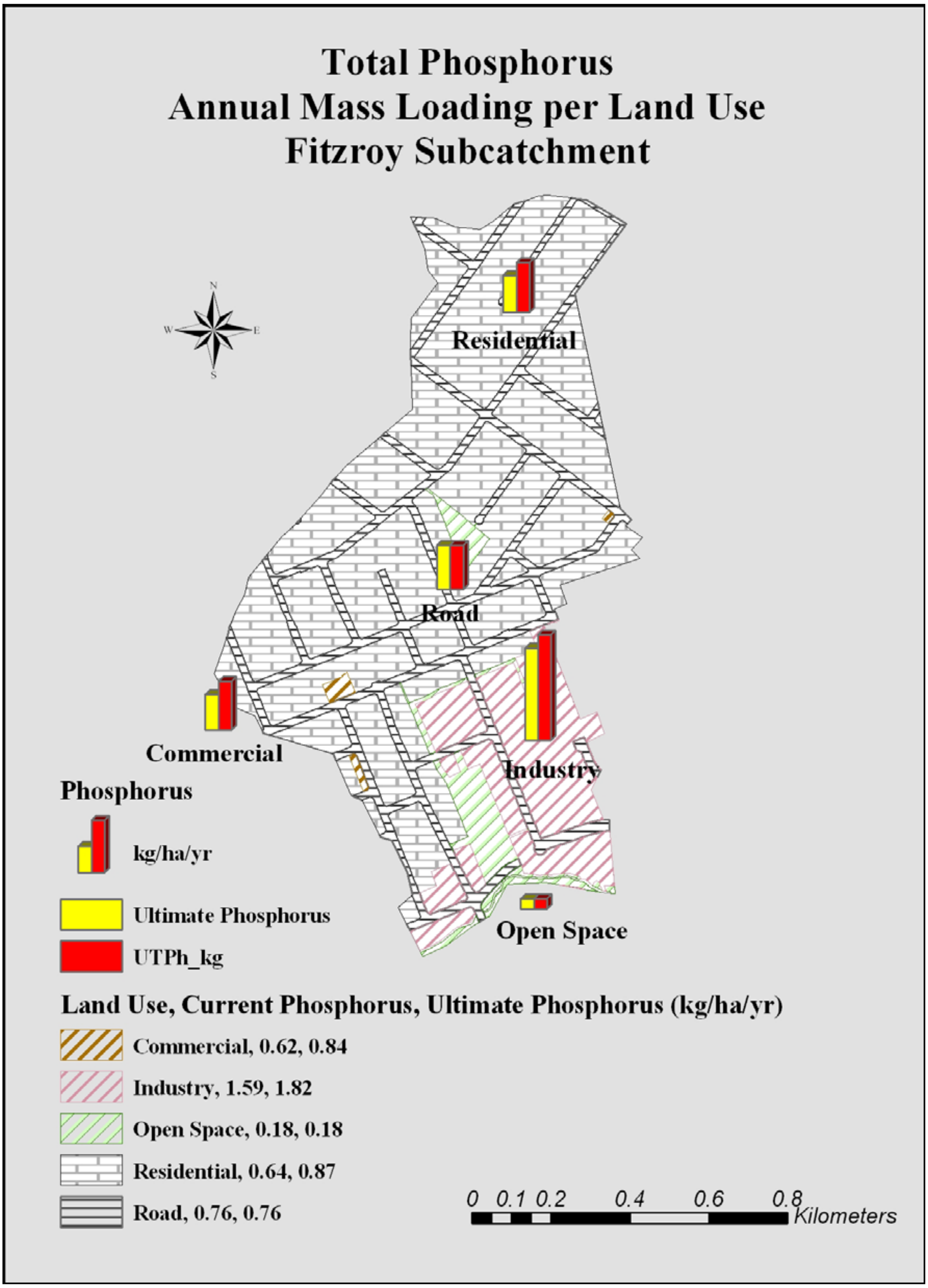


Figure A II.4: Total Copper annual mass loading (kg/ha/yr)
per land use – Fitzroy subcatchment

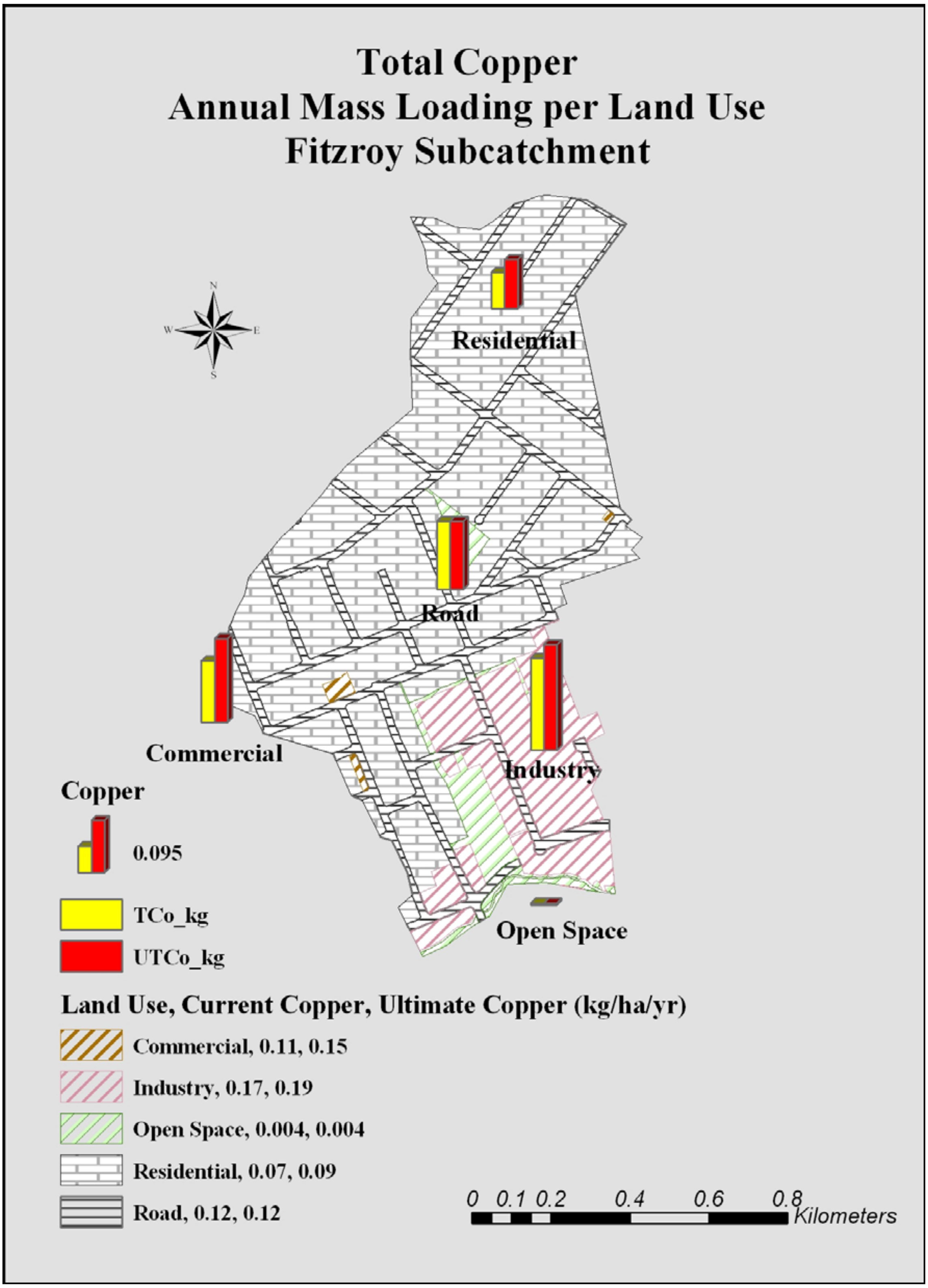


Figure A II.5: Total Lead annual mass loading (kg/ha/yr)
per land use – Fitzroy subcatchment

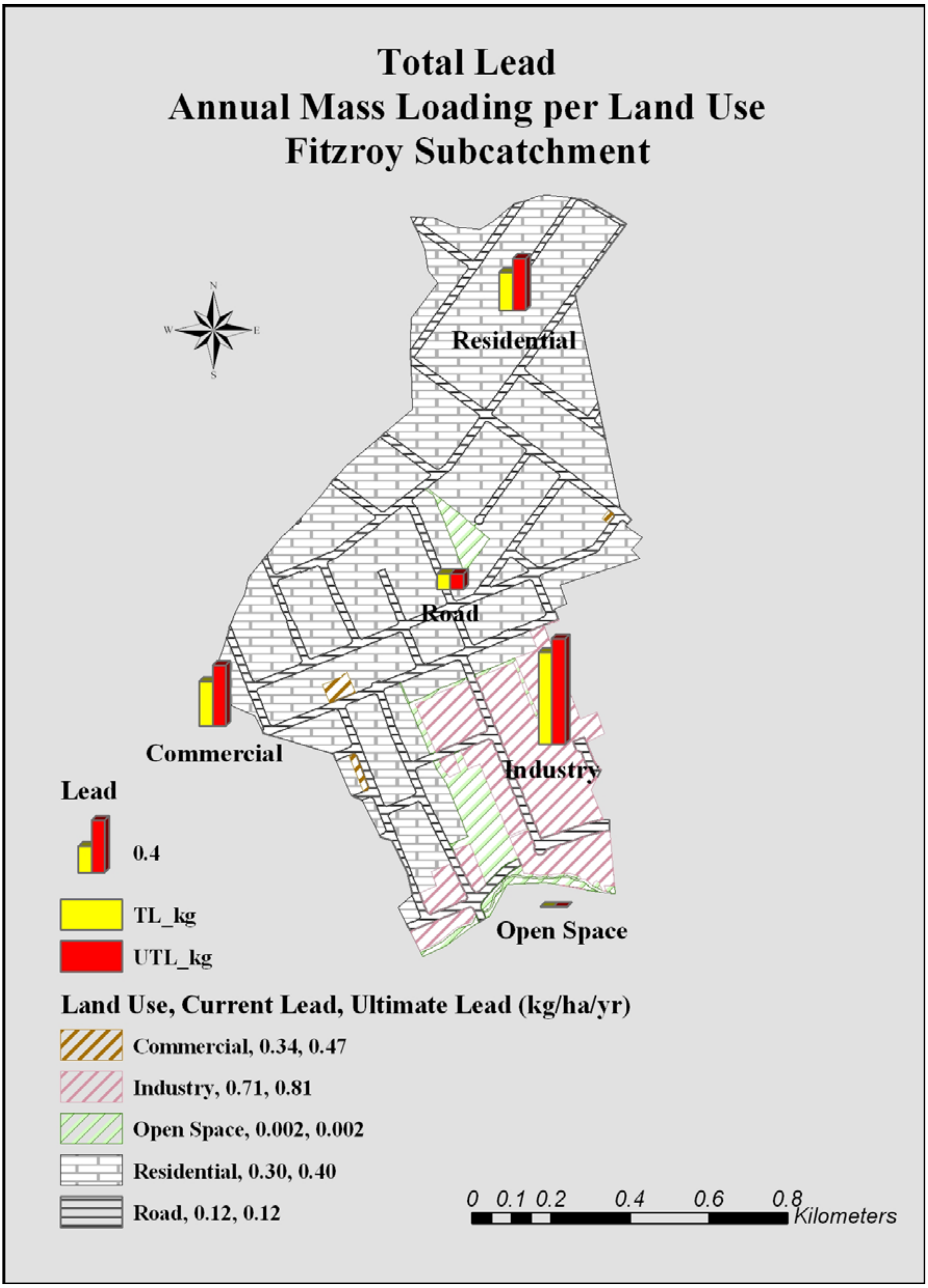


Figure A II.6: Total Zinc annual mass loading (kg/ha/yr)
per land use – Fitzroy subcatchment

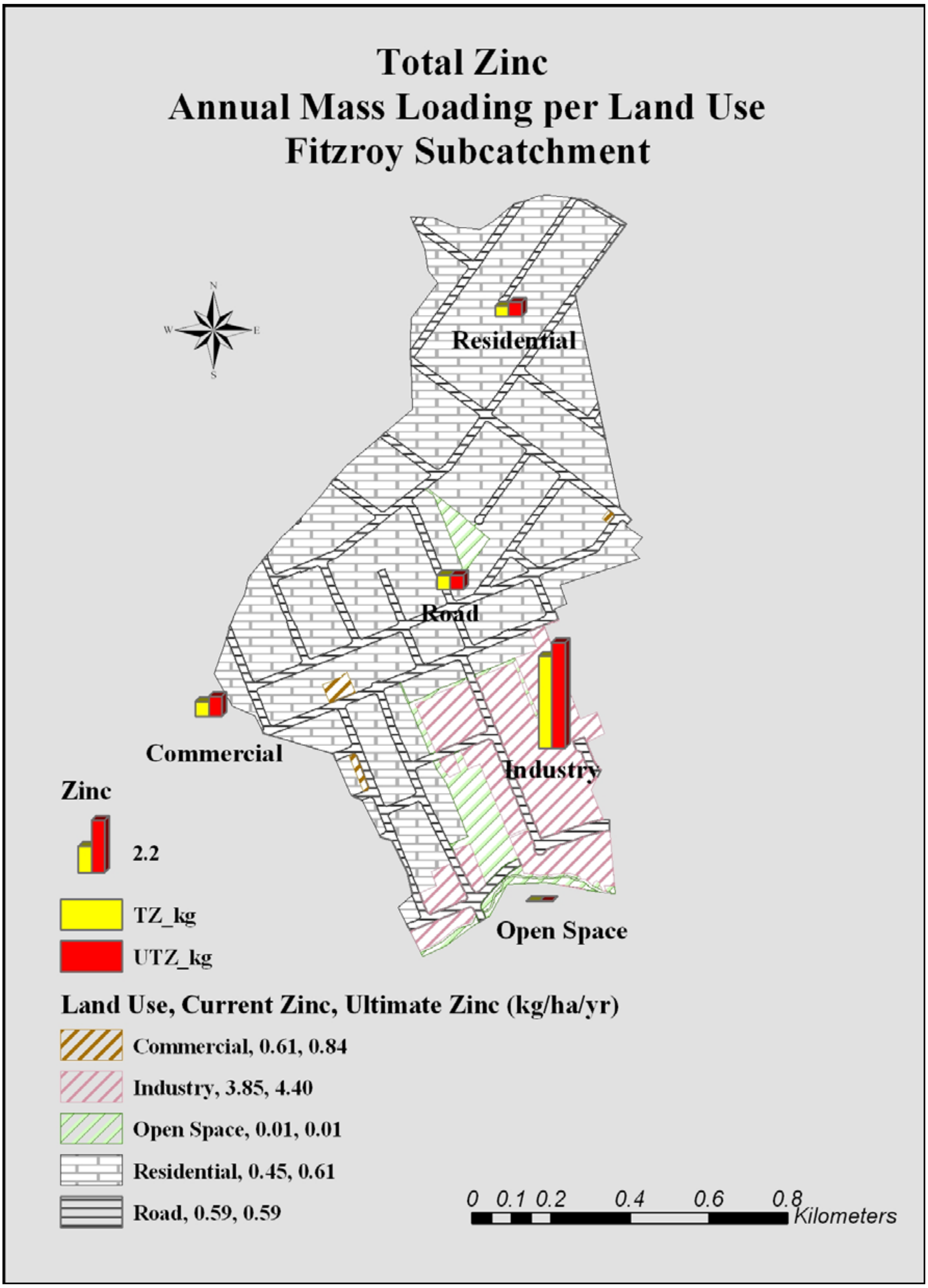


Figure A II.7: Total Kjeldahl Nitrogen annual mass loading (kg/ha/yr)
per land use – Fitzroy subcatchment

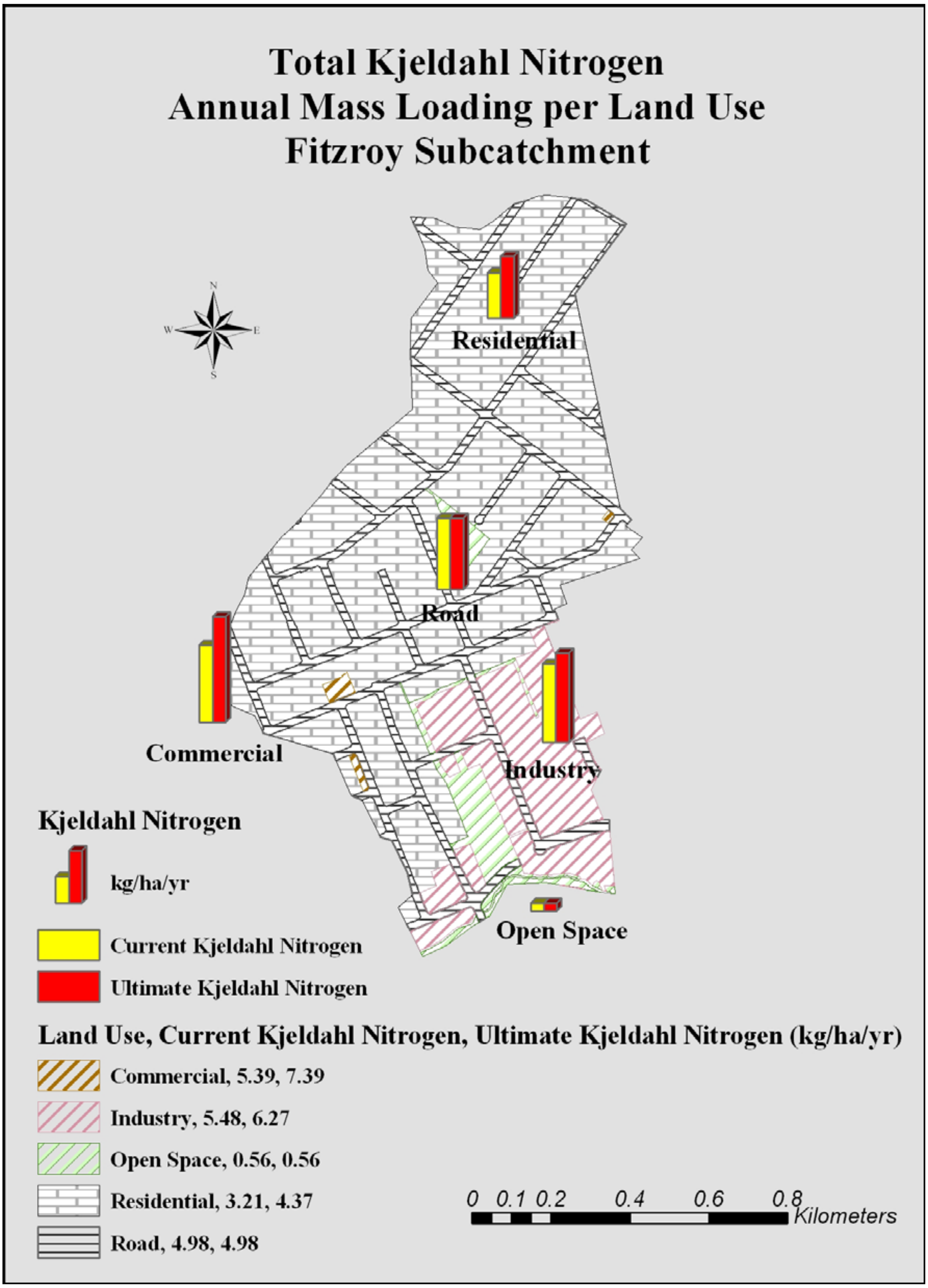


Figure A II.8: Total Petroleum Hydrocarbons annual mass loading (kg/ha/yr) per land use – Fitzroy subcatchment

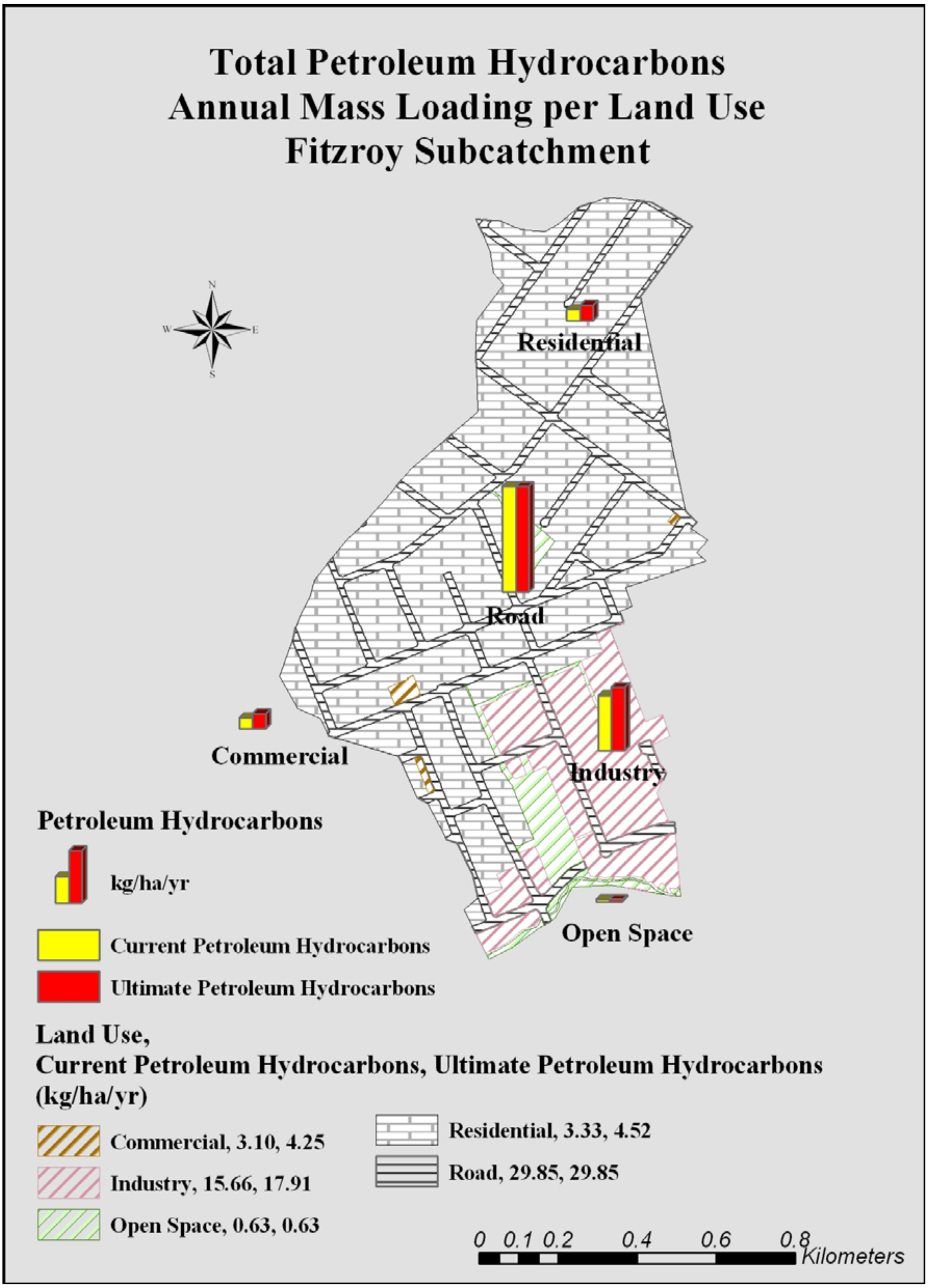


Figure A II.9: Total Suspended Solids annual mass loading (kg/ha/yr) per land use – Homai subcatchment

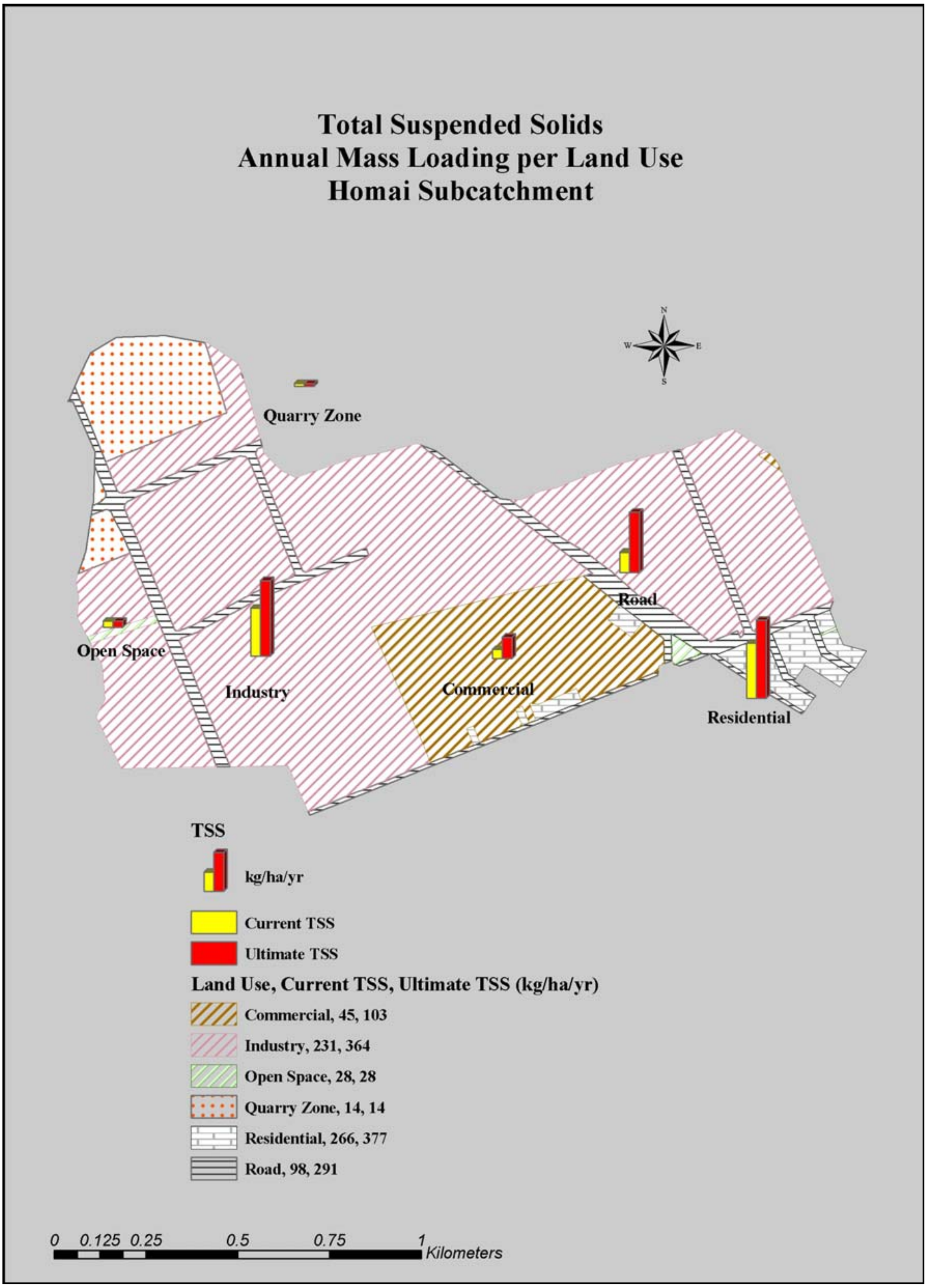


Figure A II.10: Biochemical Oxygen Demand annual mass loading (kg/ha/yr) per land use – Homai subcatchment

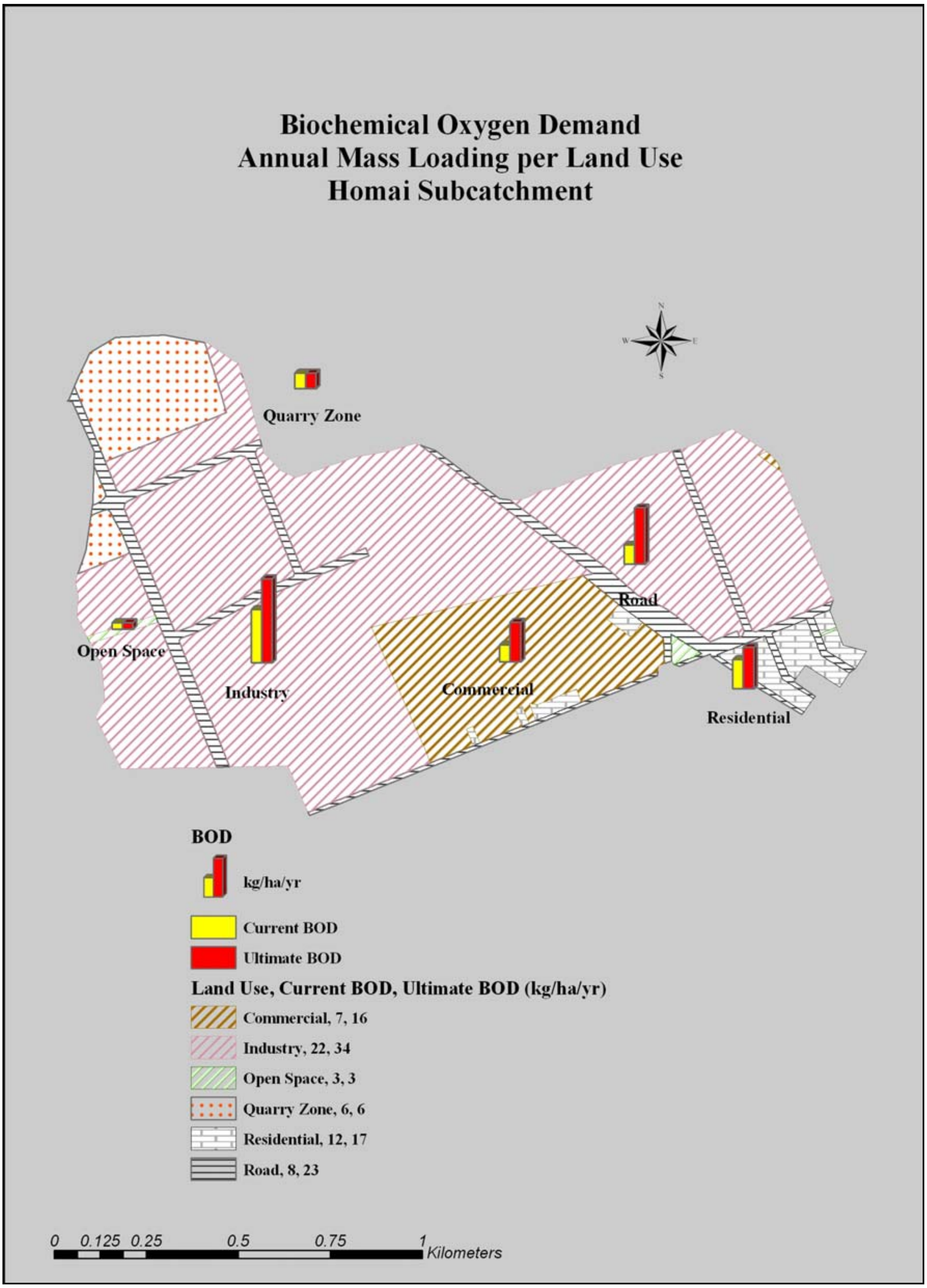


Figure A II.11: Total Phosphorus annual mass loading (kg/ha/yr) per land use – Homai subcatchment

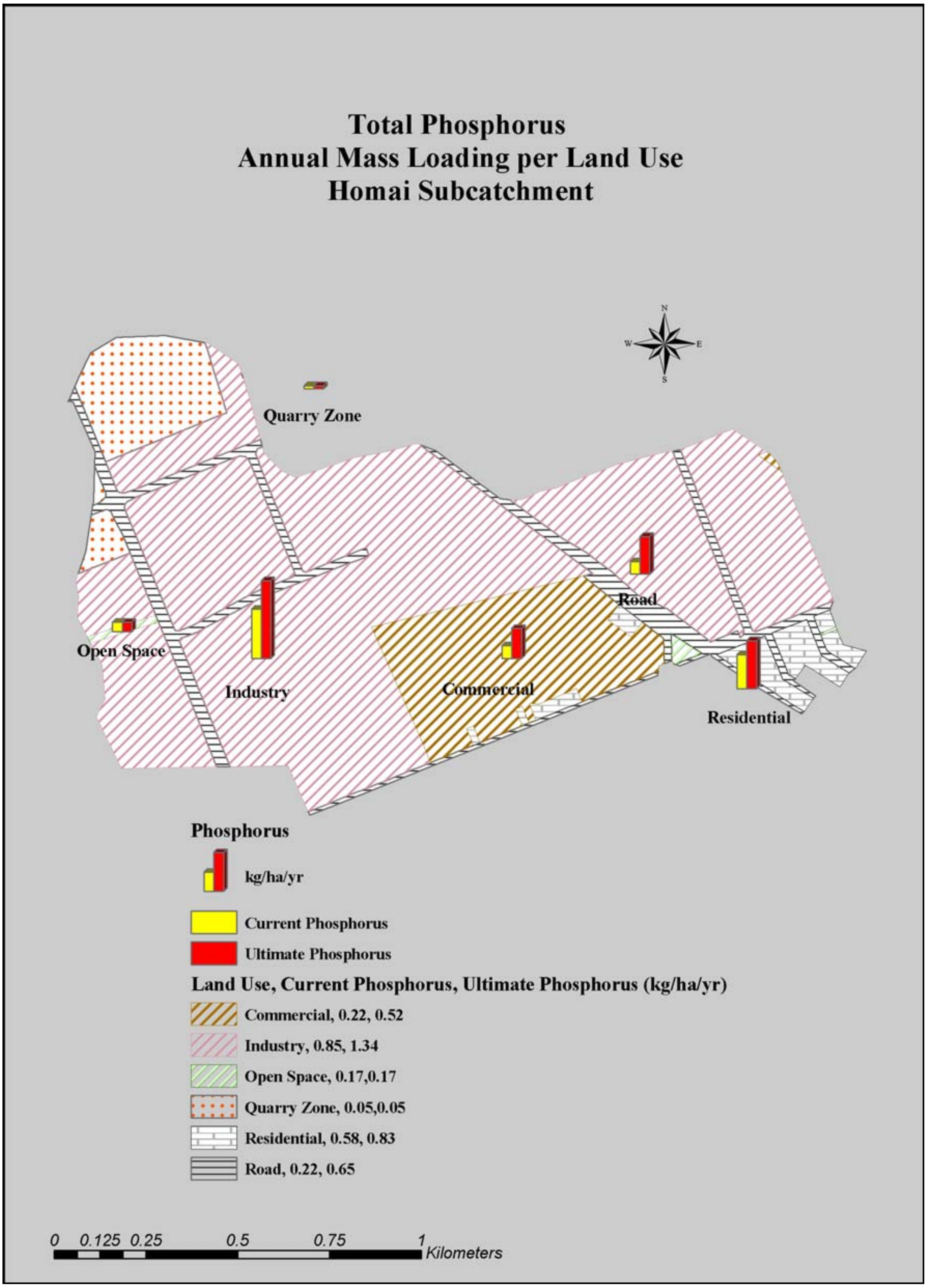


Figure A II.12: Total Copper annual mass loading (kg/ha/yr)
per land use – Homai subcatchment

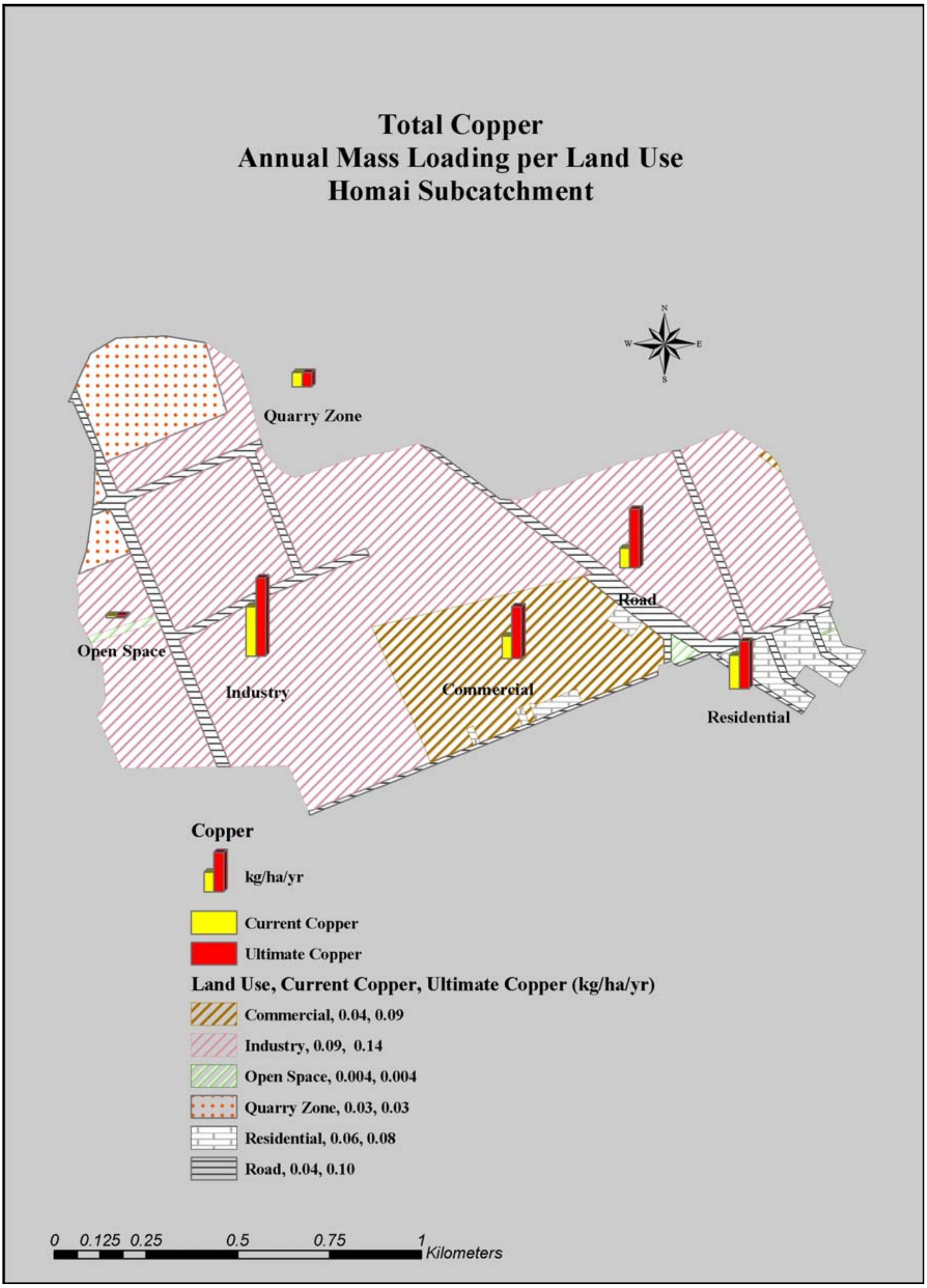


Figure A II.13: Total Lead annual mass loading (kg/ha/yr) per land use – Homai subcatchment

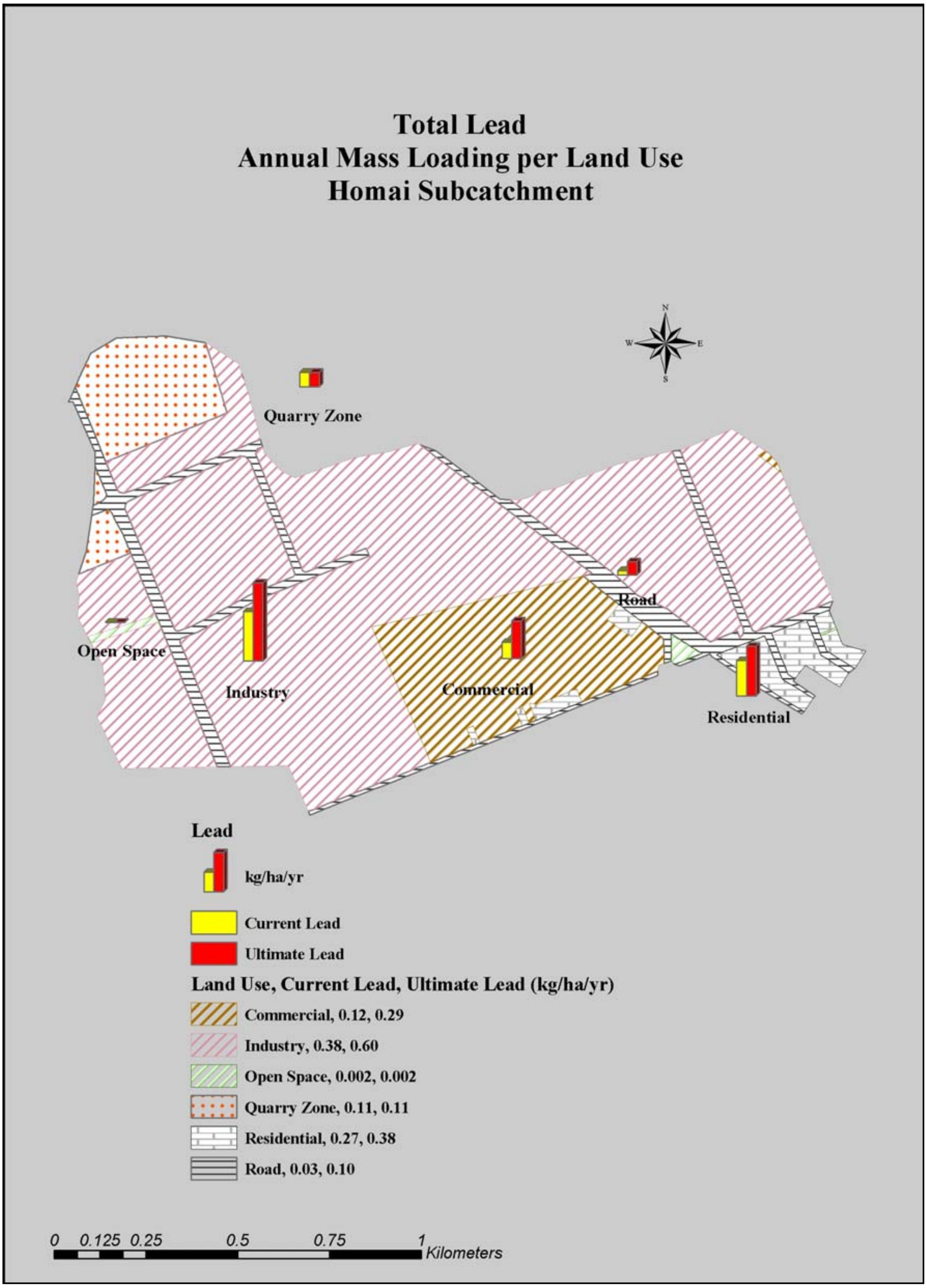


Figure A II.14: Total Zinc annual mass loading (kg/ha/yr) per land use – Homai subcatchment

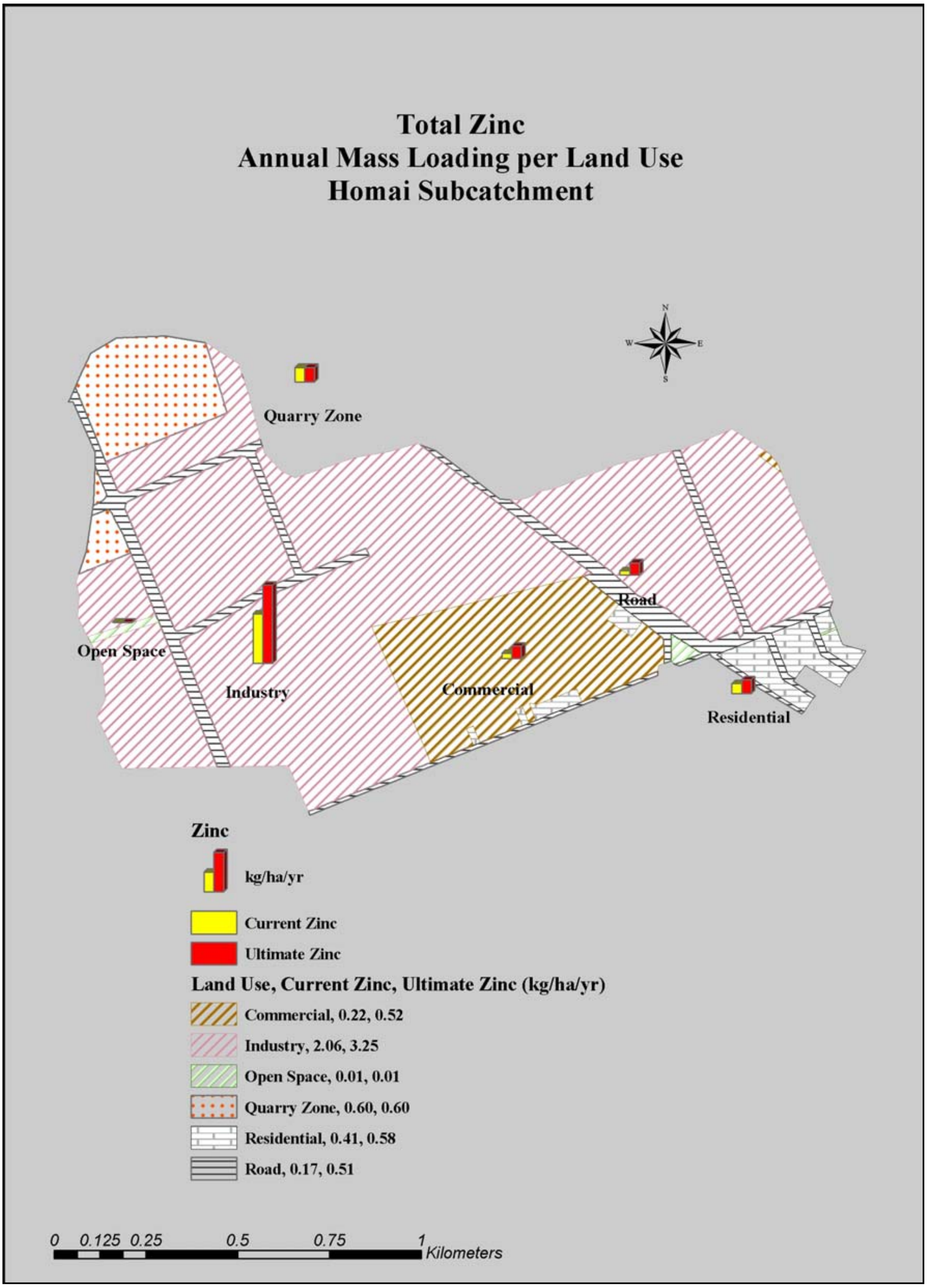


Figure A II.15: Total Kjeldahl Nitrogen annual mass loading (kg/ha/yr) per land use – Homai subcatchment

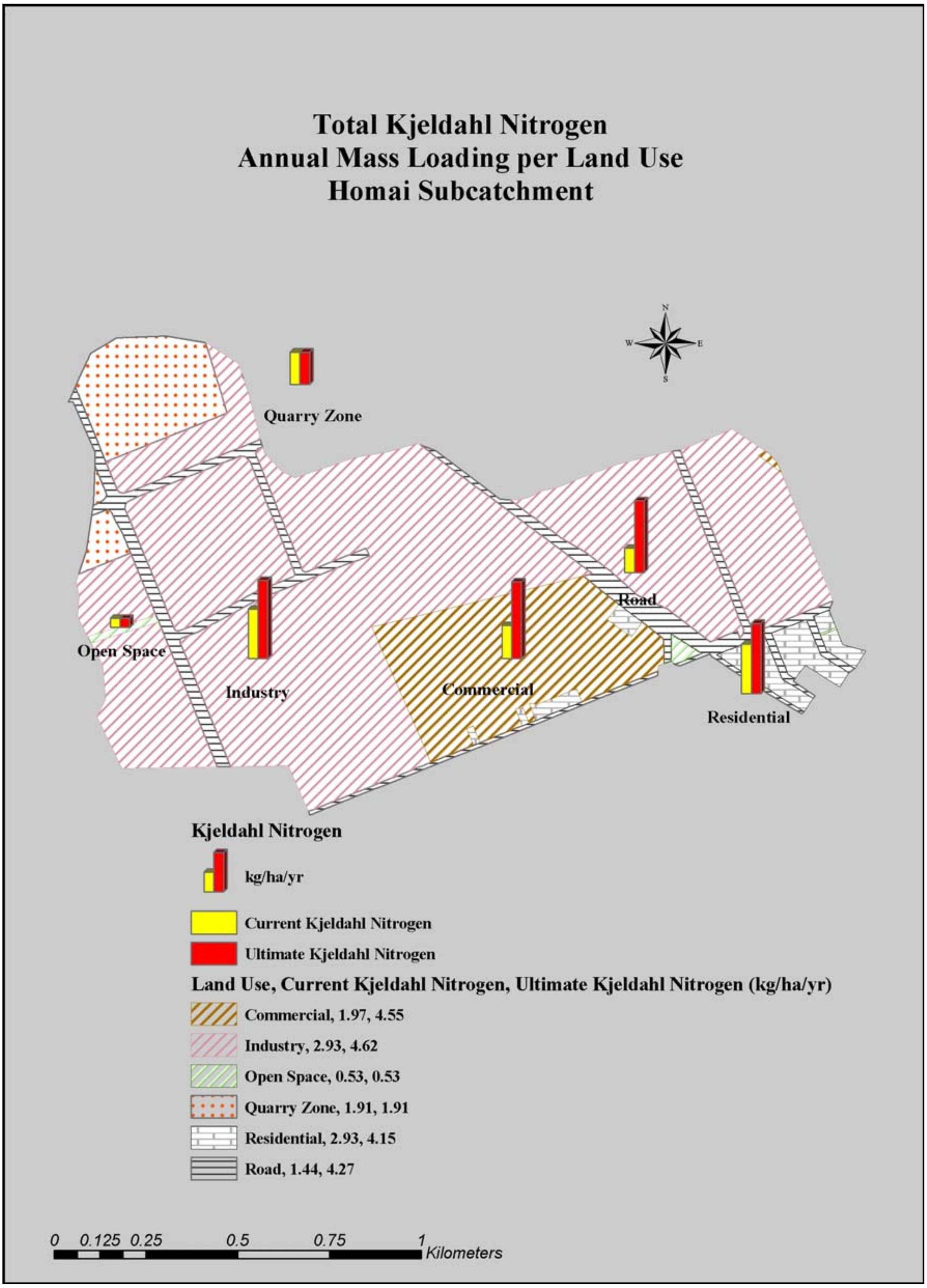


Figure A II.16: Total Petroleum Hydrocarbons annual mass loading (kg/ha/yr) per land use – Homai subcatchment

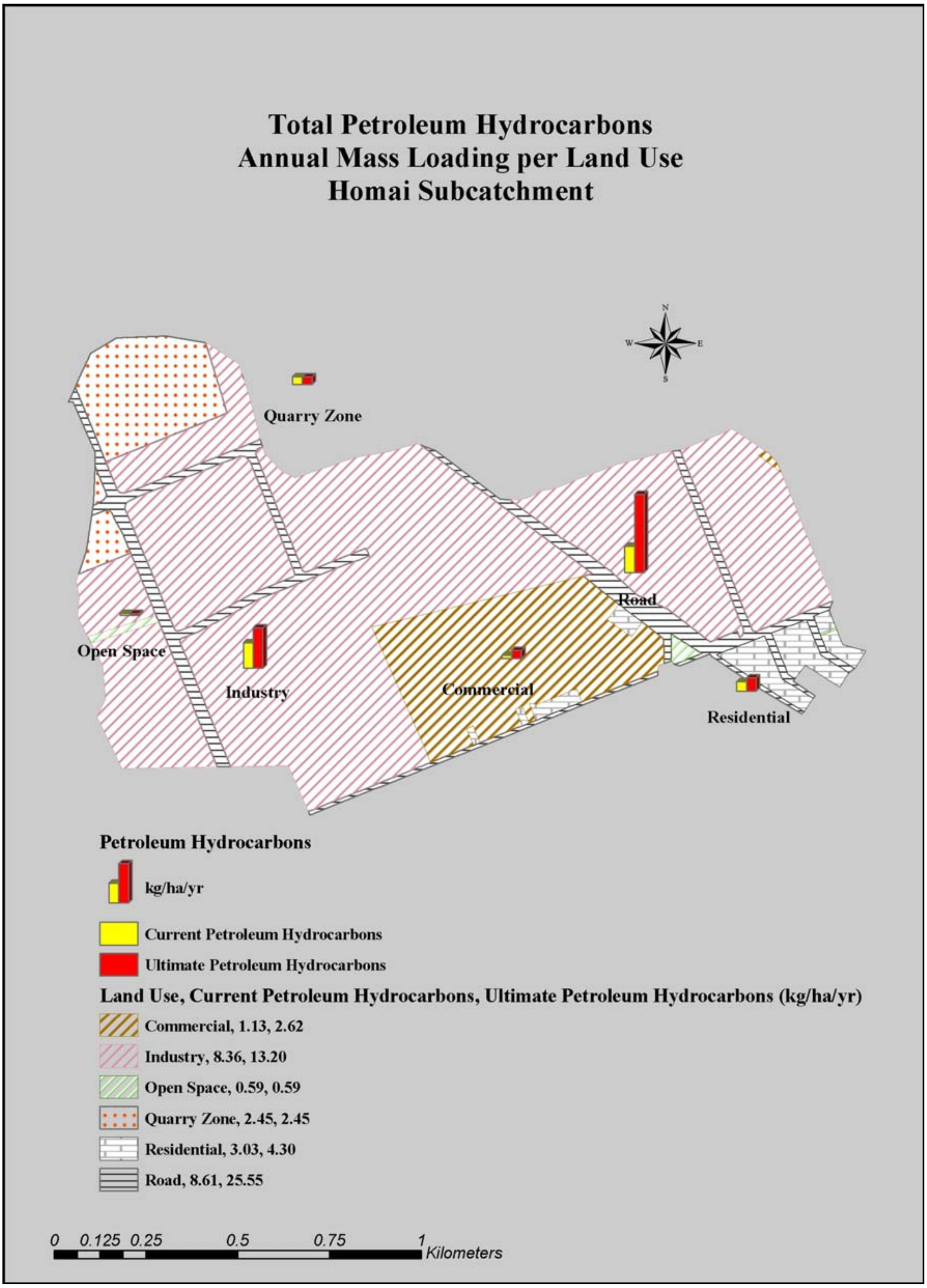


Figure A II.17: Total Suspended Solids annual mass loading (kg/ha/yr) per land use – McLaughlin subcatchment

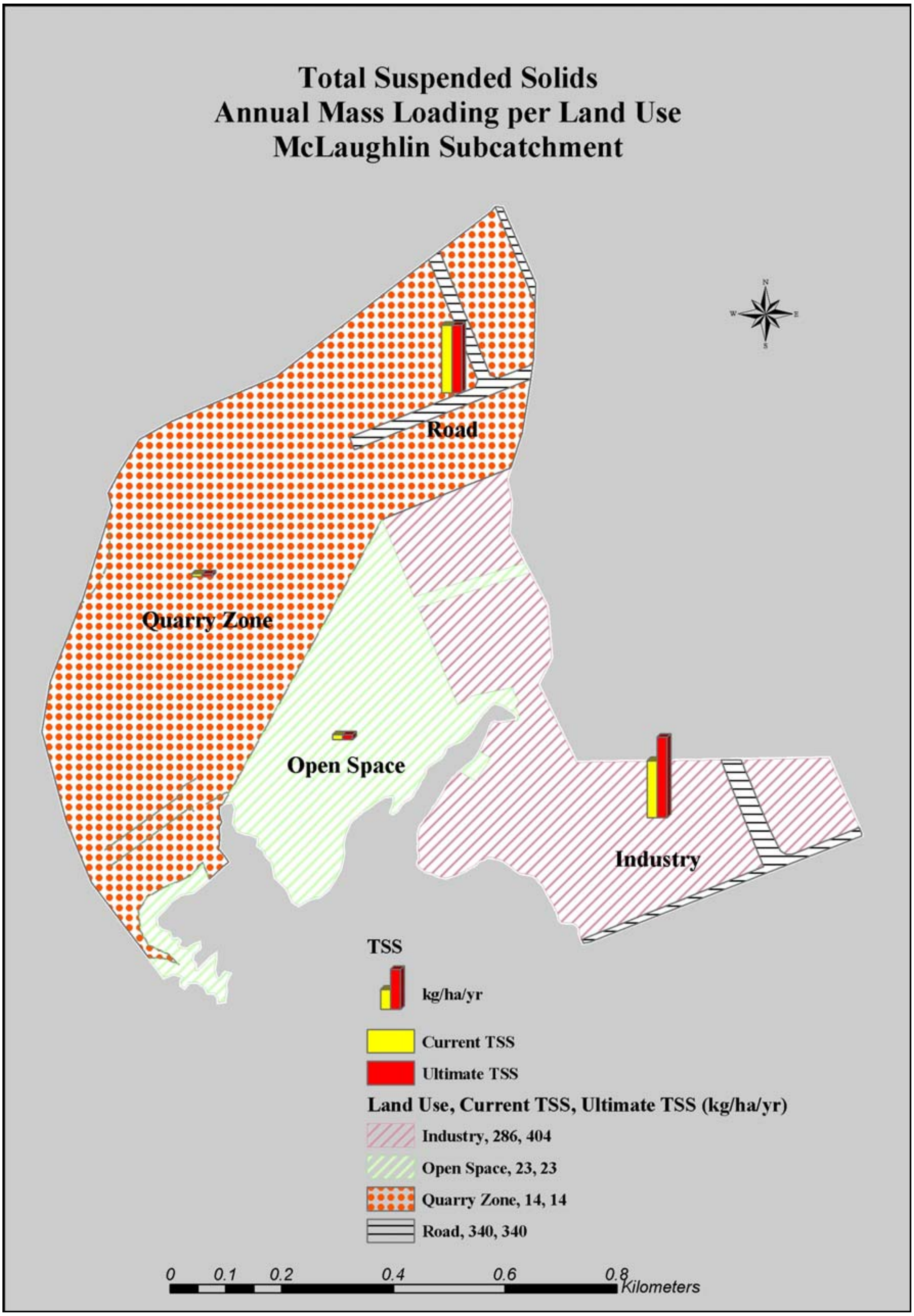


Figure A II.18: Biochemical Oxygen Demand annual mass loading (kg/ha/yr) per land use – McLaughlin subcatchment

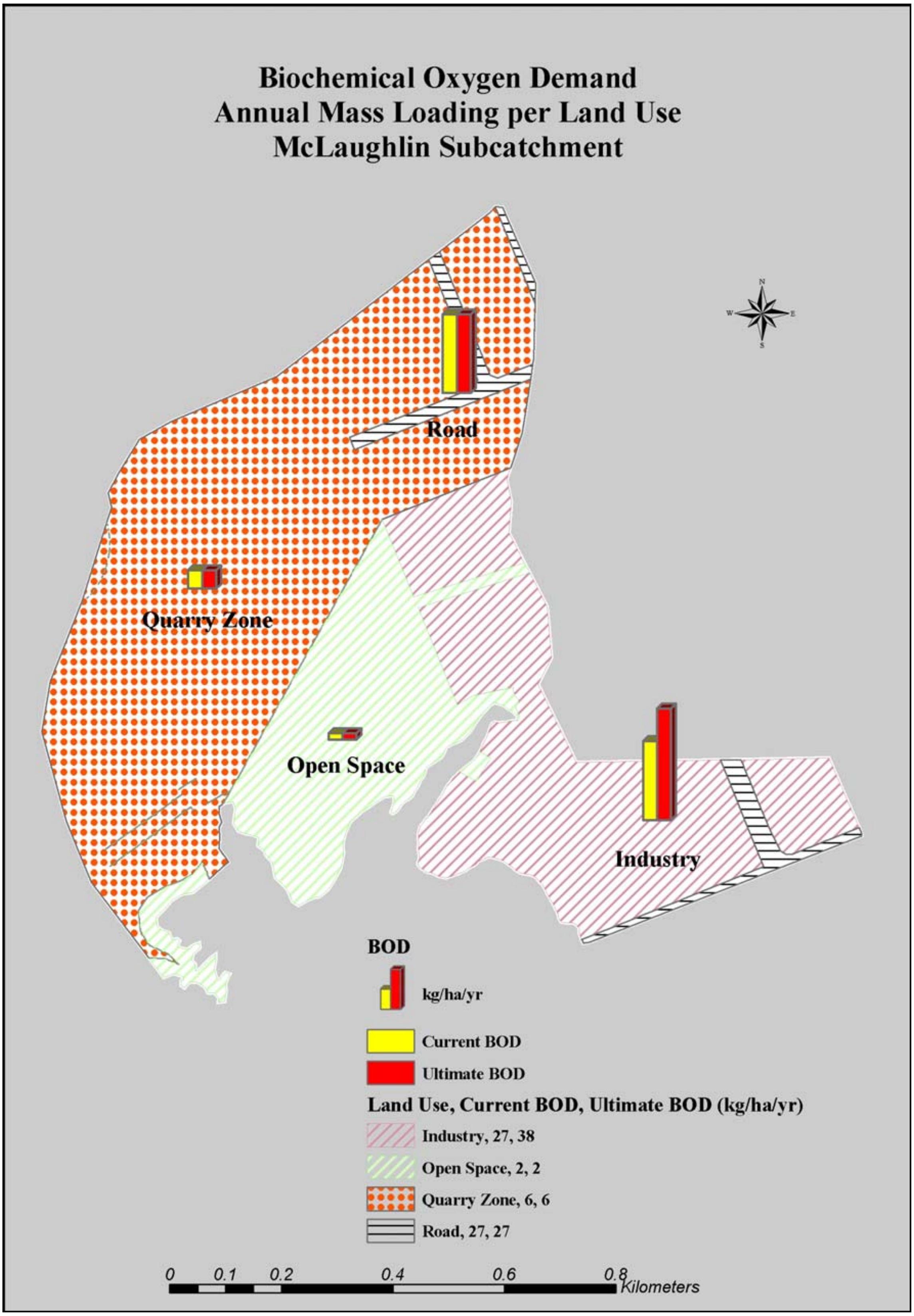


Figure A II.19: Total Phosphorus annual mass loading (kg/ha/yr) per land use – McLaughlin subcatchment

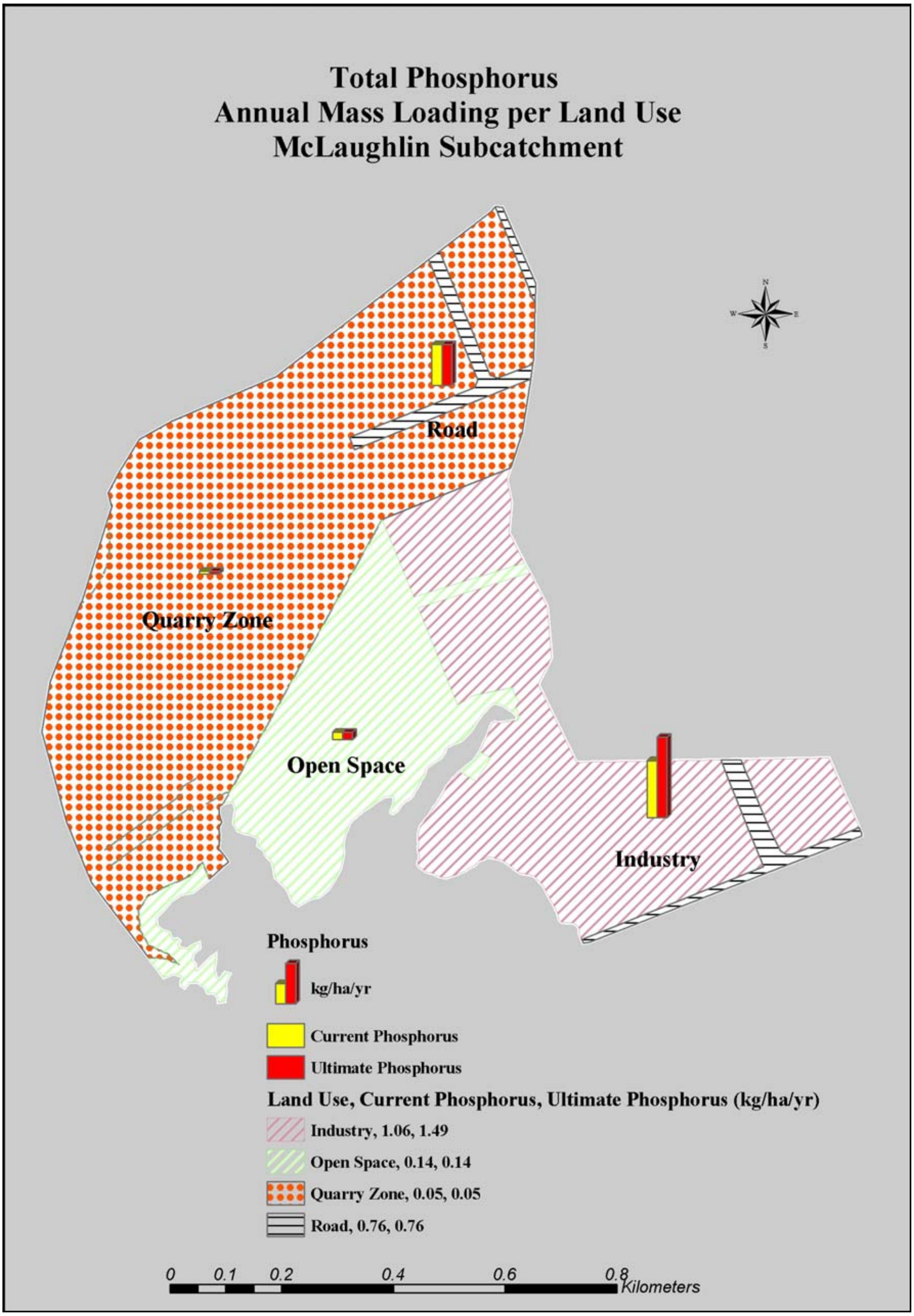


Figure A II.20: Total Copper annual mass loading (kg/ha/yr) per land use – McLaughlin subcatchment

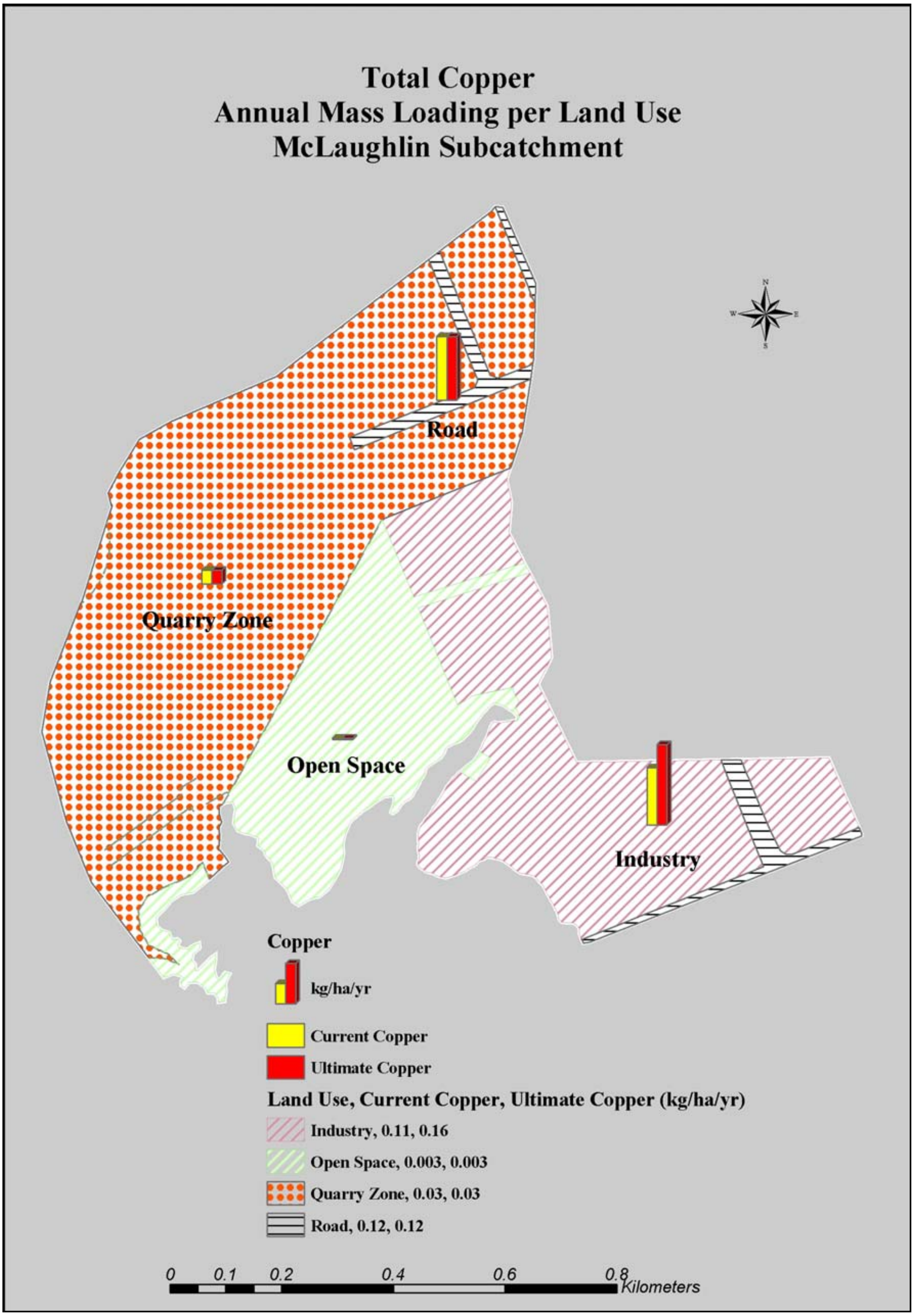


Figure A II.21: Total Lead annual mass loading (kg/ha/yr)
per land use – McLaughlin subcatchment

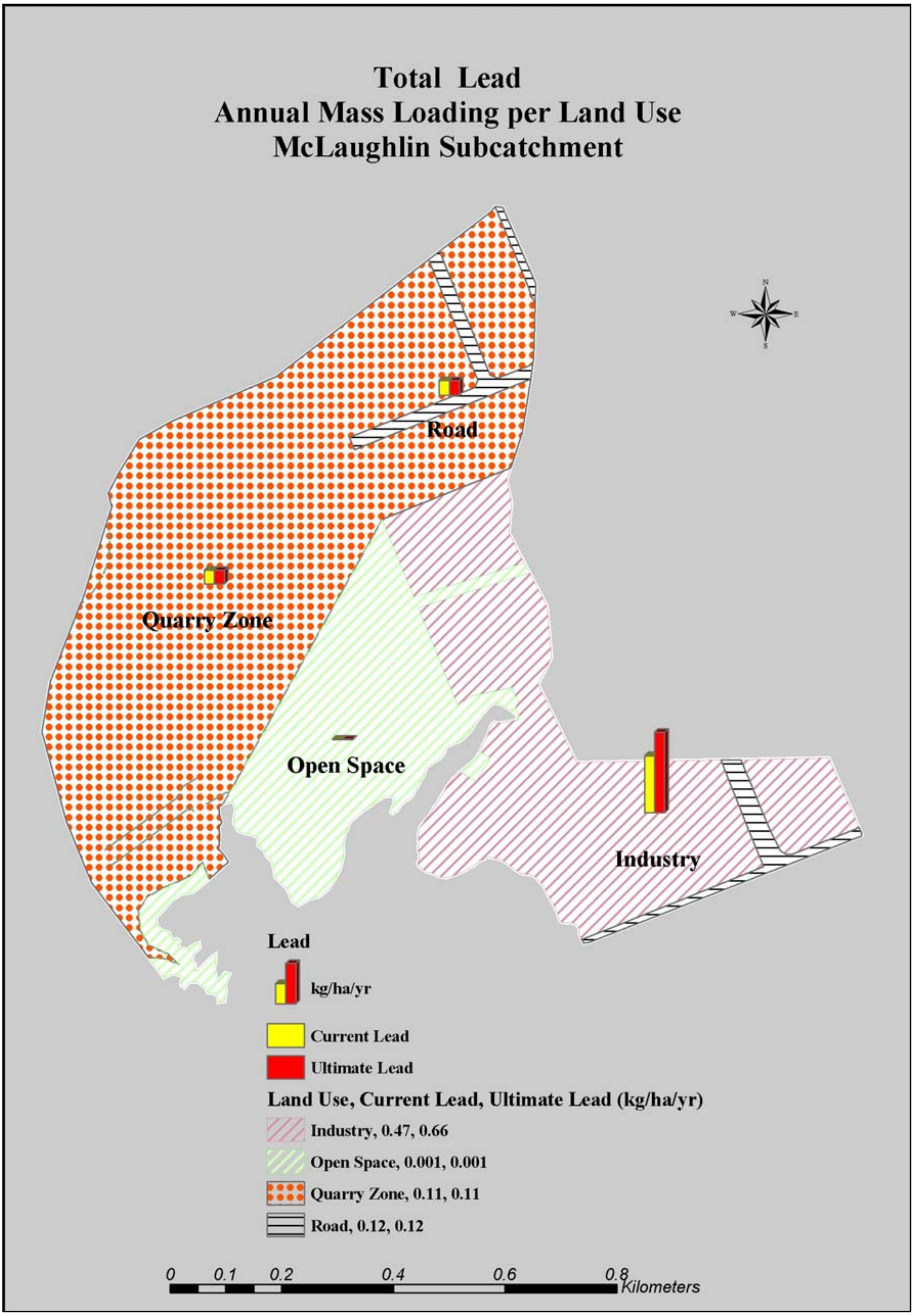


Figure A II.22: Total Zinc annual mass loading (kg/ha/yr)
per land use – McLaughlin subcatchment

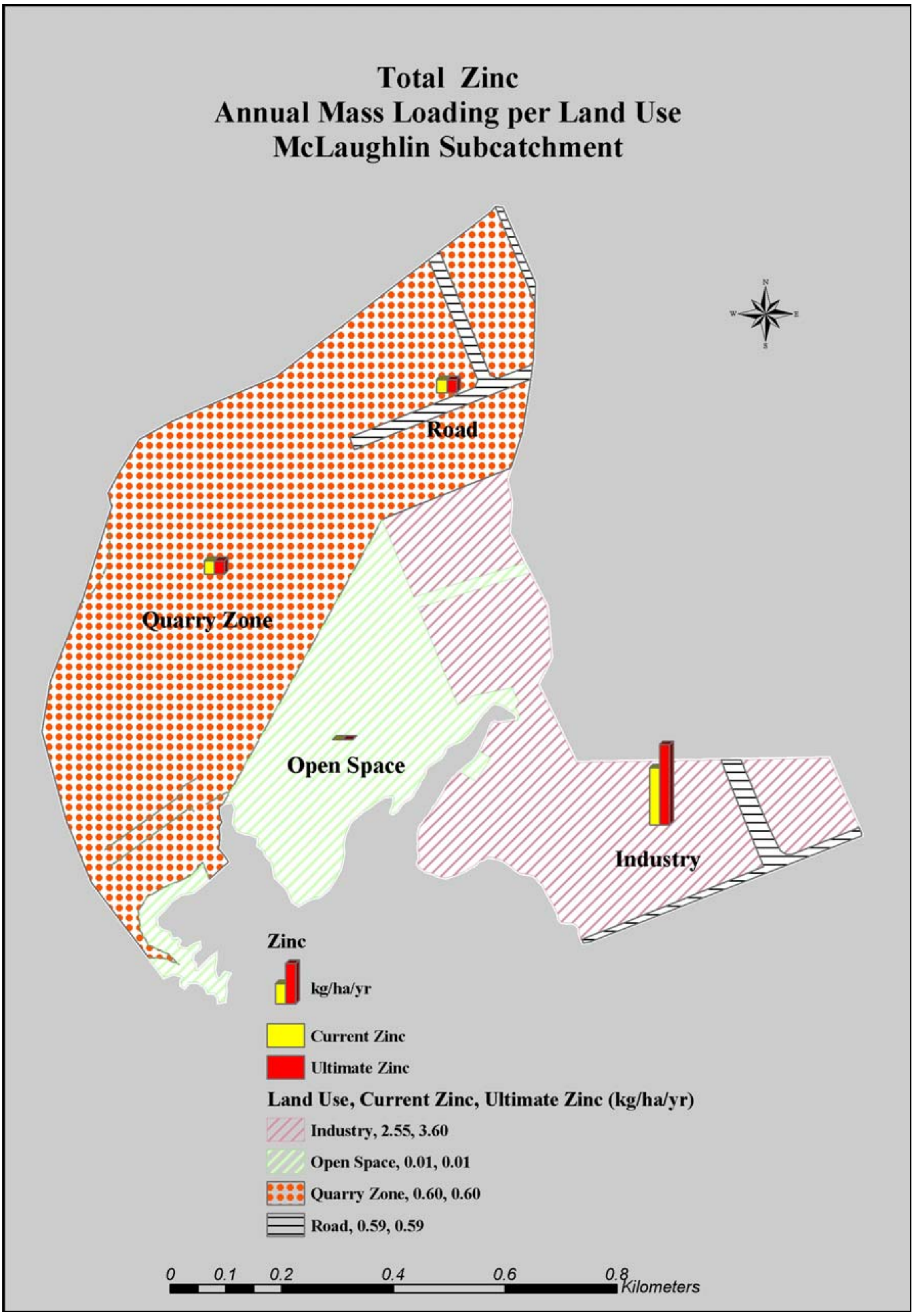


Figure A II.23: Total Kjeldahl Nitrogen annual mass loading (kg/ha/yr) per land use – McLaughlin subcatchment

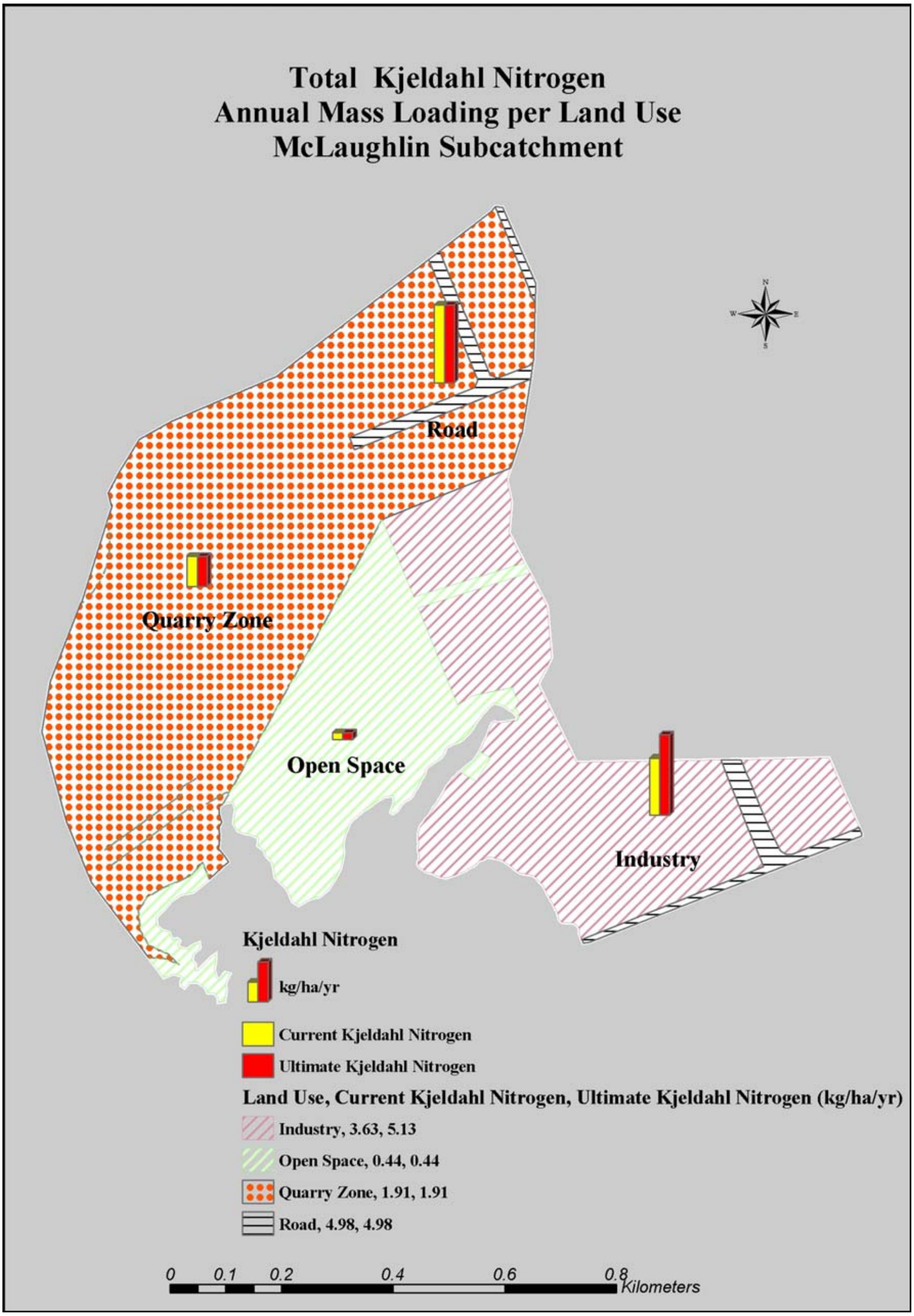


Figure A II.24: Total Petroleum Hydrocarbons annual mass loading (kg/ha/yr) per land use – McLaughlin subcatchment

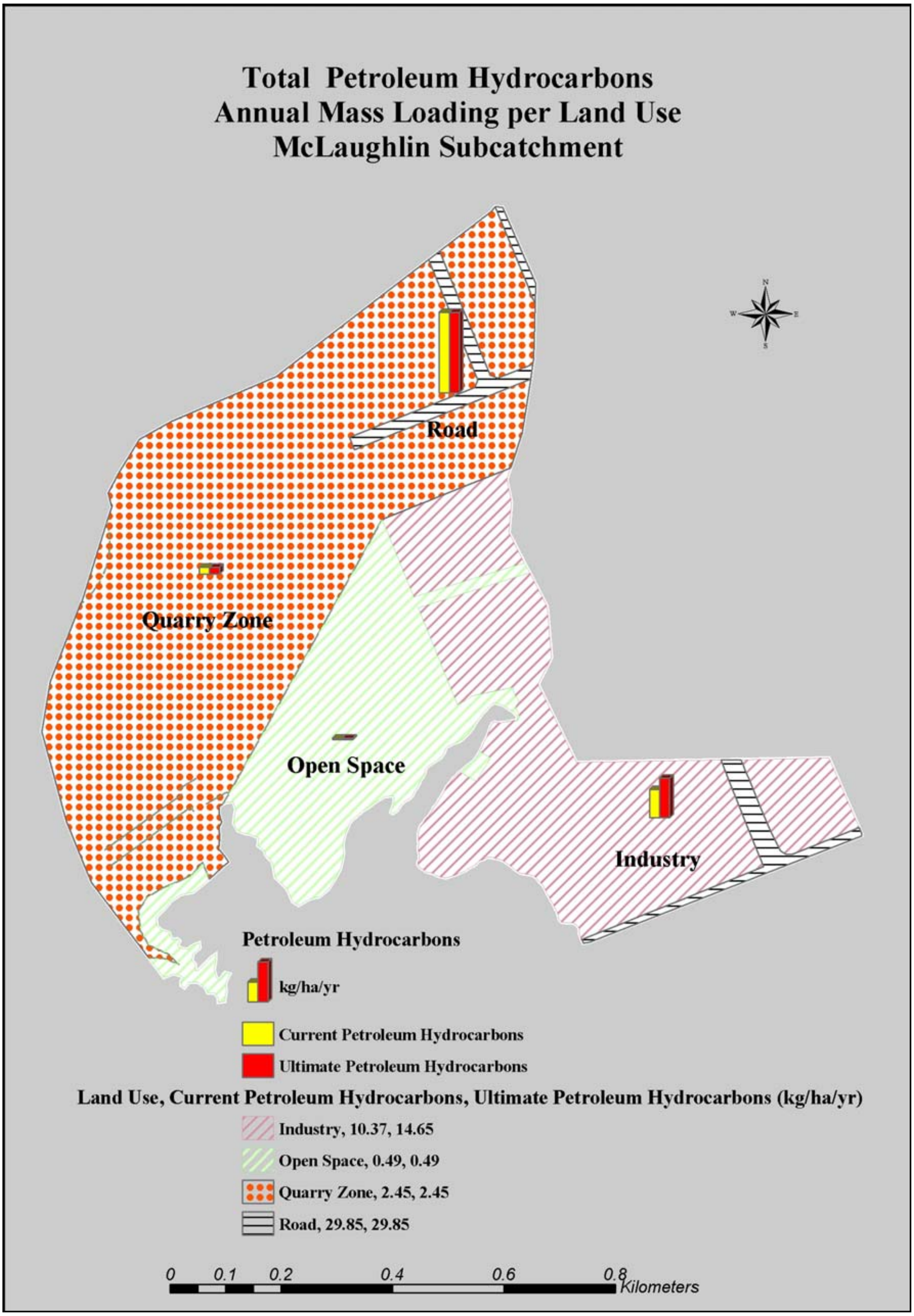


Figure A II.25: Total Suspended Solids annual mass loading (kg/ha/yr) per land use – P17 subcatchment

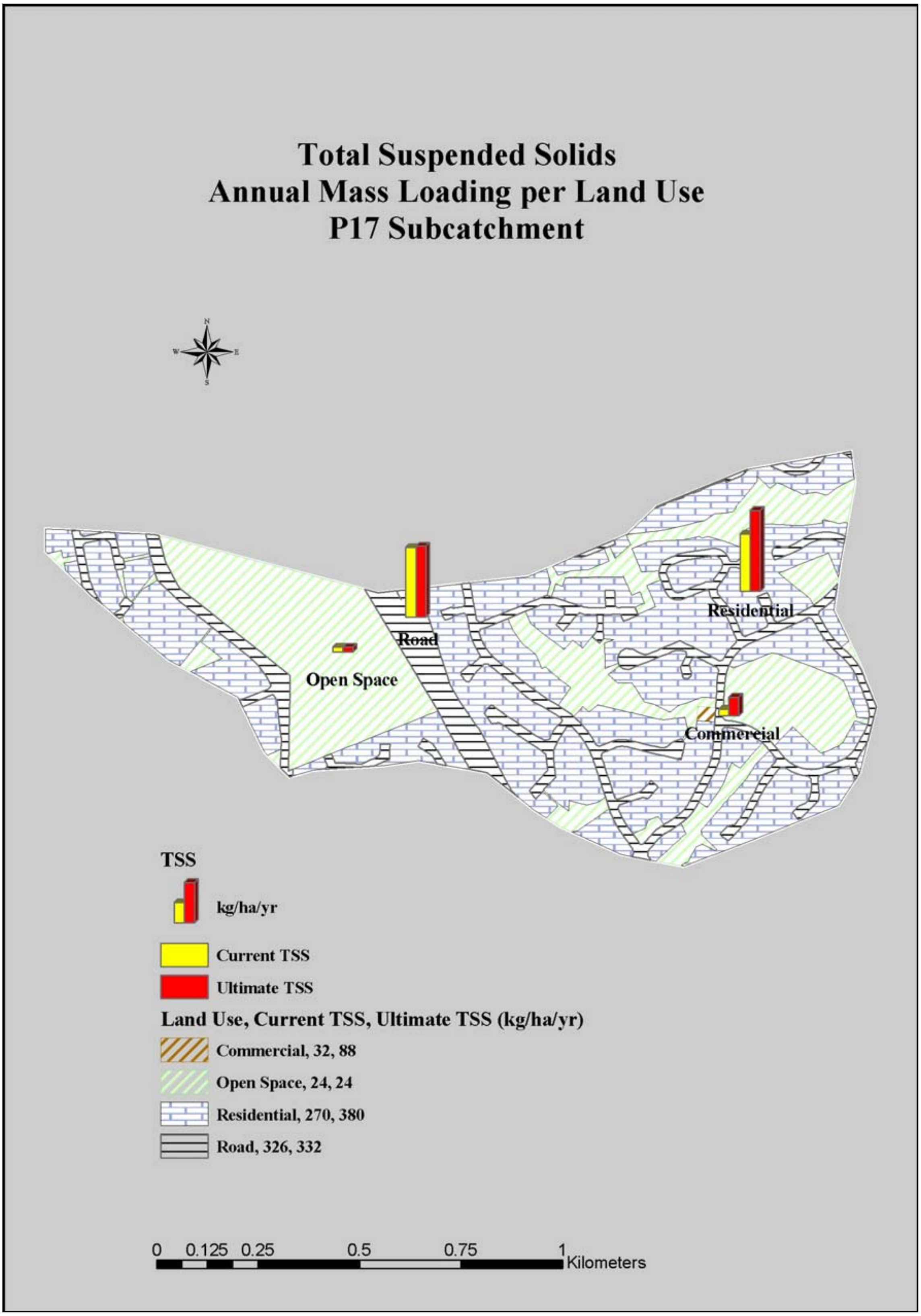


Figure A II.26: Biochemical Oxygen Demand annual mass loading (kg/ha/yr) per land use – P17 subcatchment

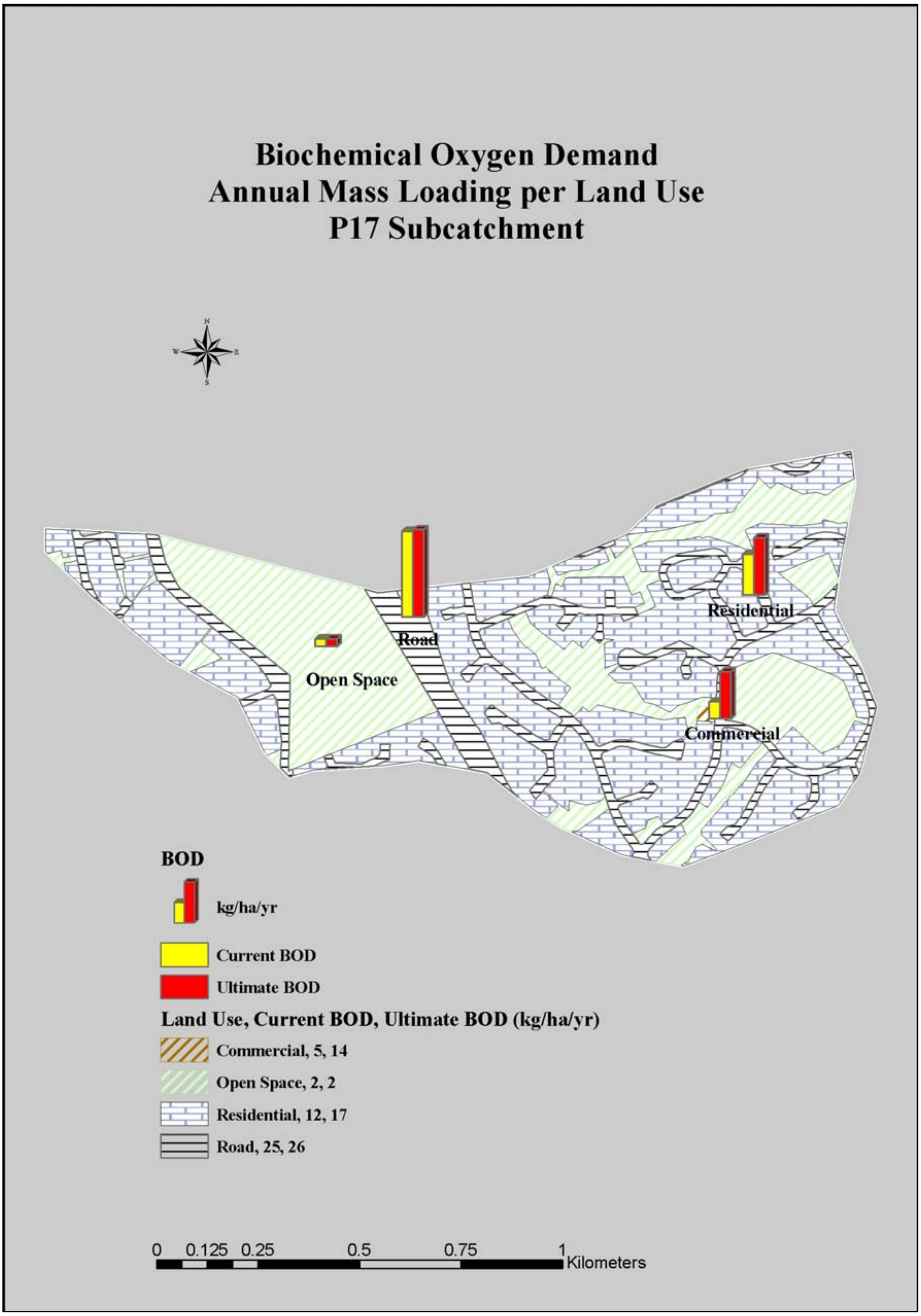


Figure A II.27: Total Phosphorus annual mass loading (kg/ha/yr) per land use – P17 subcatchment

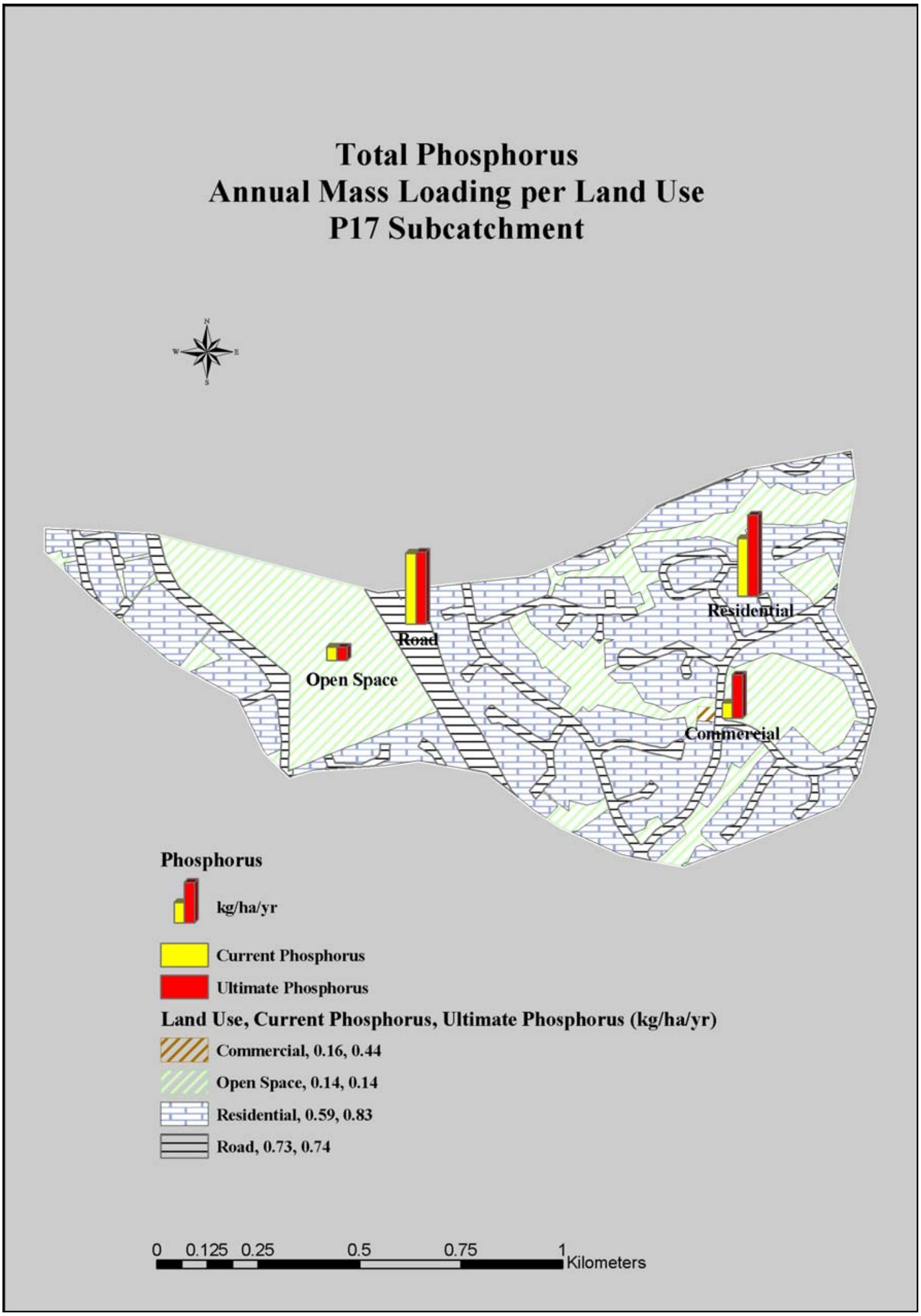


Figure A II.28: Total Copper annual mass loading (kg/ha/yr)
per land use – P17 subcatchment

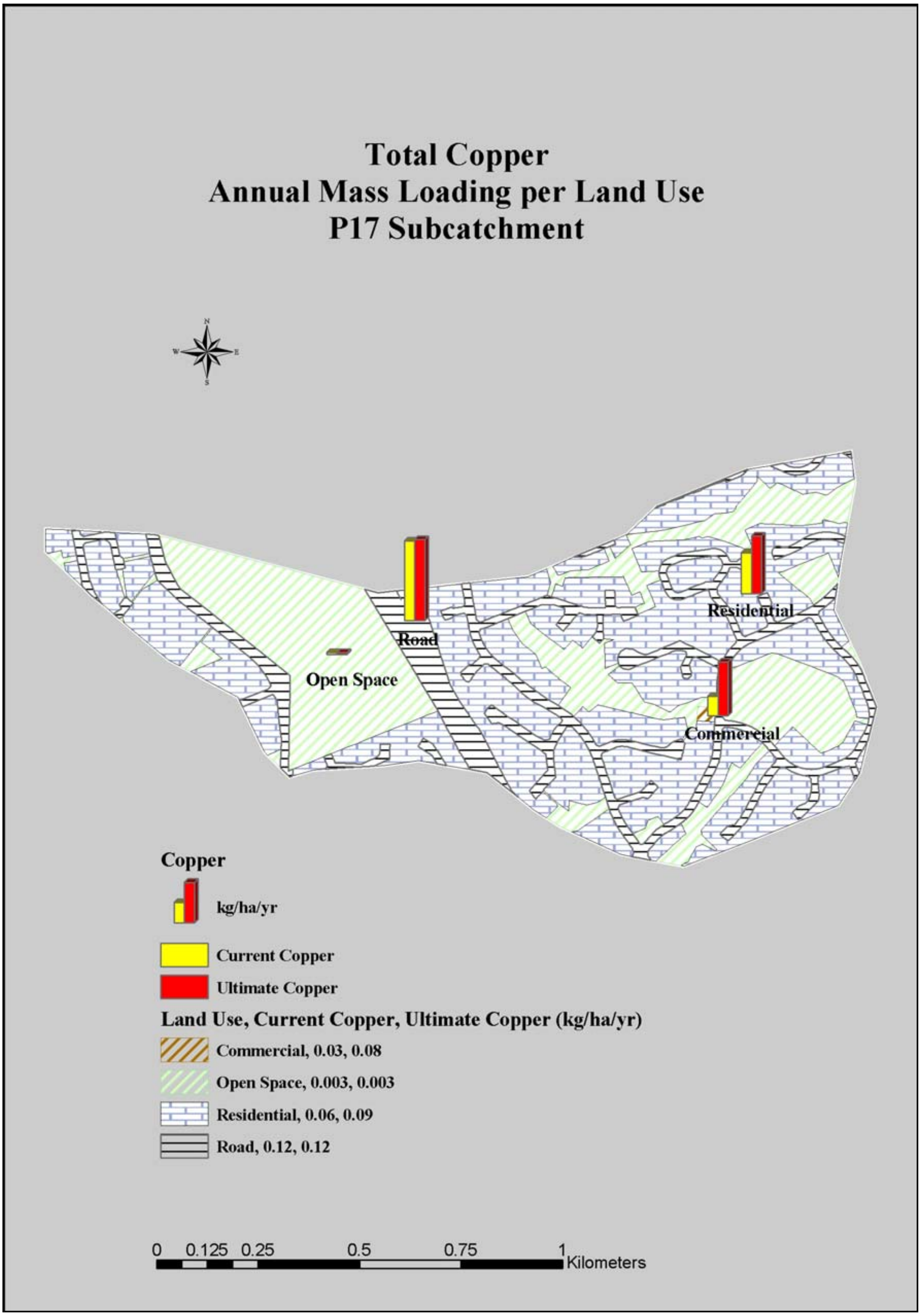


Figure A II.29: Total Lead annual mass loading (kg/ha/yr) per land use – P17 subcatchment

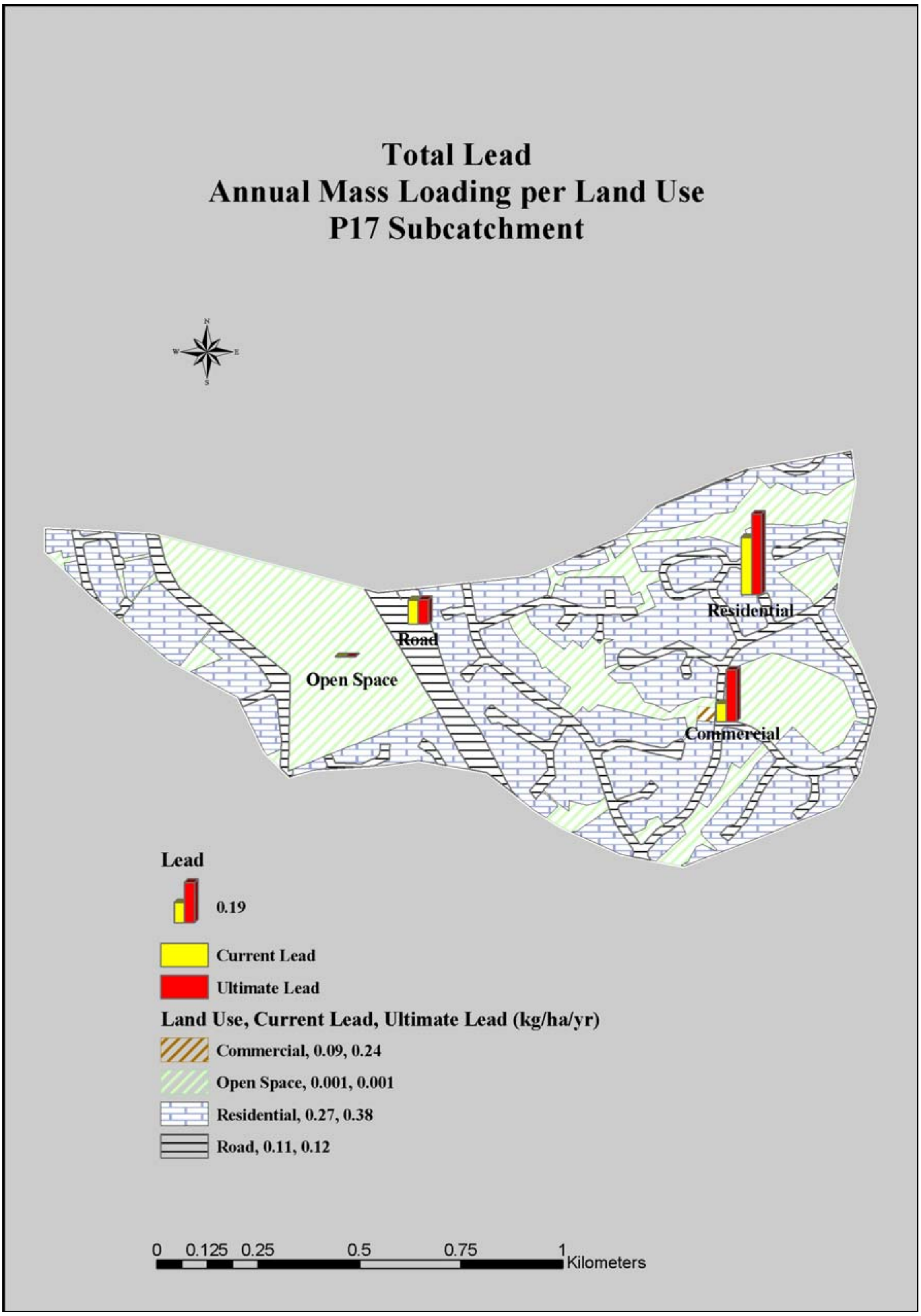


Figure A II.30: Total Zinc annual mass loading (kg/ha/yr)
per land use – P17 subcatchment

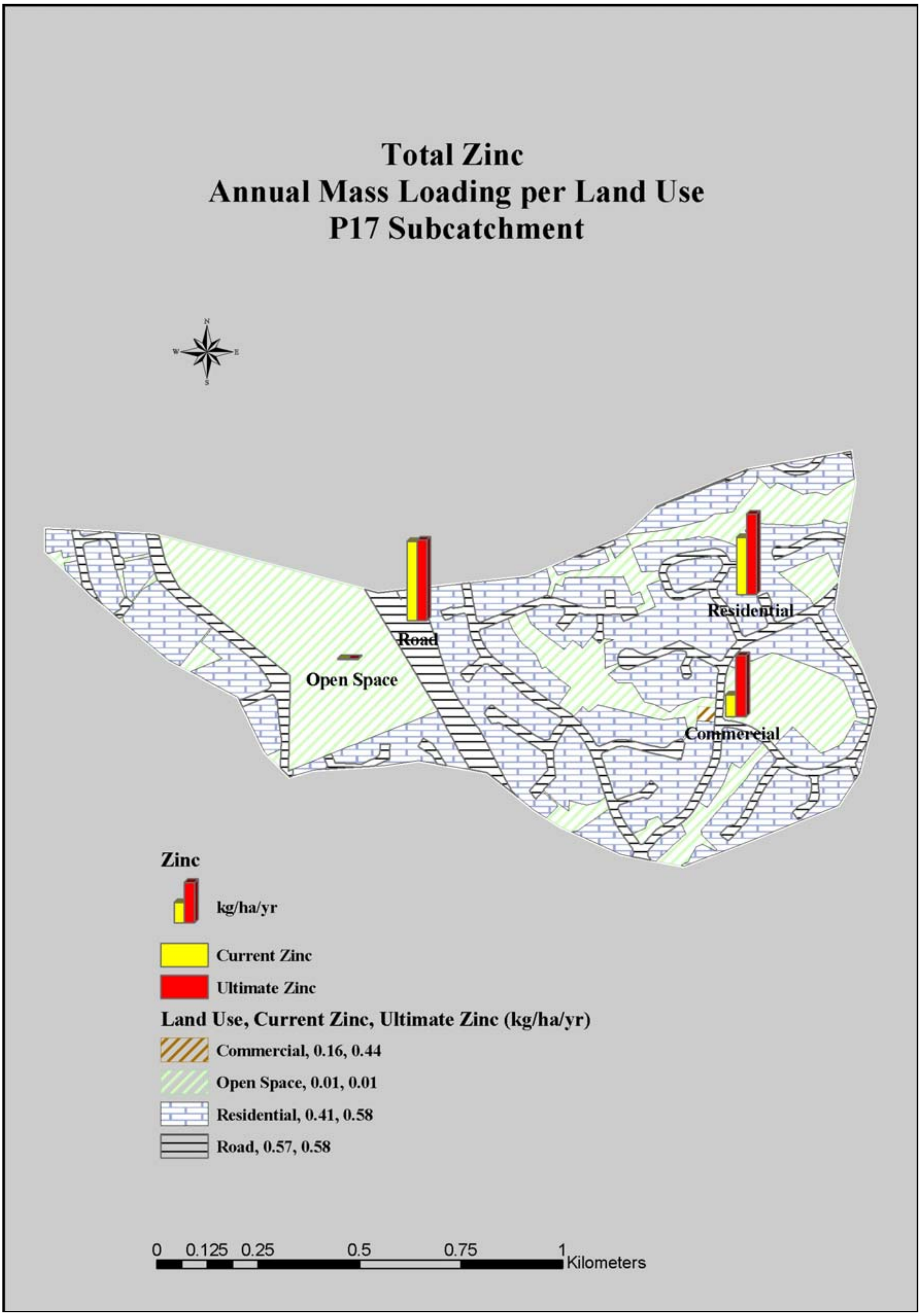


Figure A II.31: Total Kjeldahl Nitrogen annual mass loading (kg/ha/yr)
per land use – P17 subcatchment

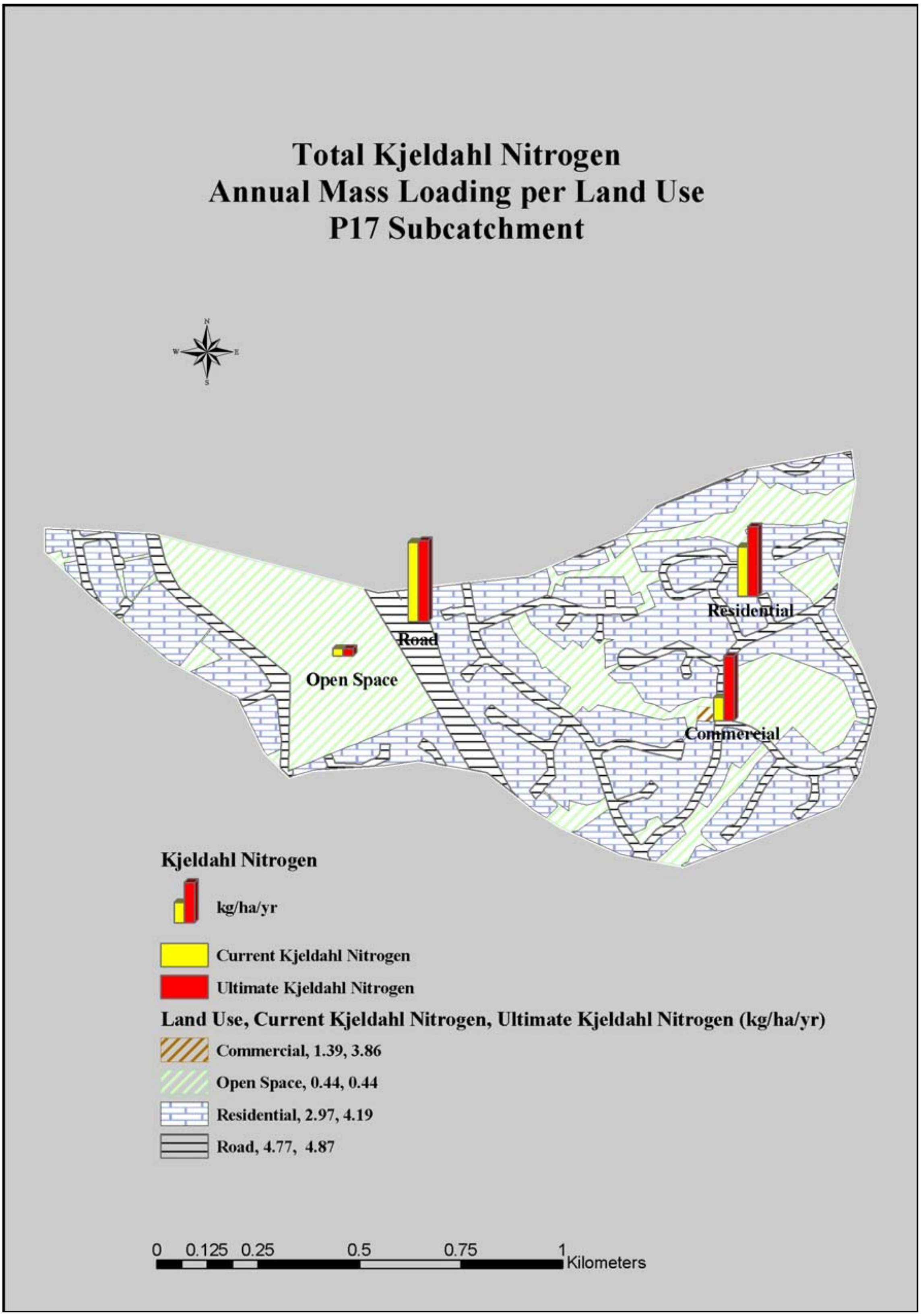


Figure A II.32: Total Petroleum Hydrocarbons annual mass loading (kg/ha/yr) per land use – P17 subcatchment

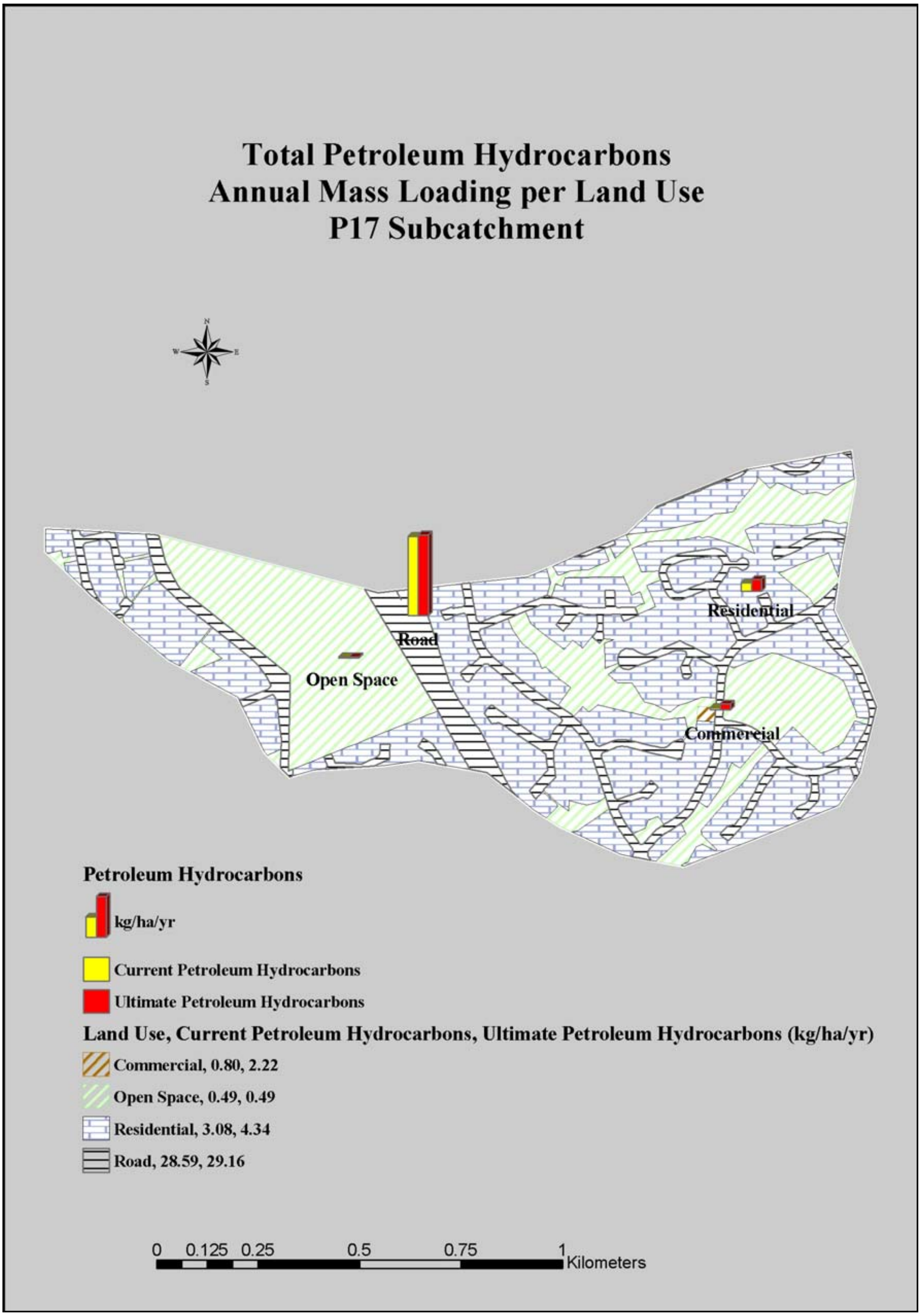


Figure A II.33: Total Suspended Solids annual mass loading (kg/ha/yr) per land use – P18 subcatchment

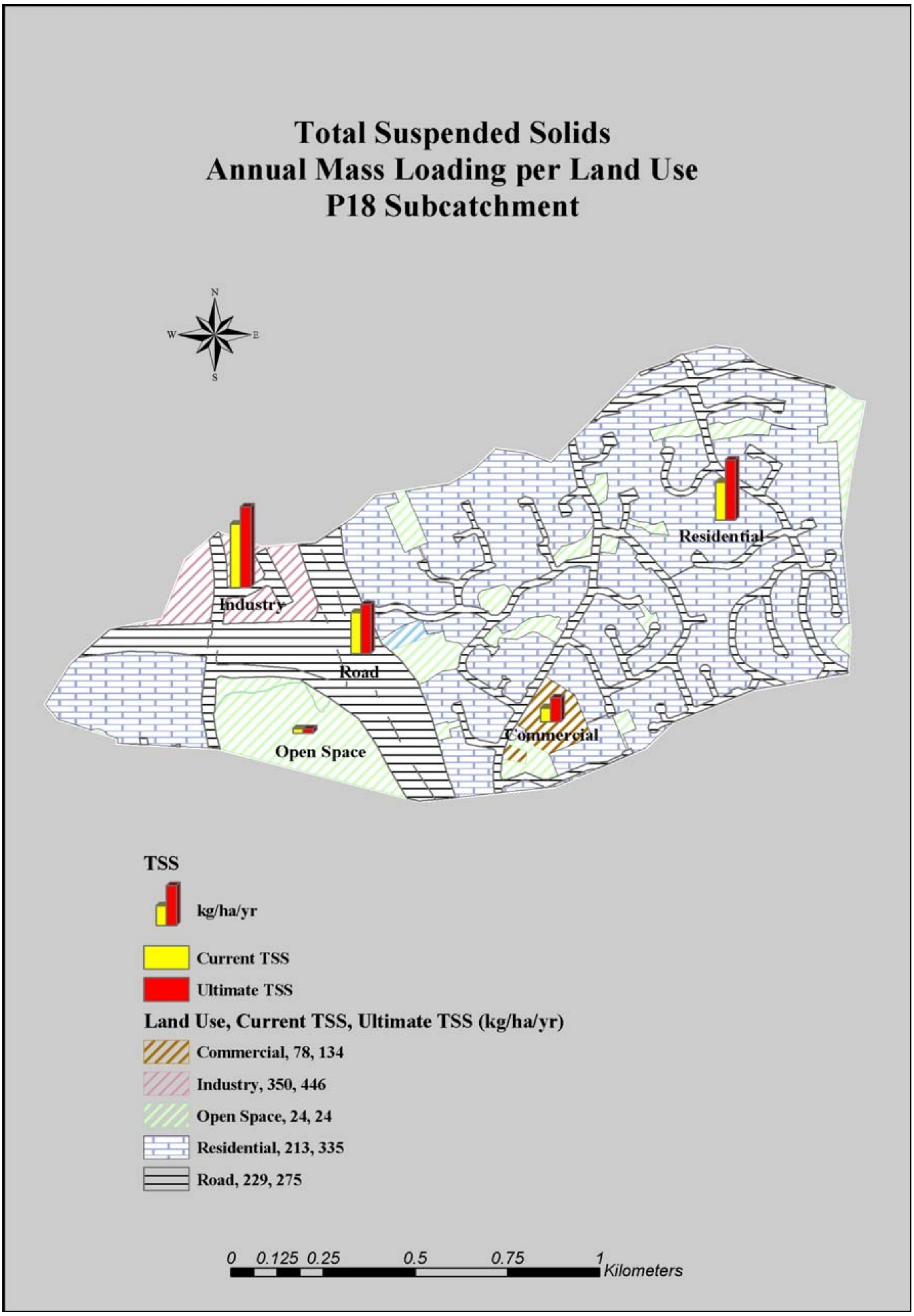


Figure A II.34: Biochemical Oxygen Demand annual mass loading (kg/ha/yr) per land use – P18 subcatchment

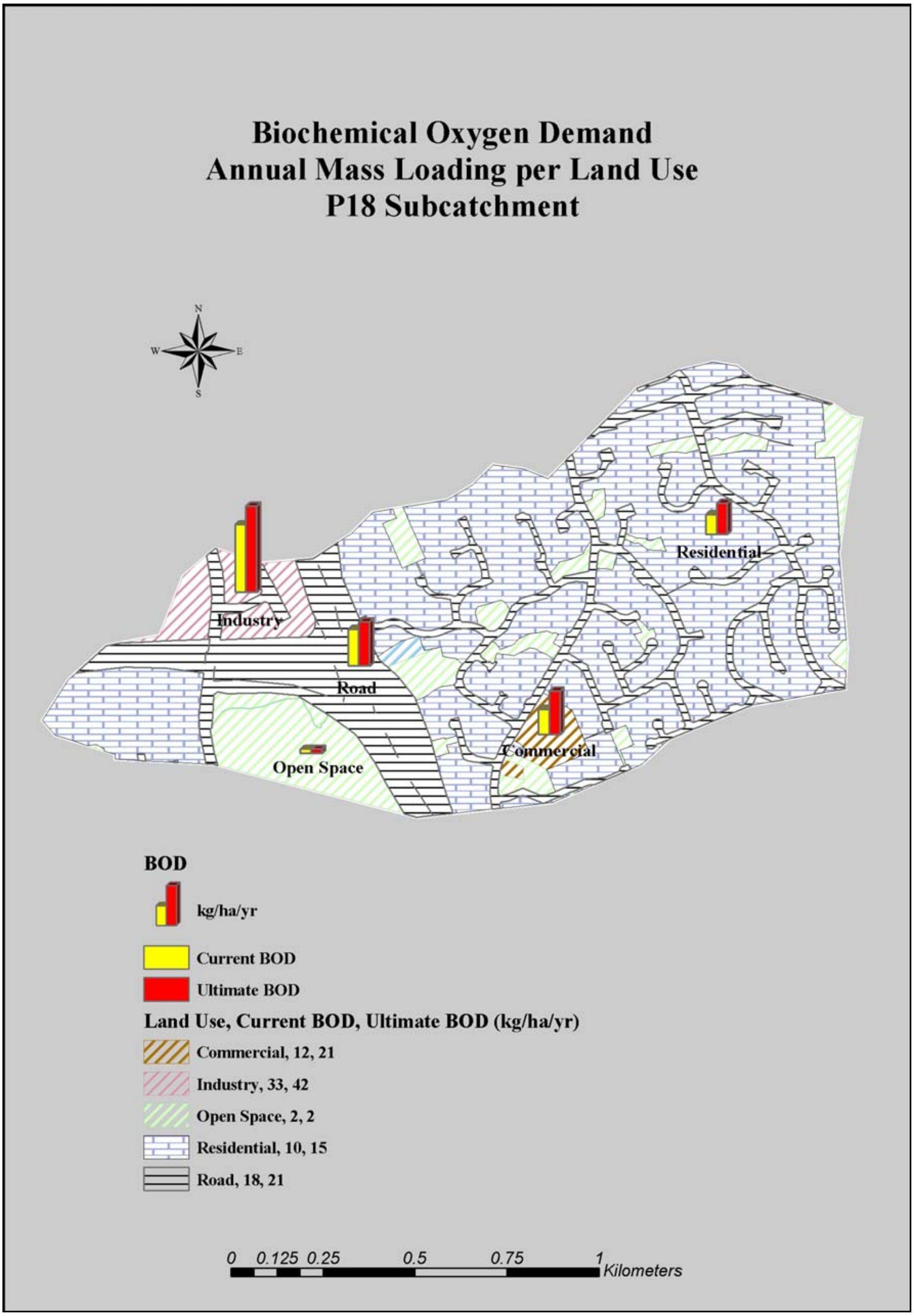


Figure A II.35: Total Phosphorus annual mass loading (kg/ha/yr) per land use – P18 subcatchment

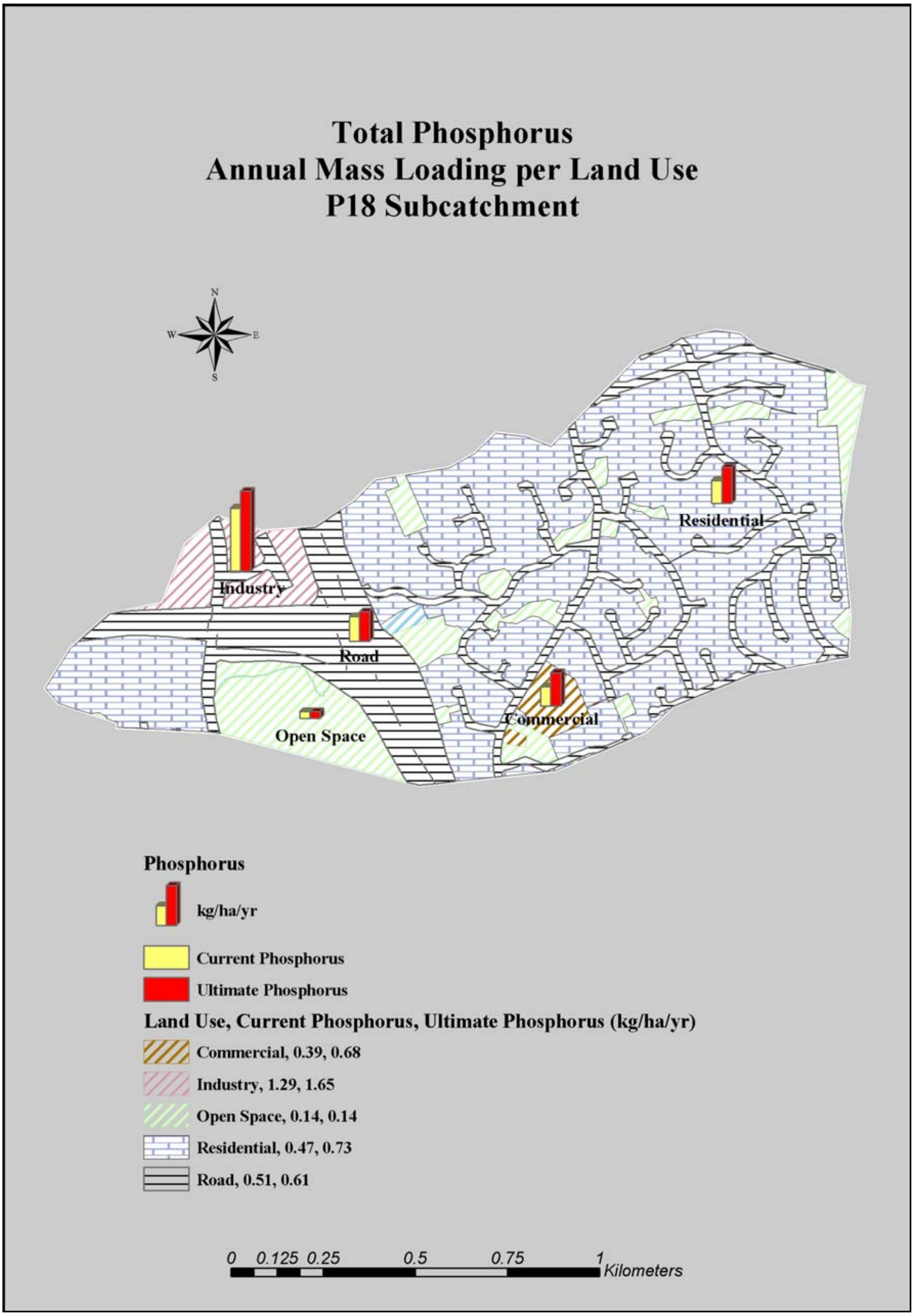


Figure A II.36: Total Copper annual mass loading (kg/ha/yr) per land use – P18 subcatchment

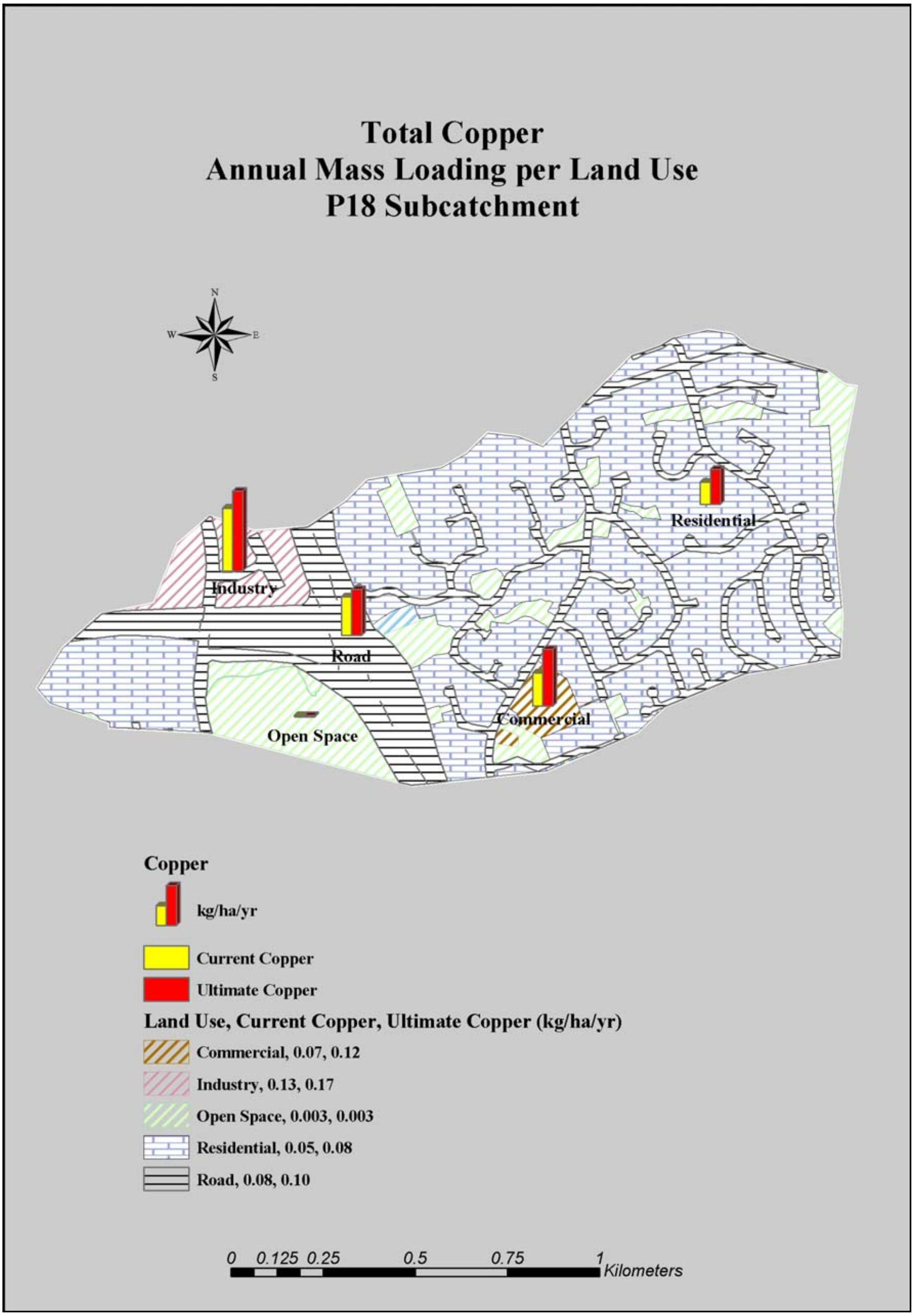


Figure A II.37: Total Lead annual mass loading (kg/ha/yr)
per land use – P18 subcatchment

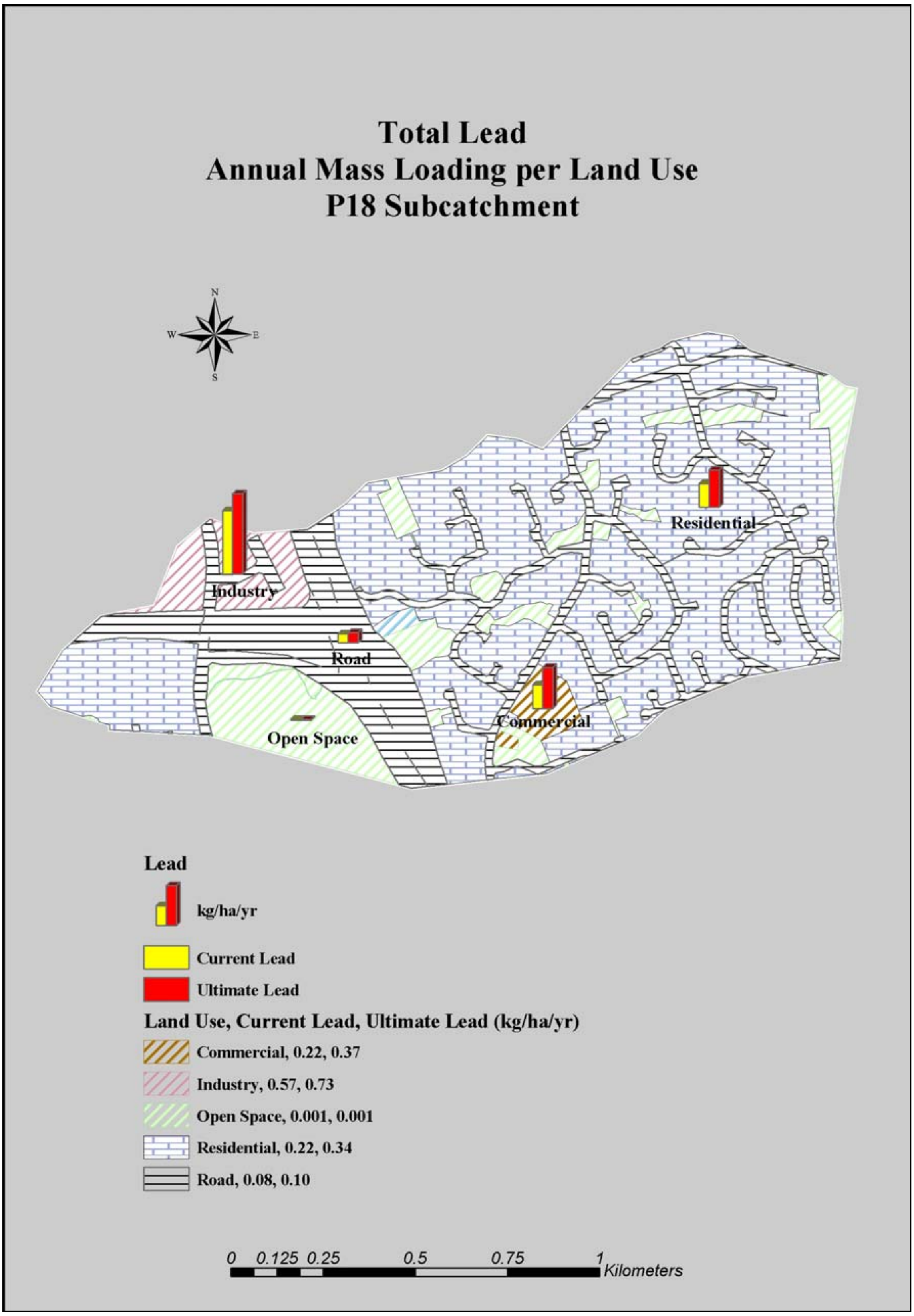


Figure A II.38: Total Zinc annual mass loading (kg/ha/yr)

per land use – P18 subcatchment

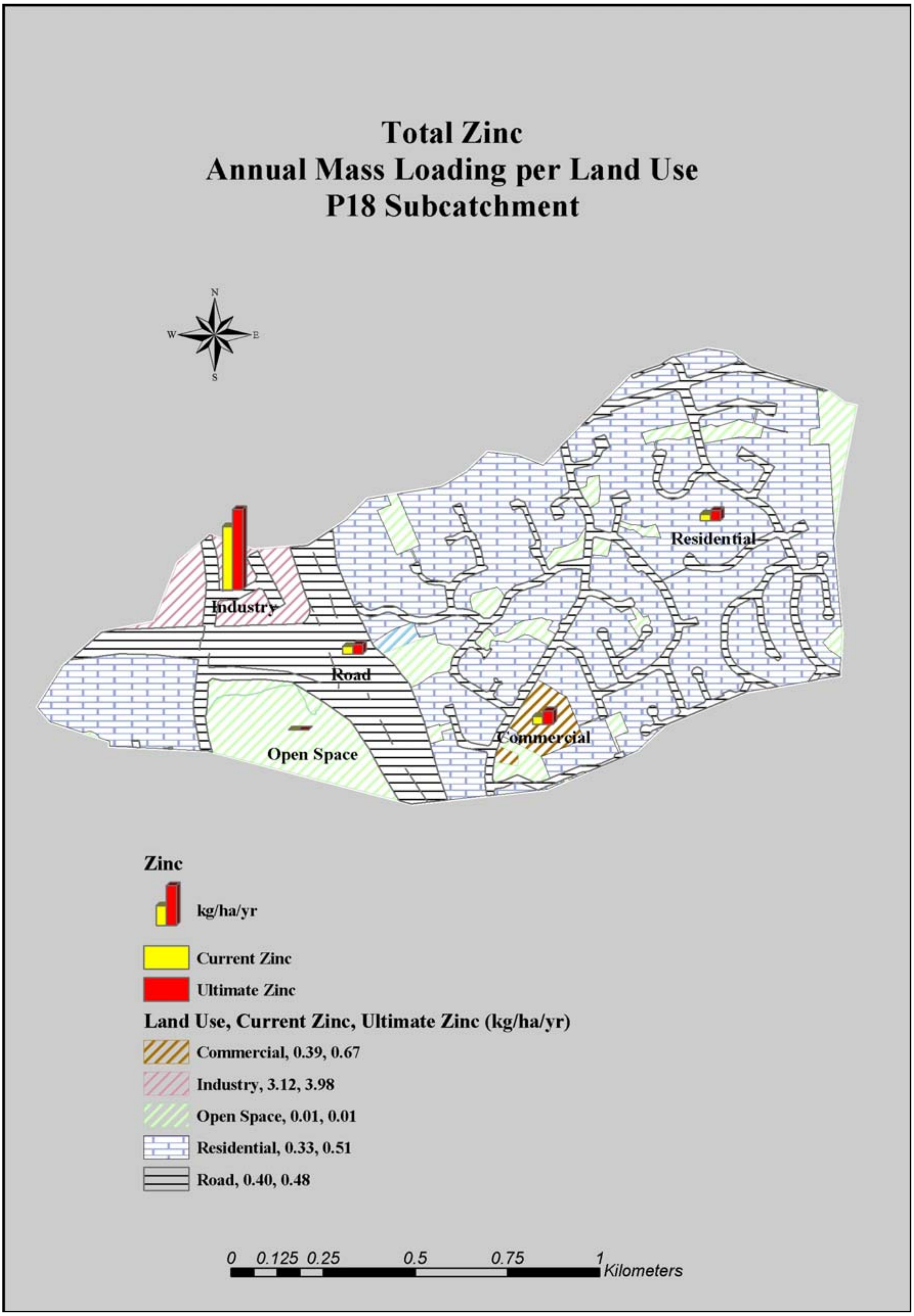


Figure A II.39: Total Kjeldahl Nitrogen annual mass loading (kg/ha/yr)
per land use – P18 subcatchment

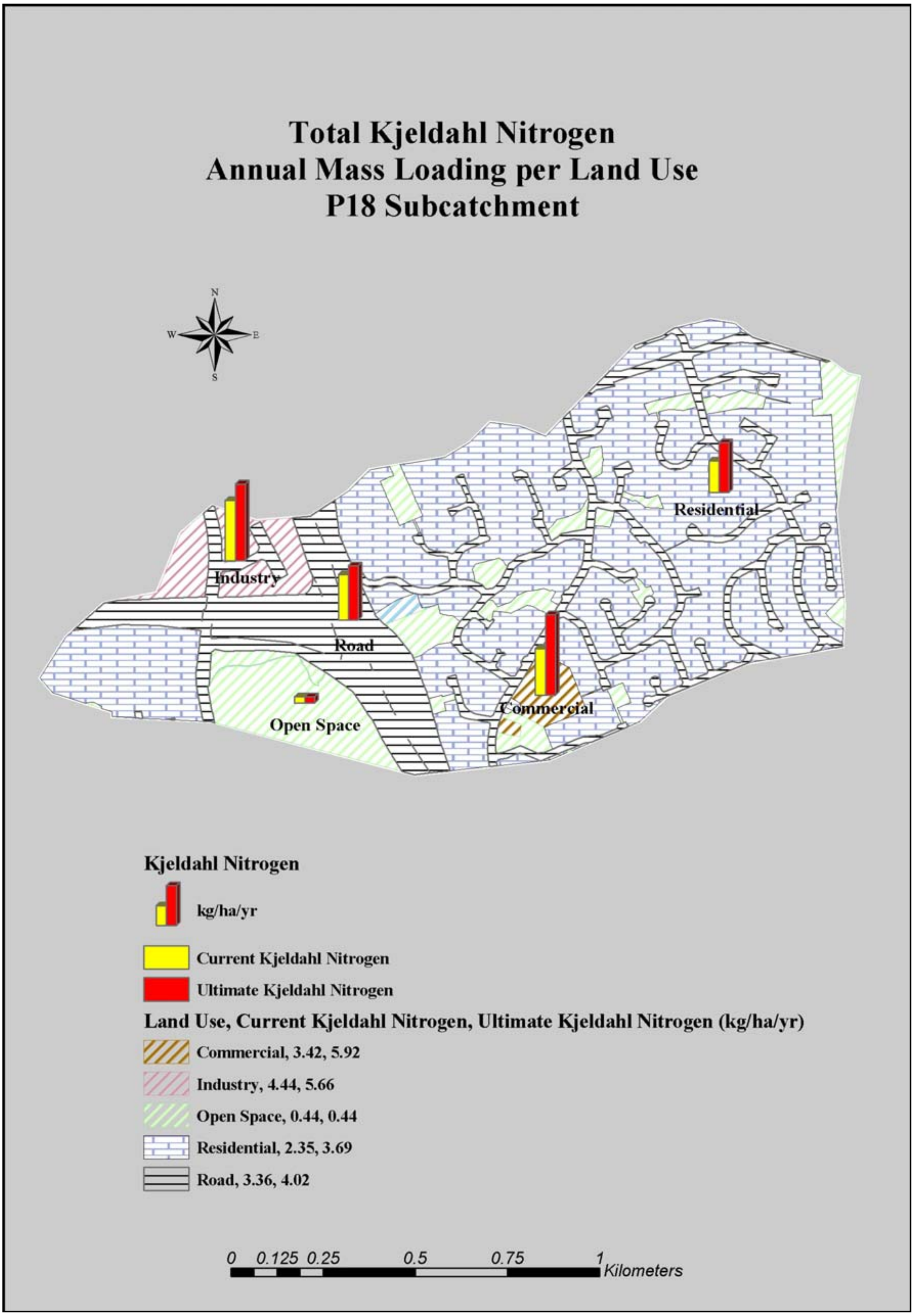


Figure A II.40: Total Petroleum Hydrocarbons annual mass loading (kg/ha/yr) per land use – P18 subcatchment

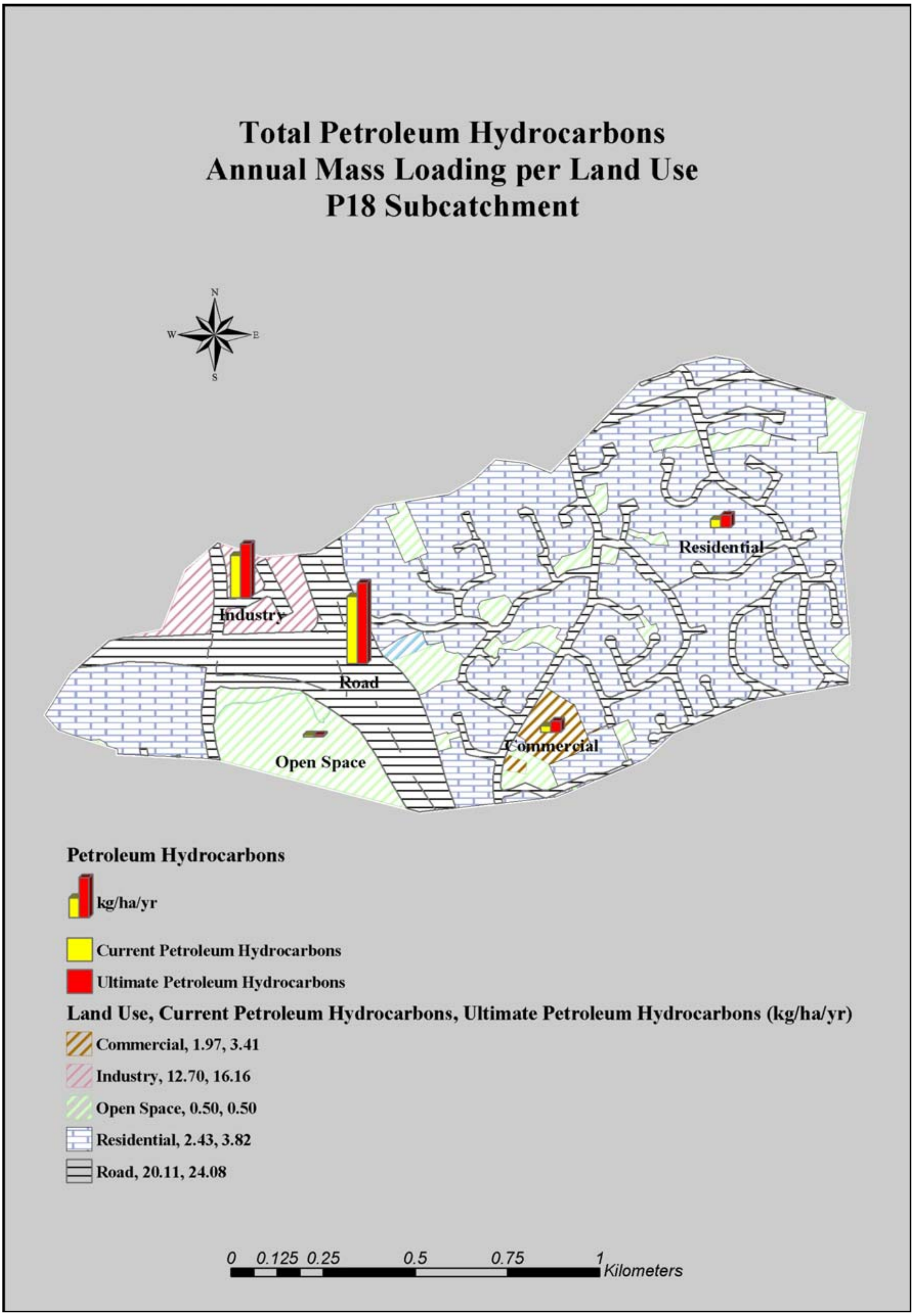


Figure A II.41: Total Suspended Solids annual mass loading (kg/ha/yr) per land use – Puhinui Coast subcatchment

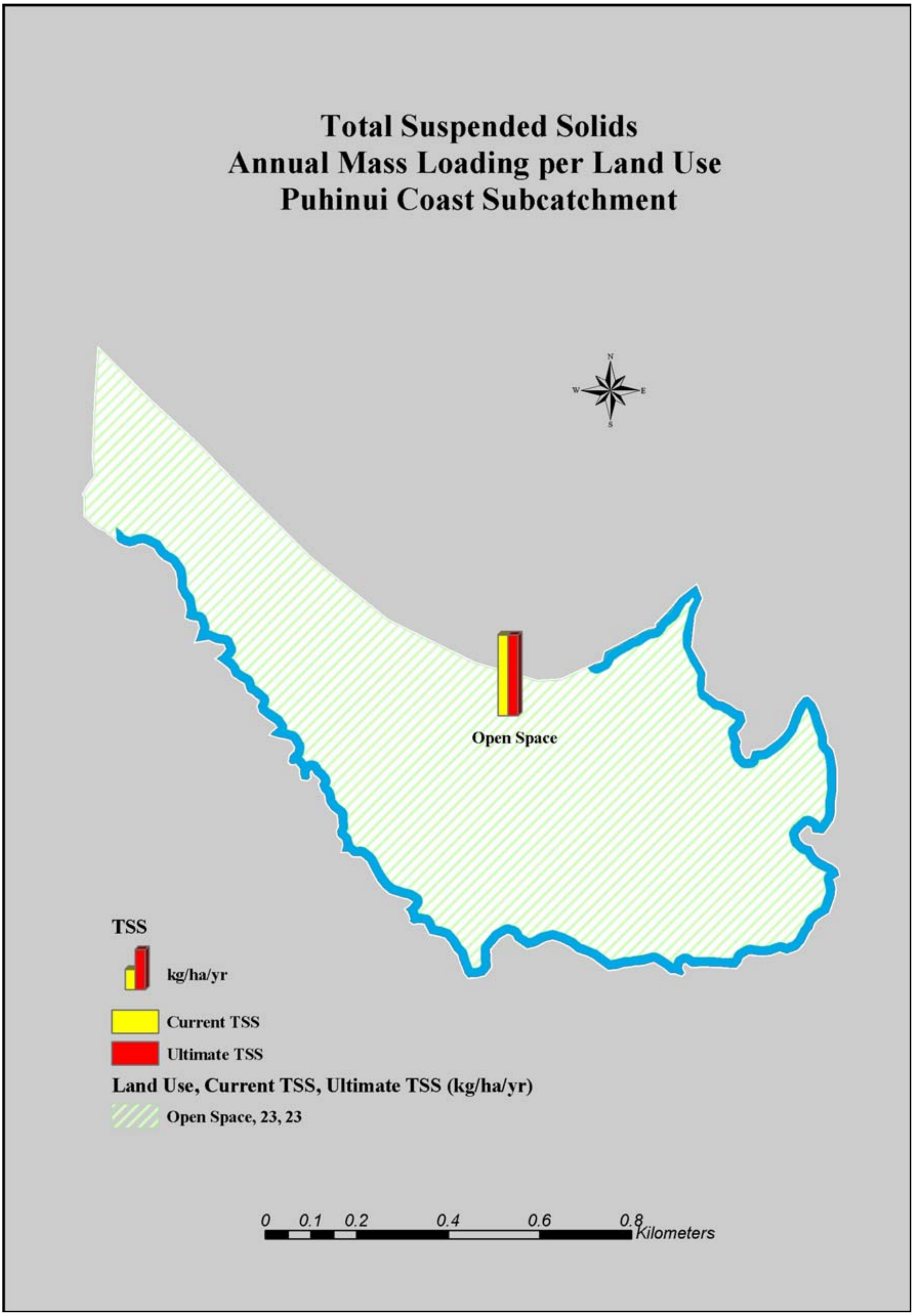


Figure A II.42: Biochemical Oxygen Demand annual mass loading (kg/ha/yr) per land use – Puhinui Coast subcatchment

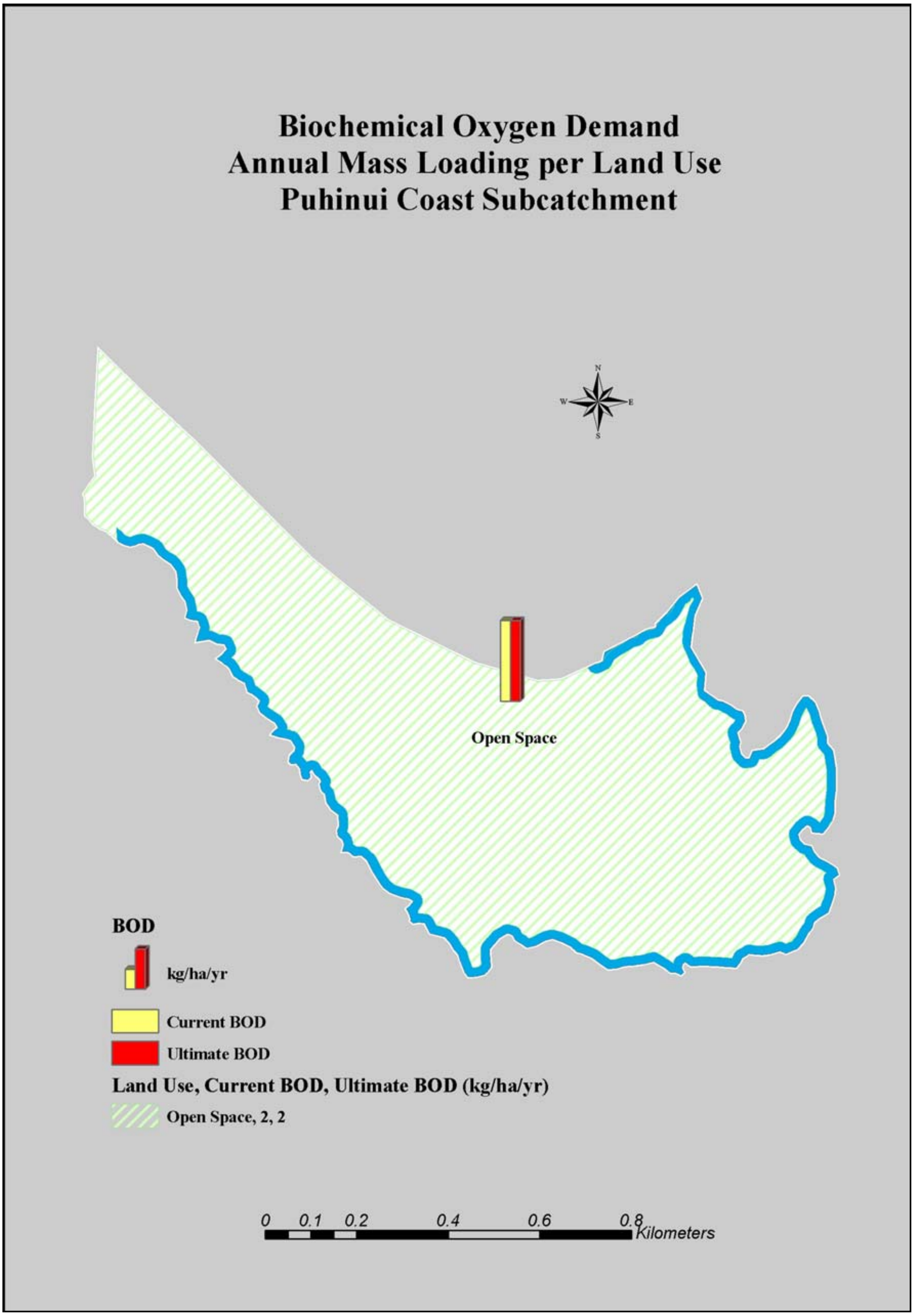


Figure A II.43: Total Phosphorus annual mass loading (kg/ha/yr) per land use – Puhinui Coast subcatchment

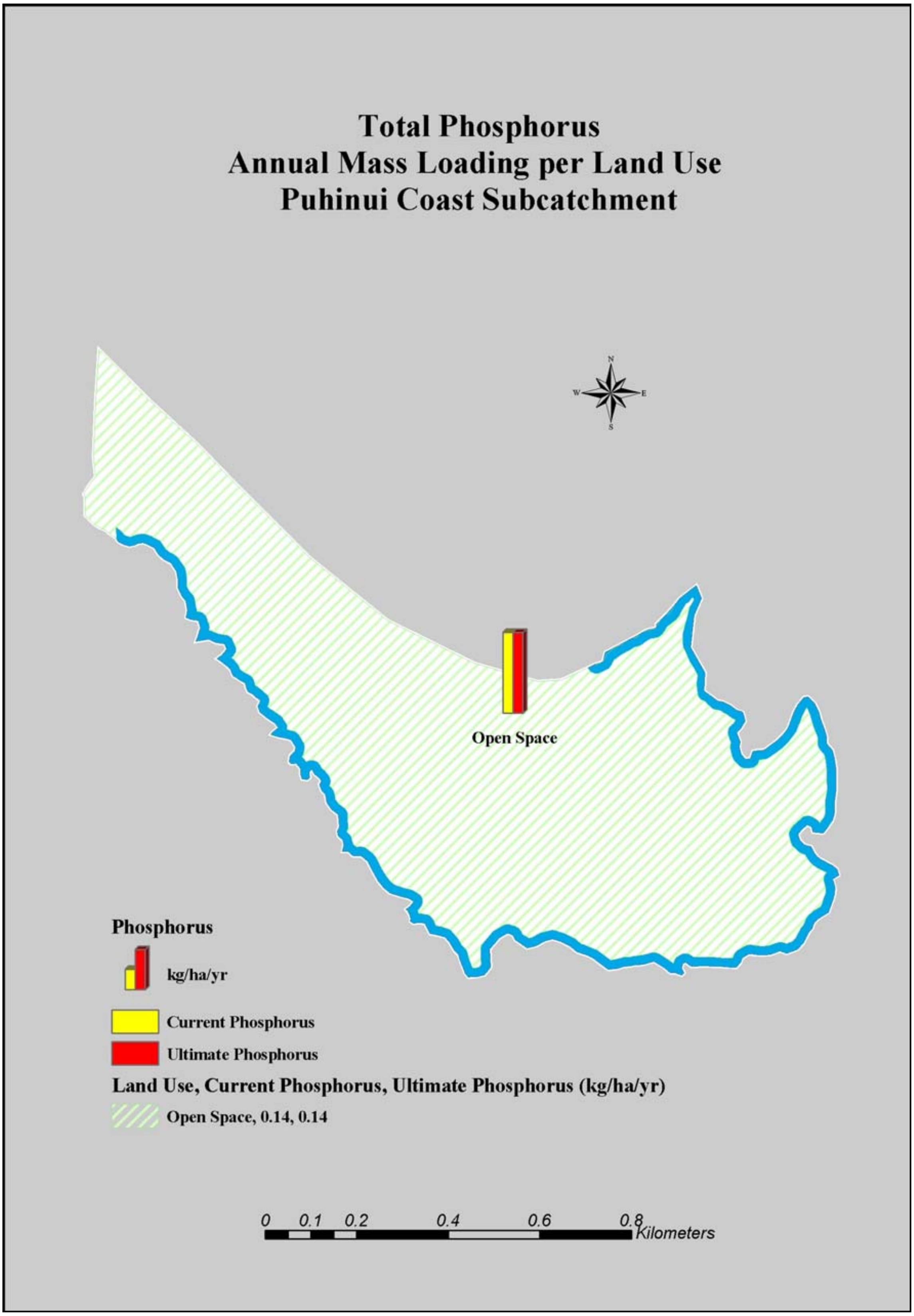


Figure A II.44: Total Copper annual mass loading (kg/ha/yr)
per land use – Puhinui Coast subcatchment

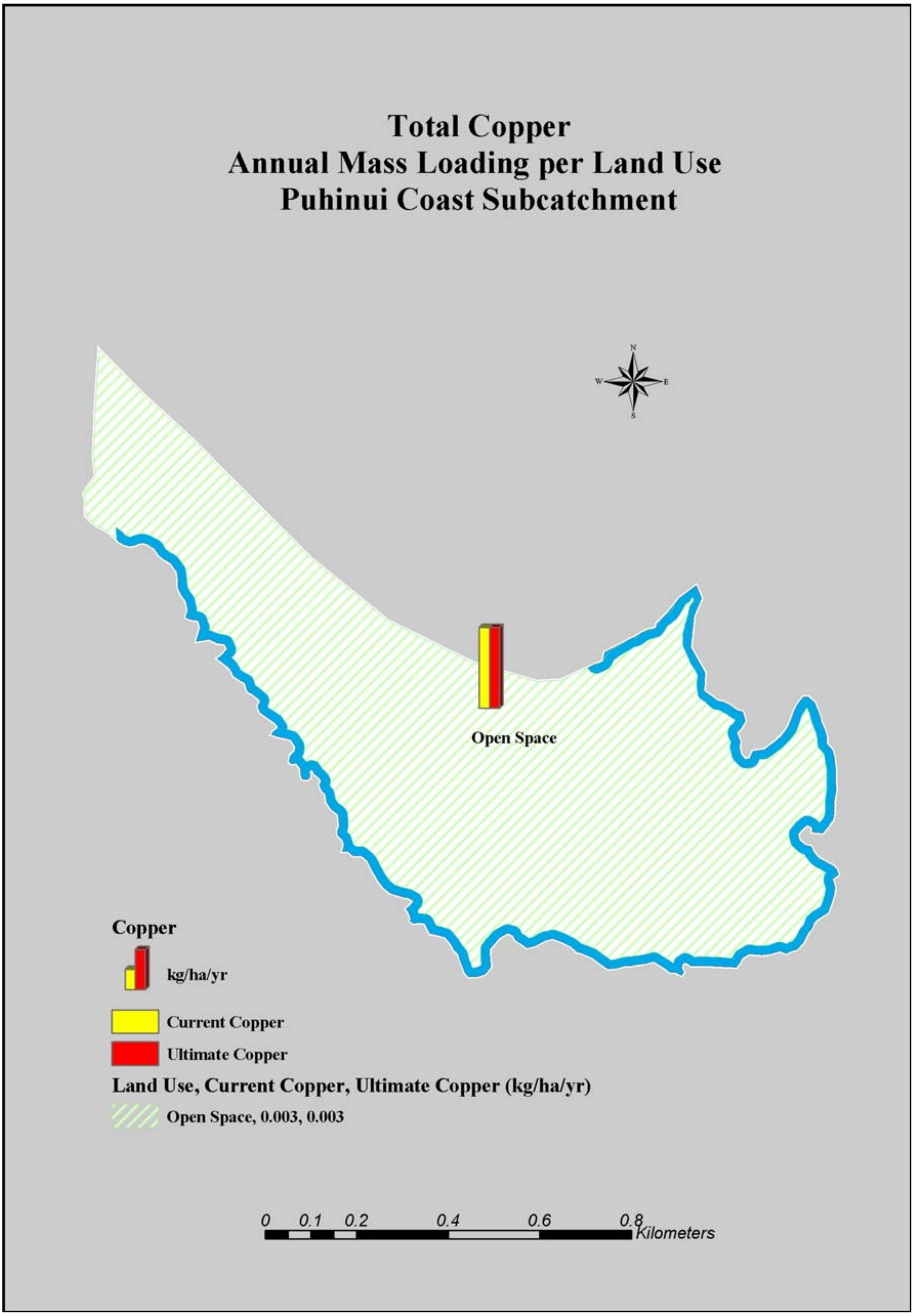


Figure A II.45: Total Lead annual mass loading (kg/ha/yr) per land use – Puhinui Coast subcatchment

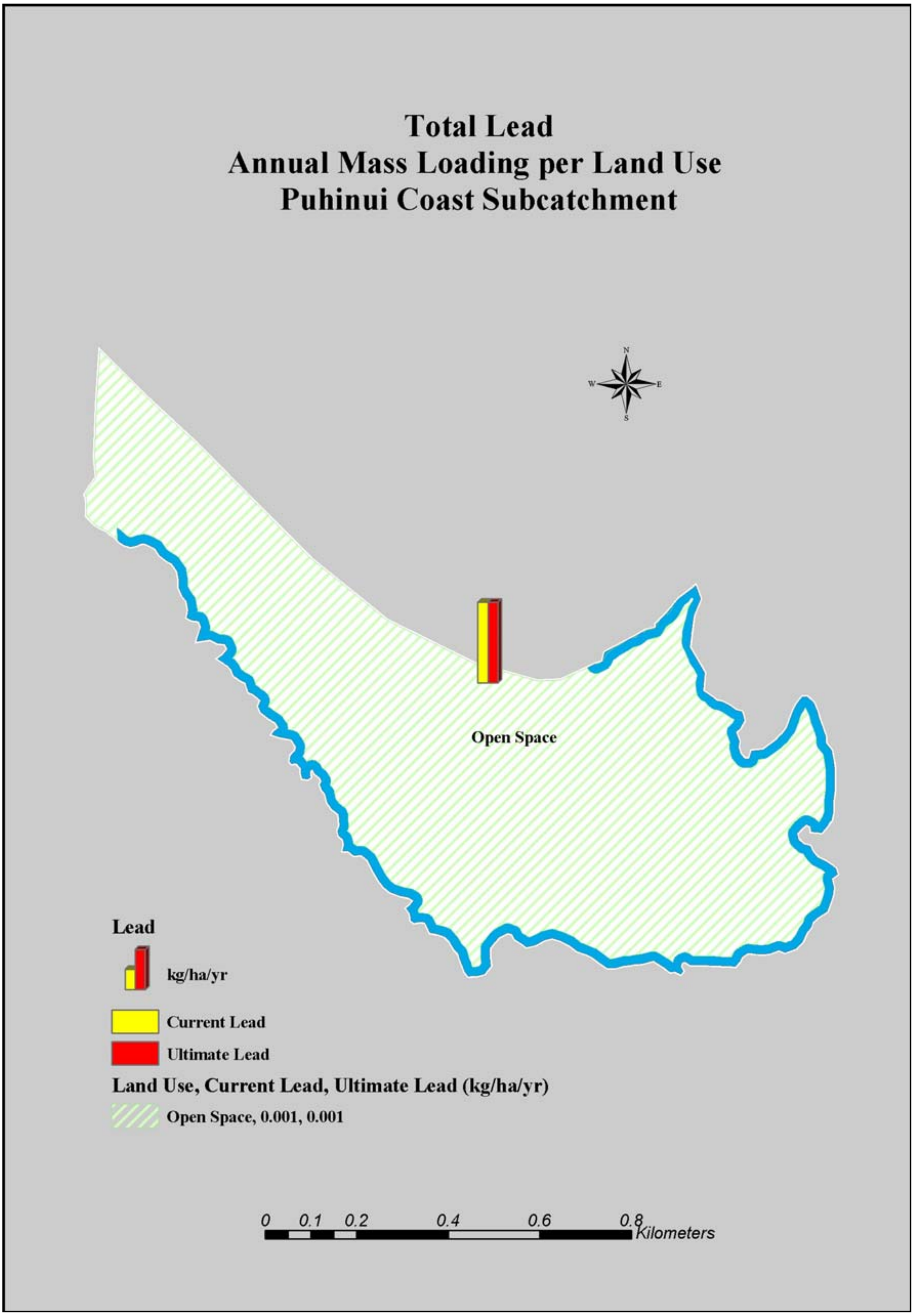


Figure A II.46: Total Zinc annual mass loading (kg/ha/yr) per land use – Puhinui Coast subcatchment

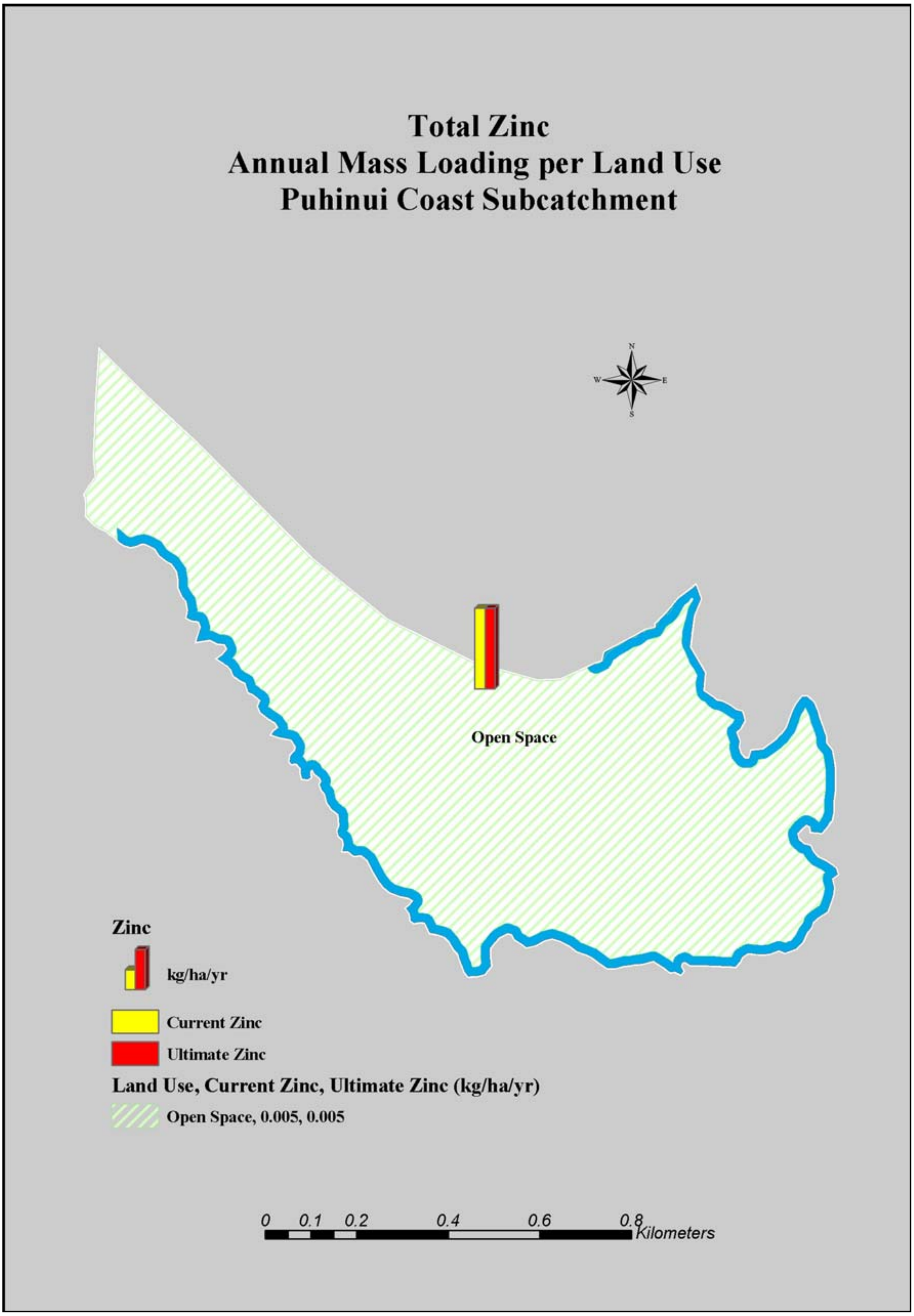


Figure A II.47: Total Kjeldahl Nitrogen annual mass loading (kg/ha/yr) per land use – Puhinui Coast subcatchment

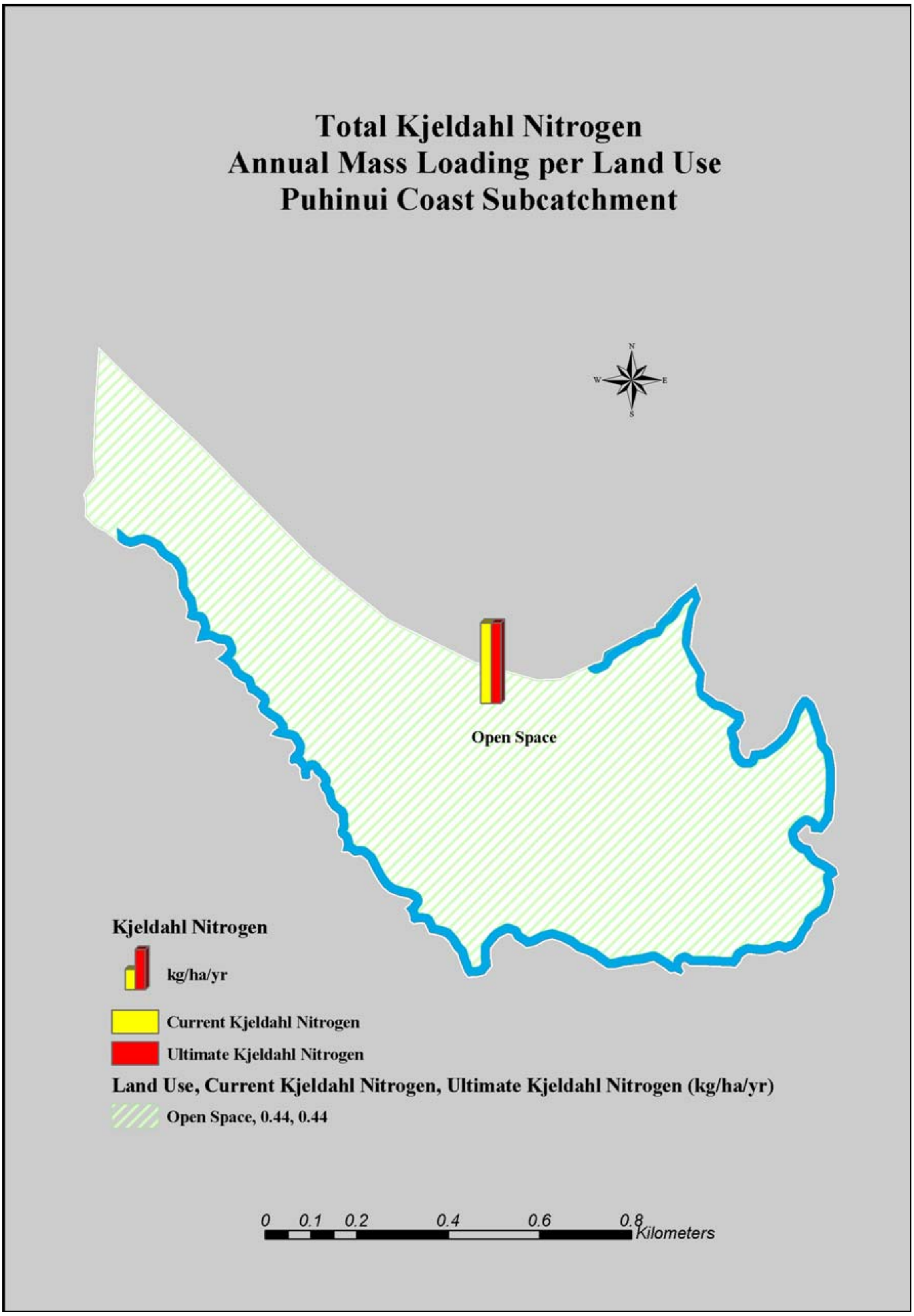


Figure A II.48: Total Petroleum Hydrocarbons annual mass loading (kg/ha/yr) per land use – Puhinui Coast subcatchment

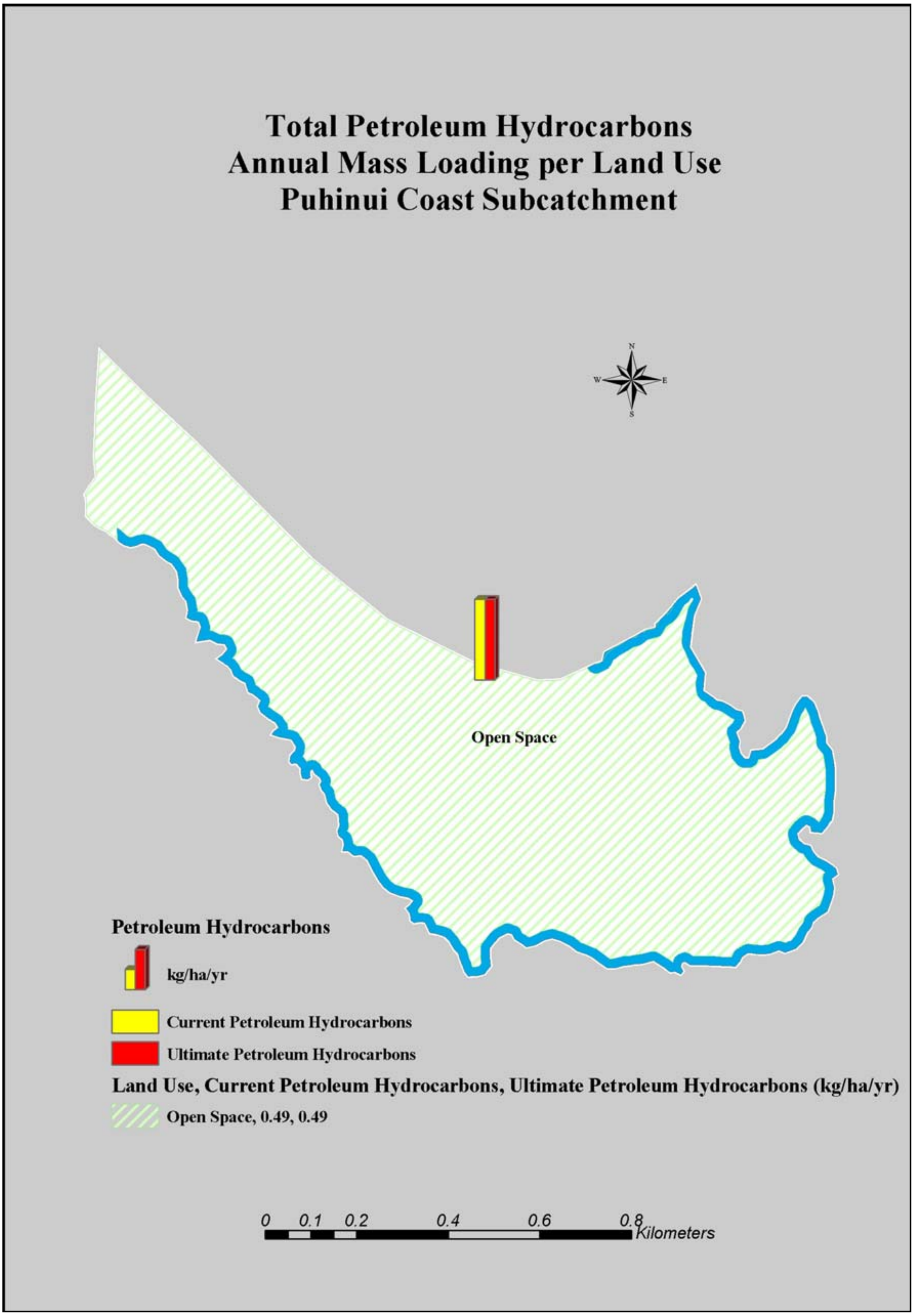


Figure A II.49: Total Suspended Solids annual mass loading (kg/ha/yr) per land use – Puhinui Stream subcatchment

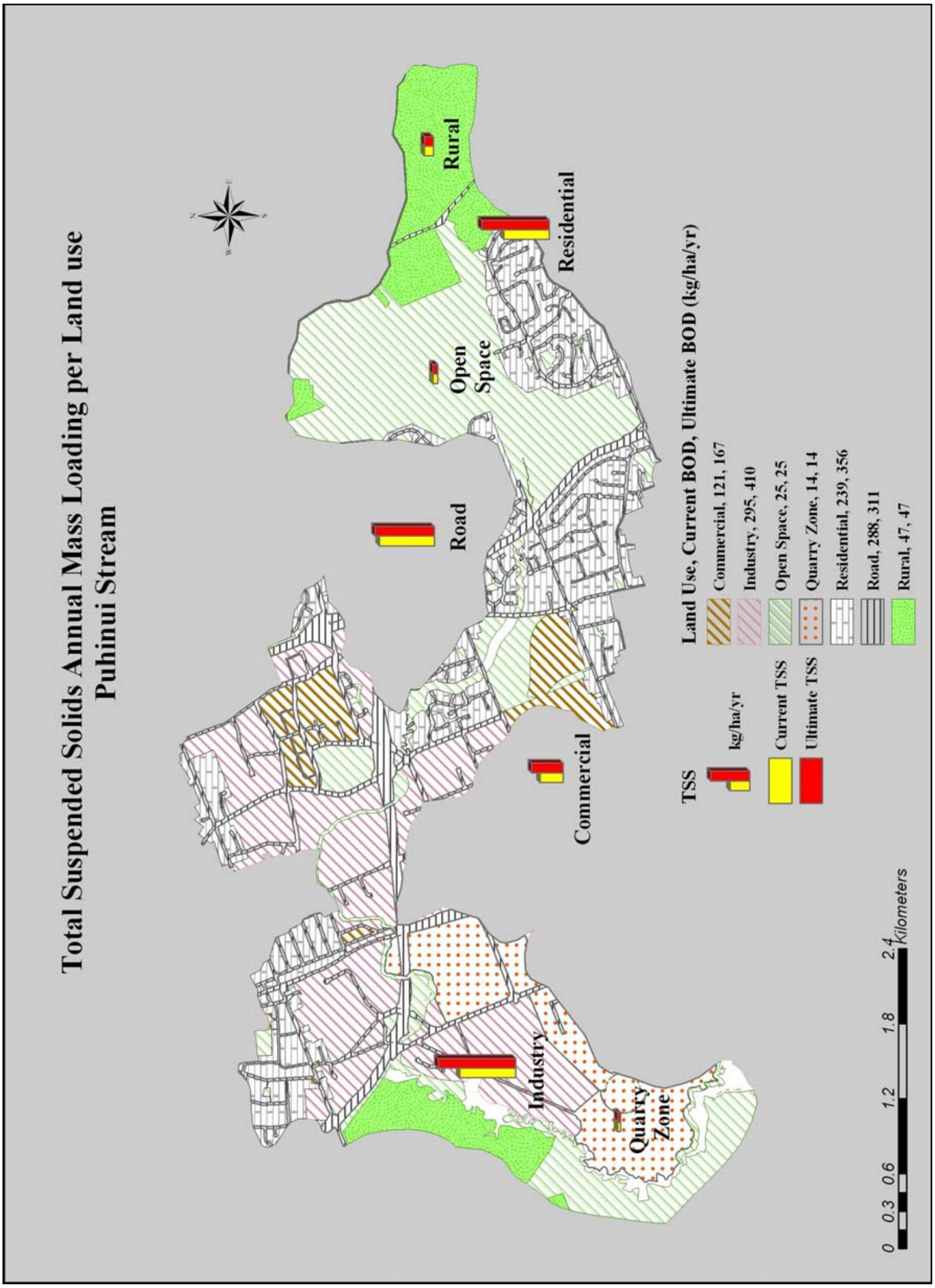


Figure A II.50: Biochemical Oxygen Demand annual mass loading (kg/ha/yr) per land use – Puhinui Stream subcatchment

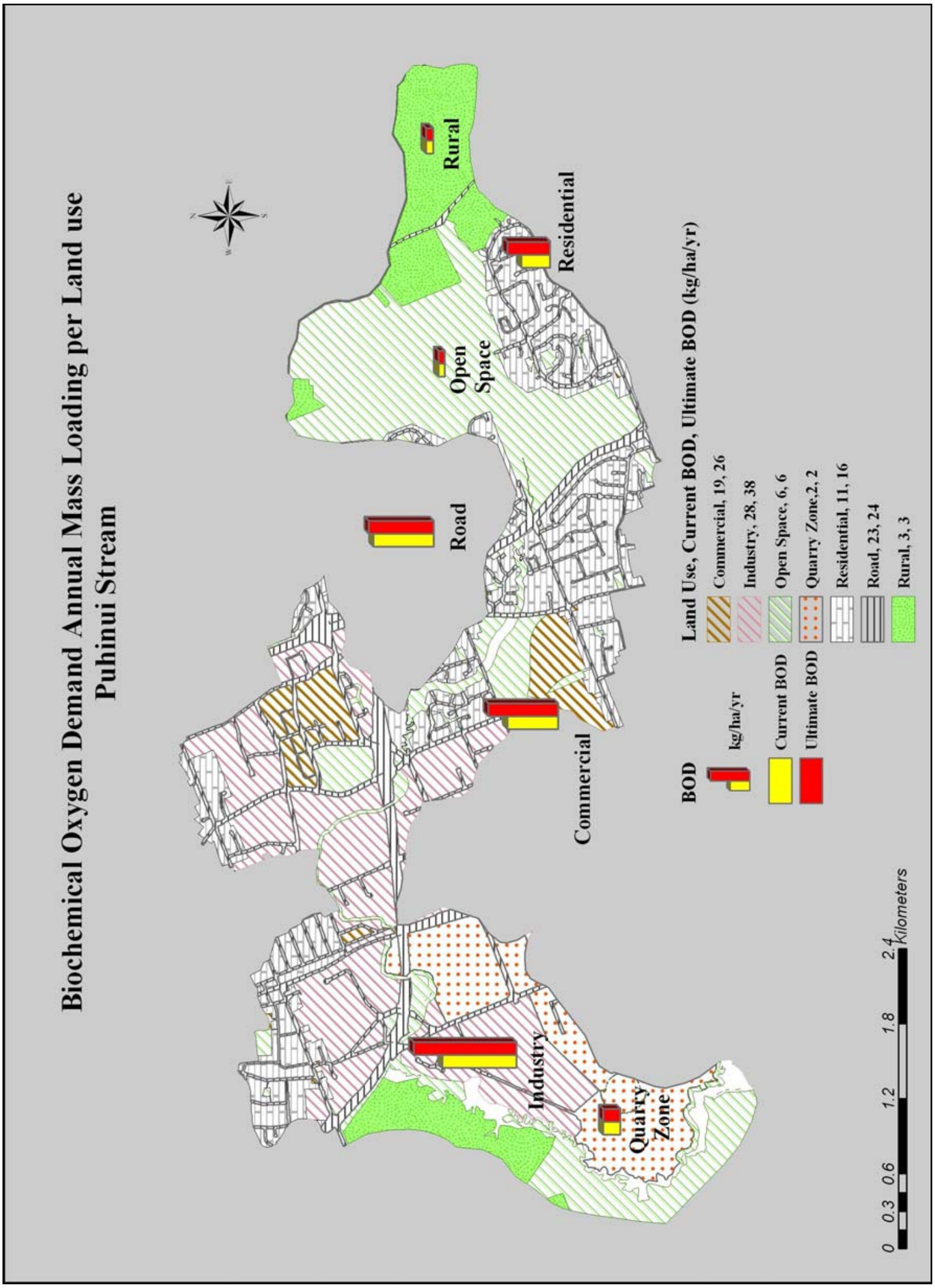


Figure A II.51: Total Phosphorus annual mass loading (kg/ha/yr)

per land use – Puhinui Stream subcatchment

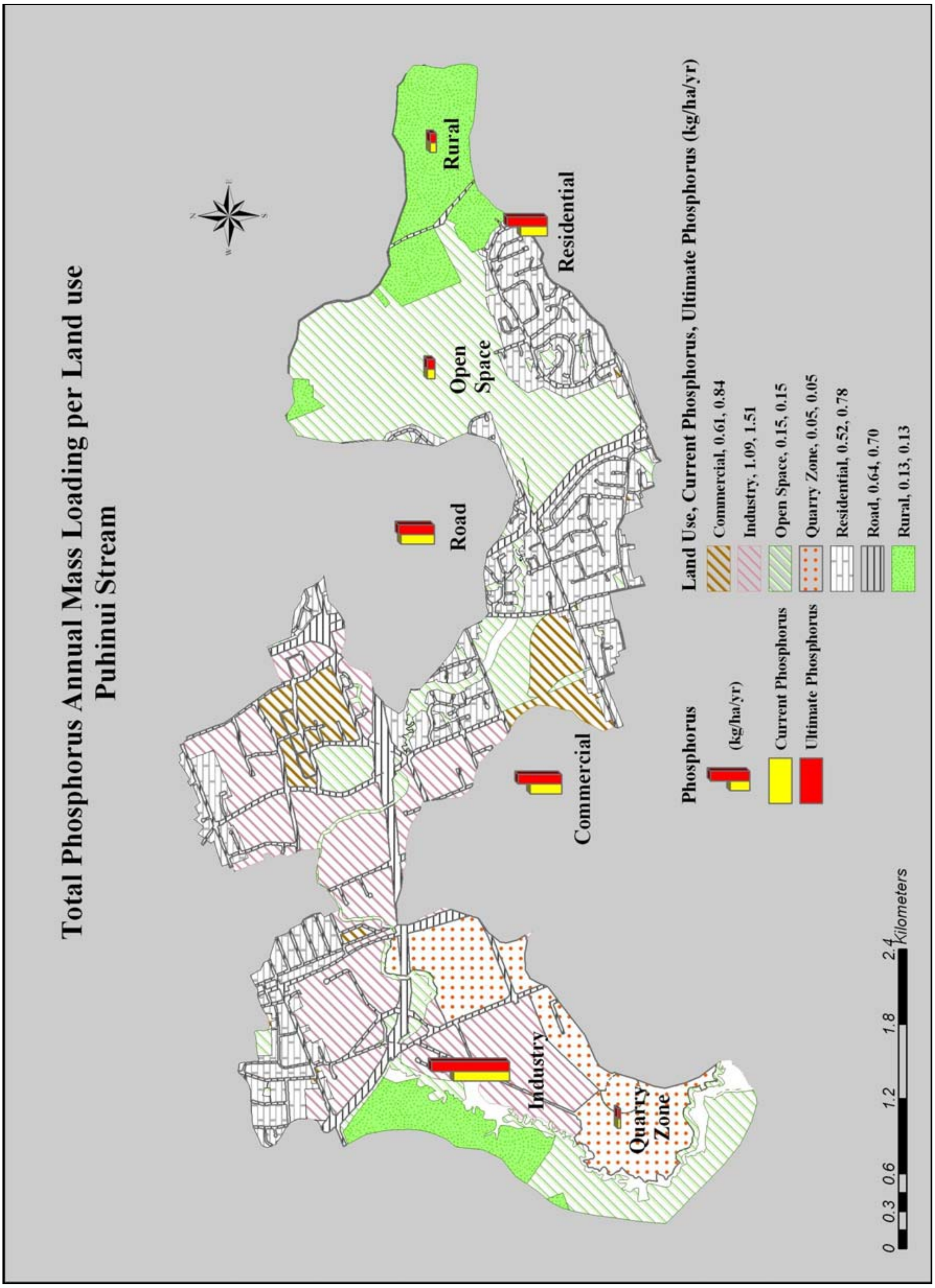


Figure A II.52: Total Copper annual mass loading (kg/ha/yr)

per land use – Puhinui Stream subcatchment

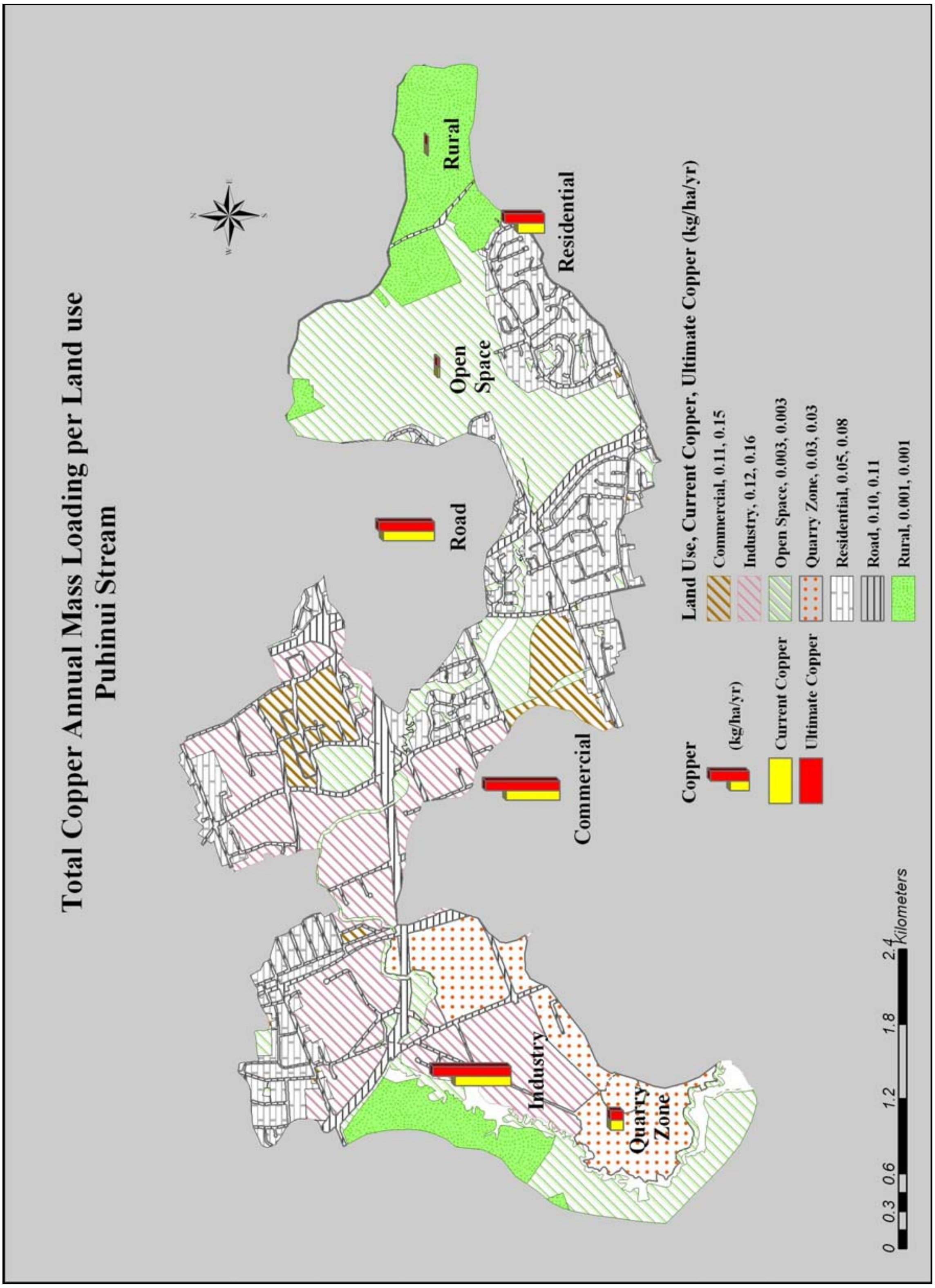


Figure A II.53: Total Lead annual mass loading (kg/ha/yr) per land use – Puhinui Stream subcatchment

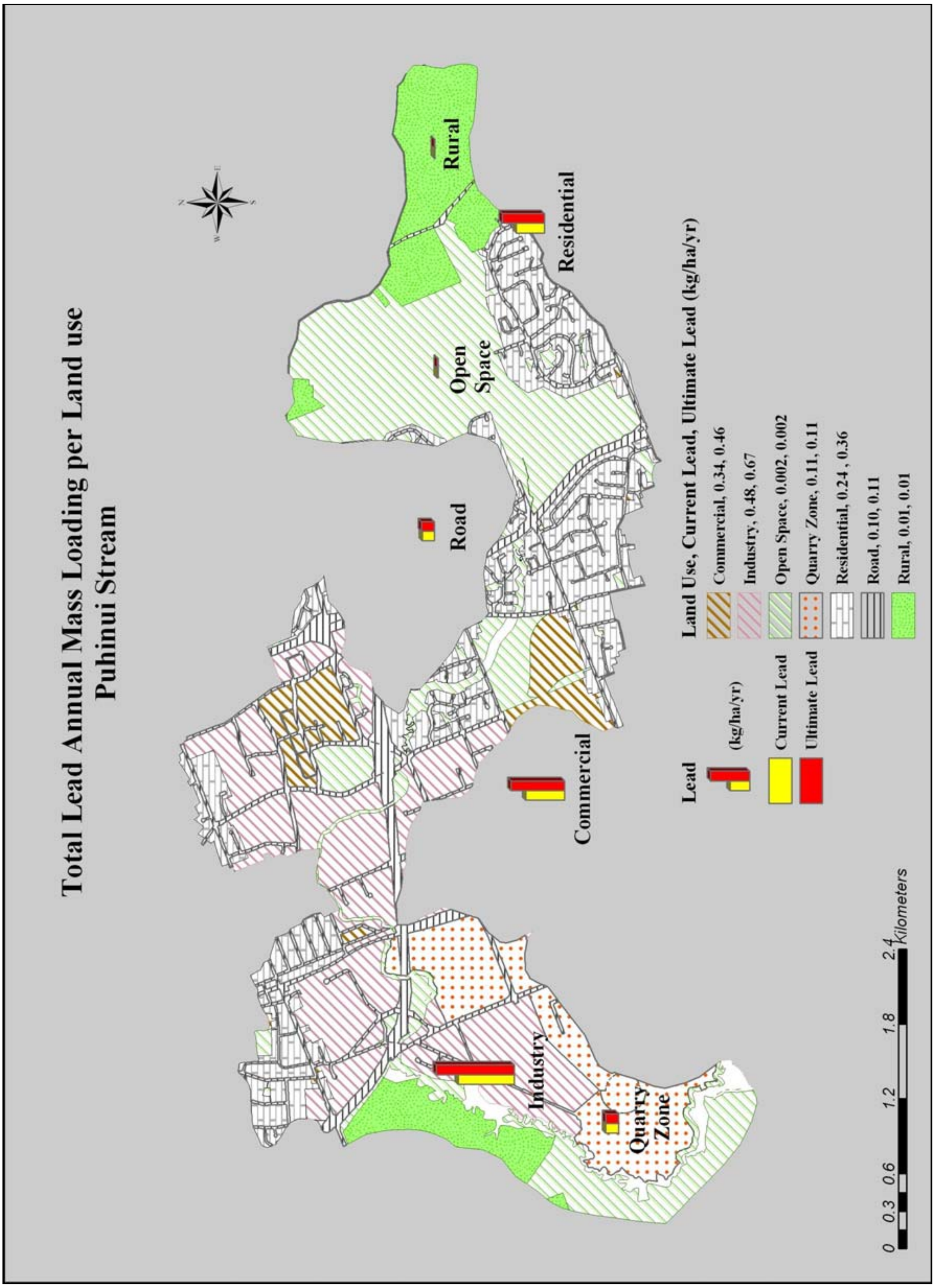


Figure A II.54: Total Zinc annual mass loading (kg/ha/yr)

per land use – Puhinui Stream subcatchment

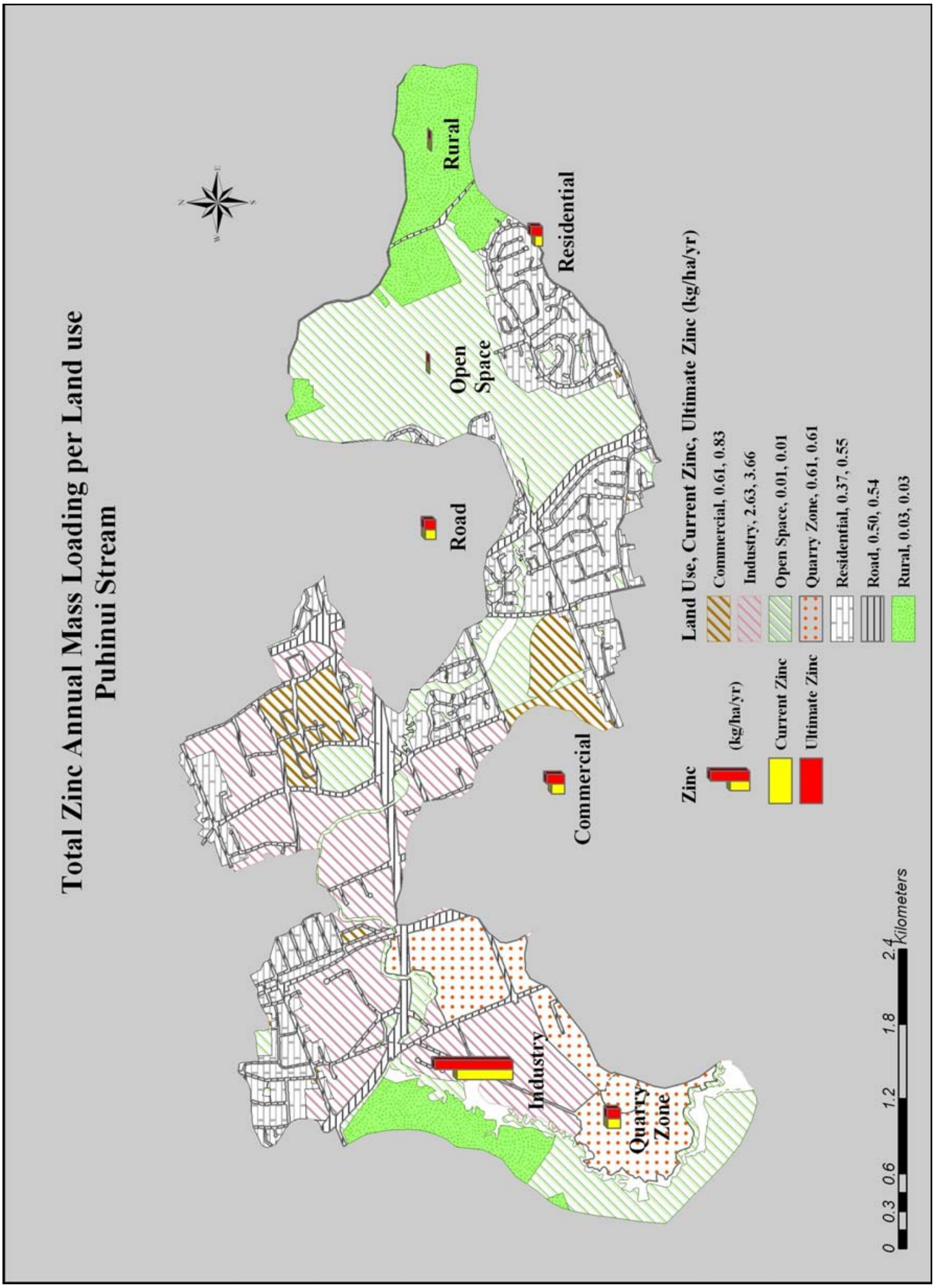


Figure A II.55: Total Kjeldahl Nitrogen annual mass loading (kg/ha/yr) per land use – Puhinui Stream subcatchment

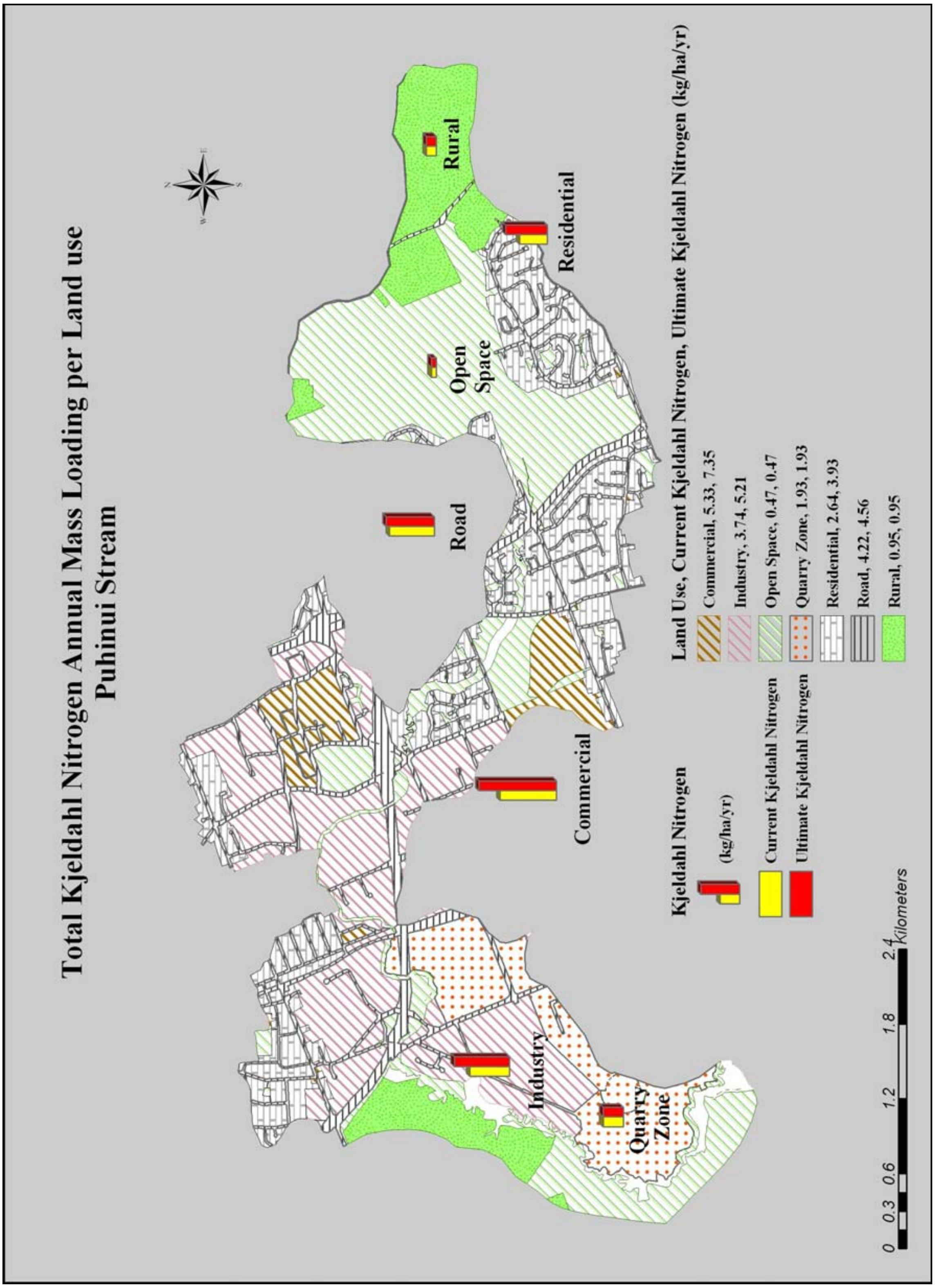


Figure A II.56: Total Petroleum Hydrocarbons annual mass loading (kg/ha/yr) per land use – Puhinui Stream subcatchment

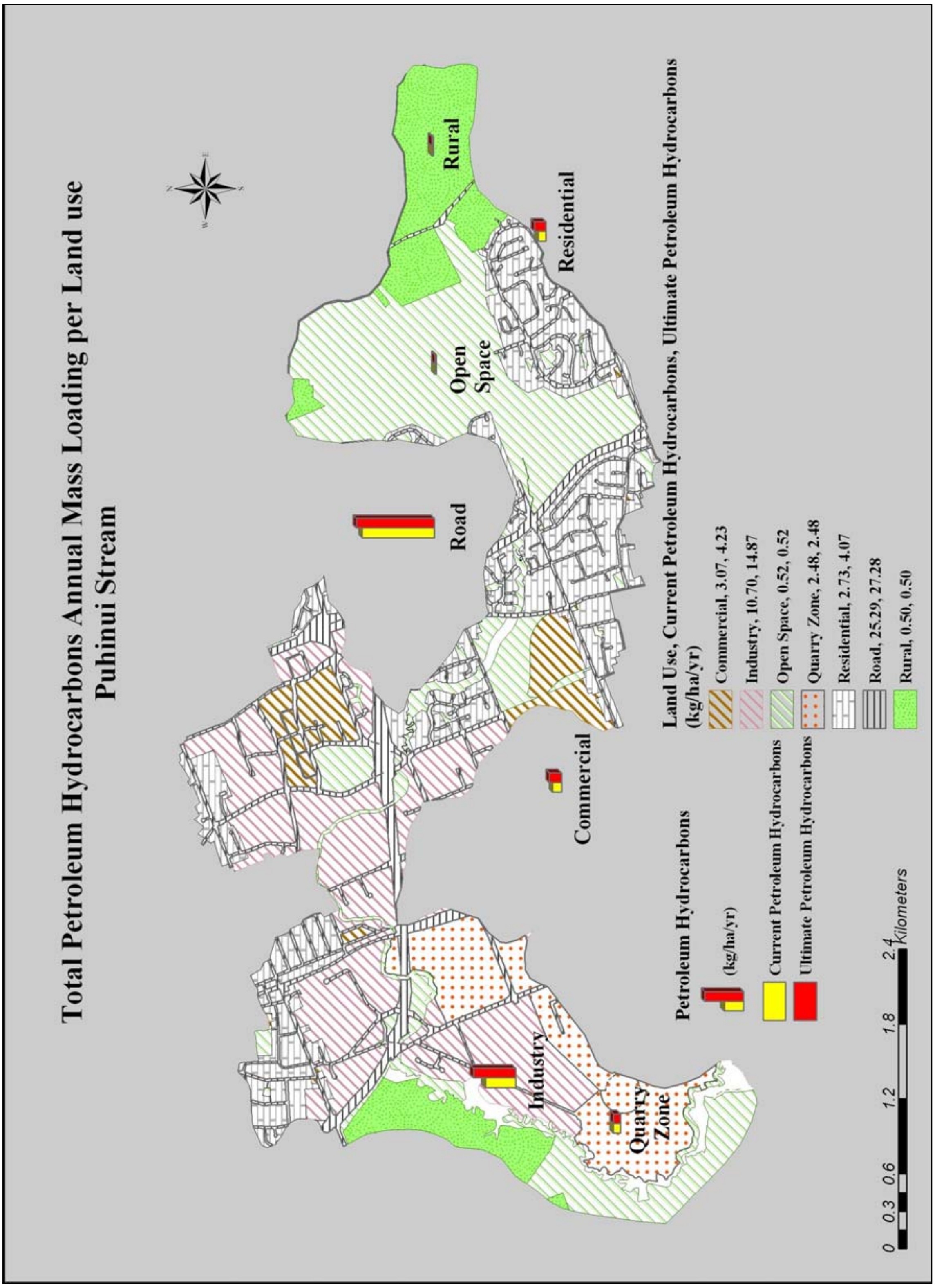


Figure A II.57: Total Suspended Solids annual mass loading (kg/ha/yr) per land use – Wiri subcatchment

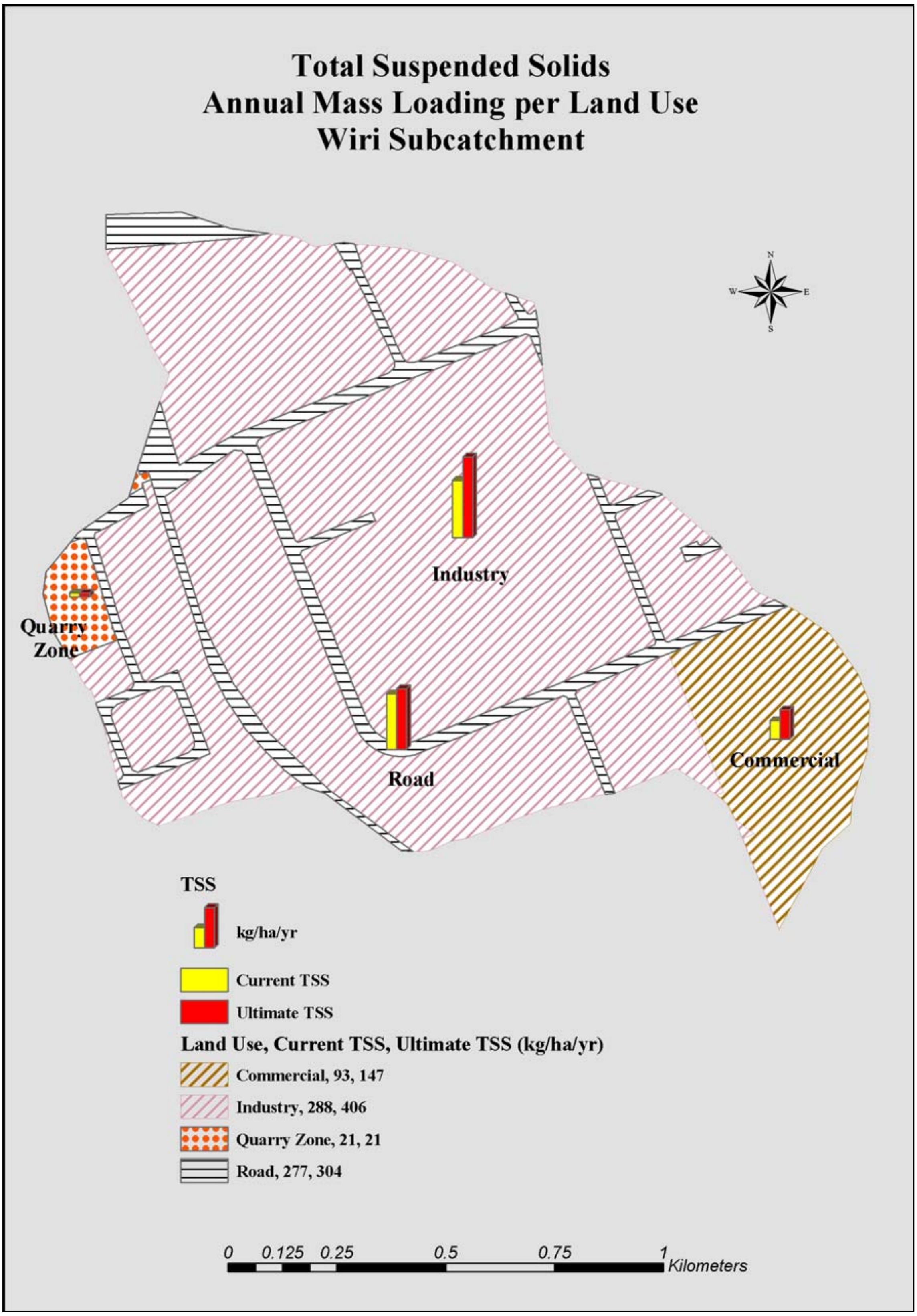


Figure A II.58: Biochemical Oxygen Demand annual mass loading (kg/ha/yr) per land use – Wiri subcatchment

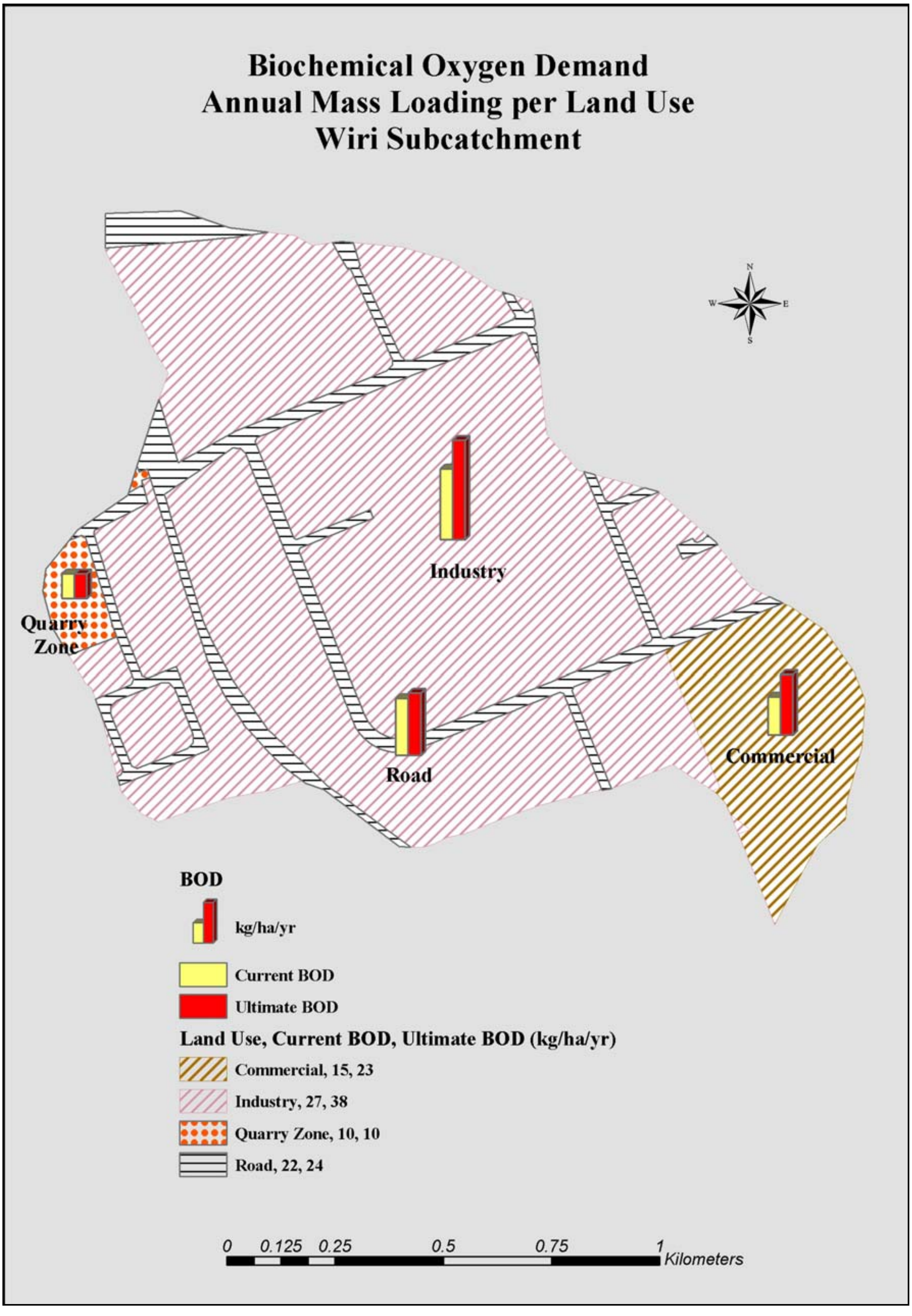


Figure A II.59: Total Phosphorus annual mass loading (kg/ha/yr) per land use – Wiri subcatchment

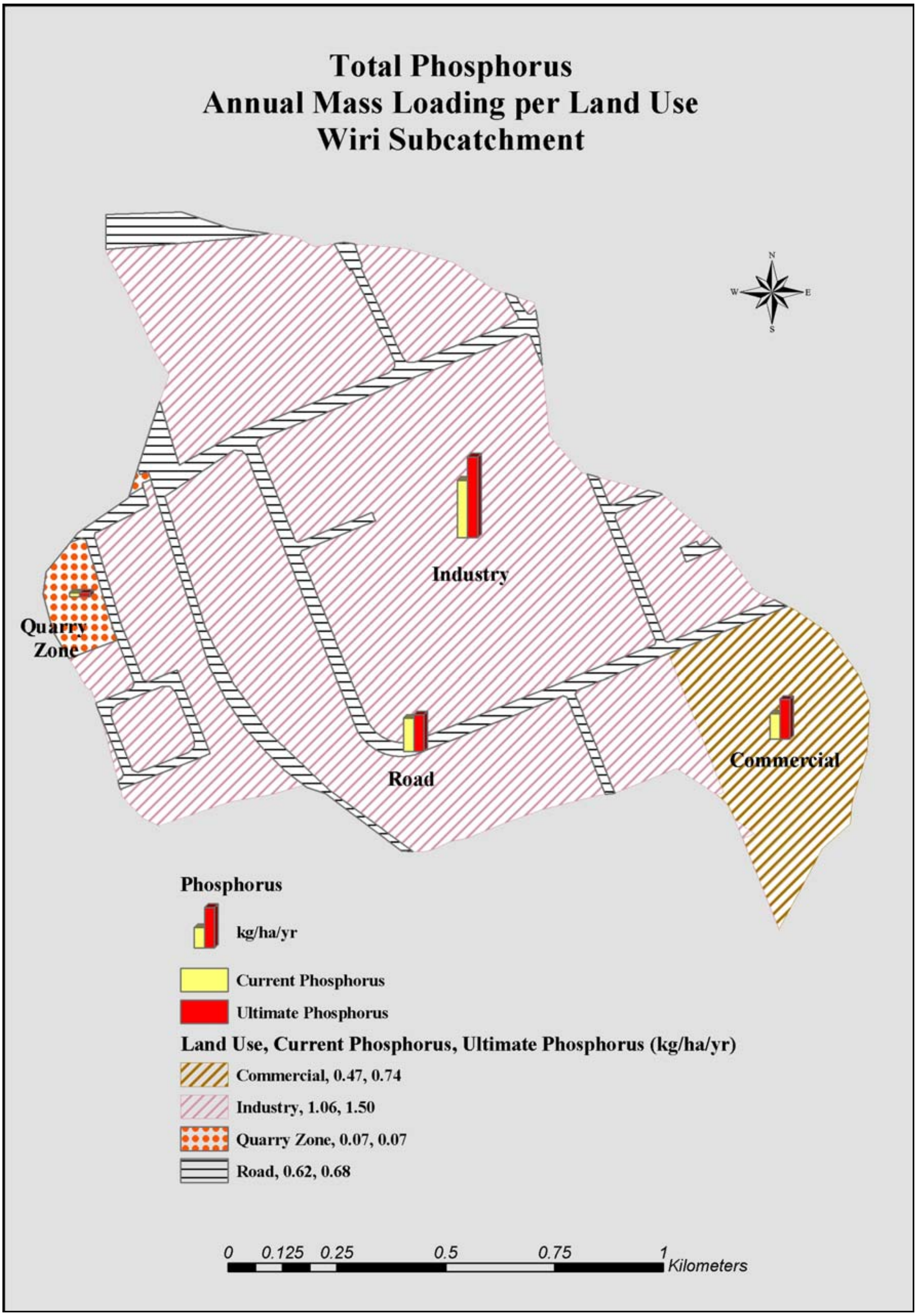


Figure A II.60: Total Copper annual mass loading (kg/ha/yr)
per land use – Wiri subcatchment

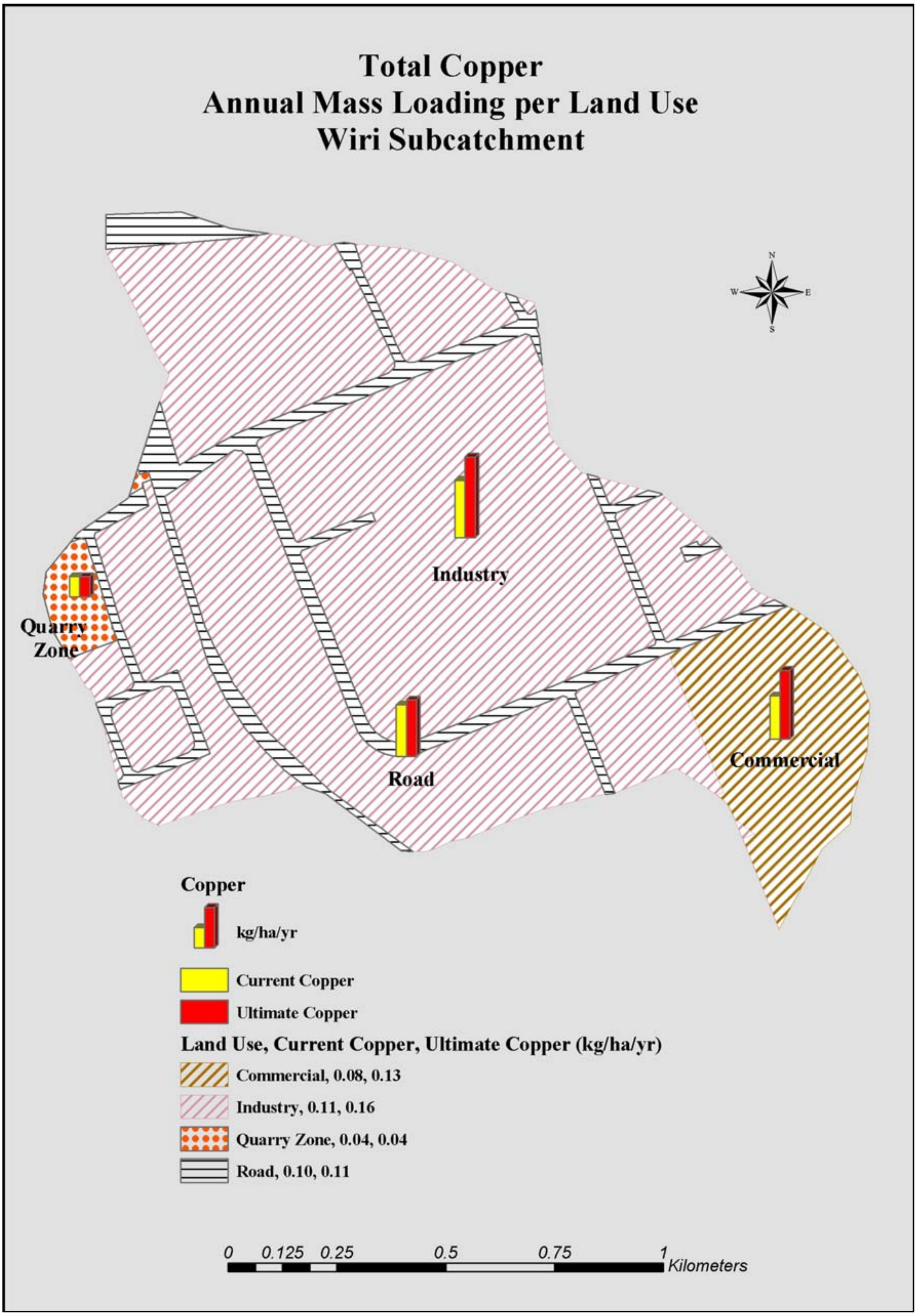


Figure A II.61: Total Lead annual mass loading (kg/ha/yr)
per land use – Wiri subcatchment

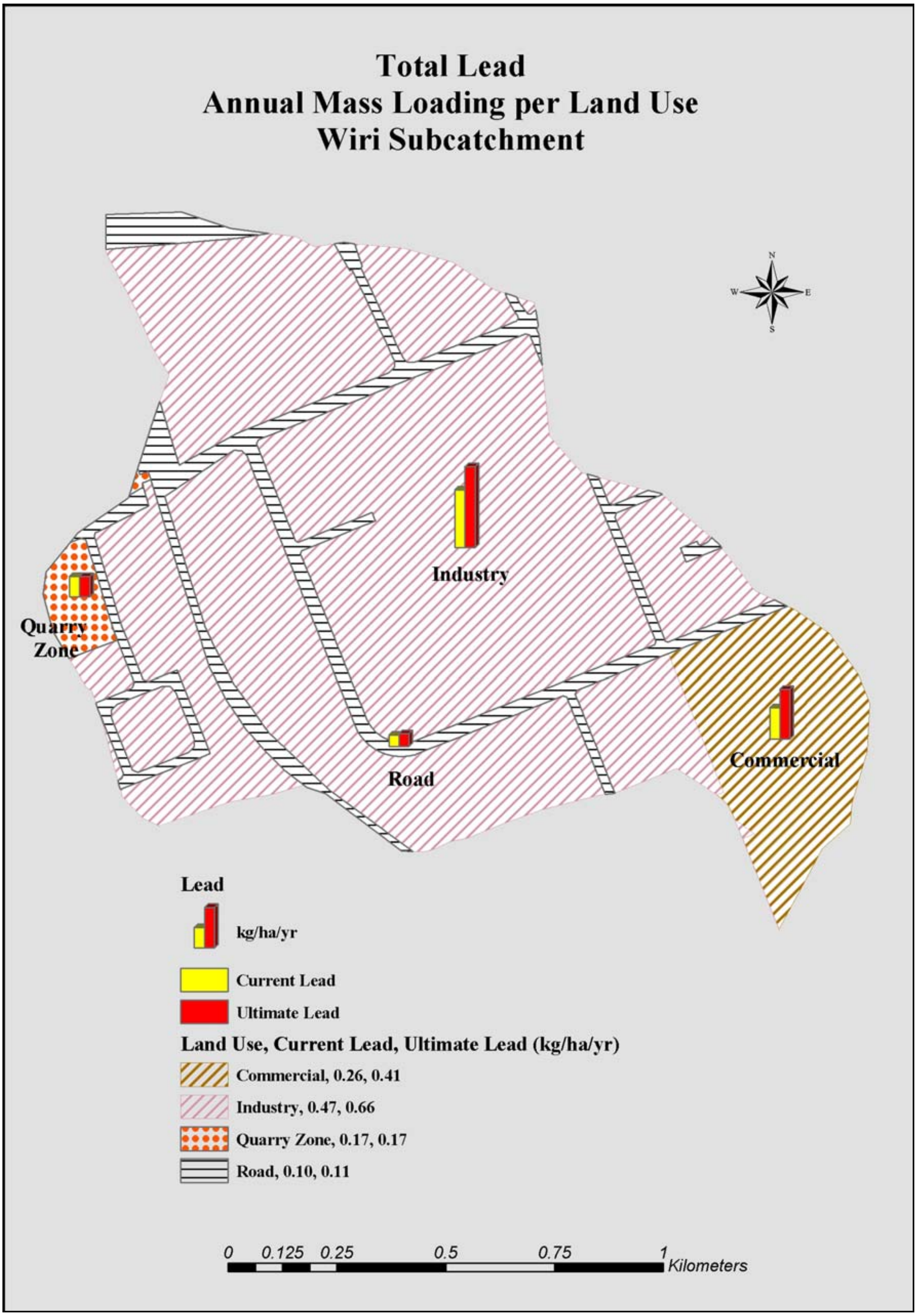


Figure A II.62: Total Zinc annual mass loading (kg/ha/yr) per land use – Wiri subcatchment

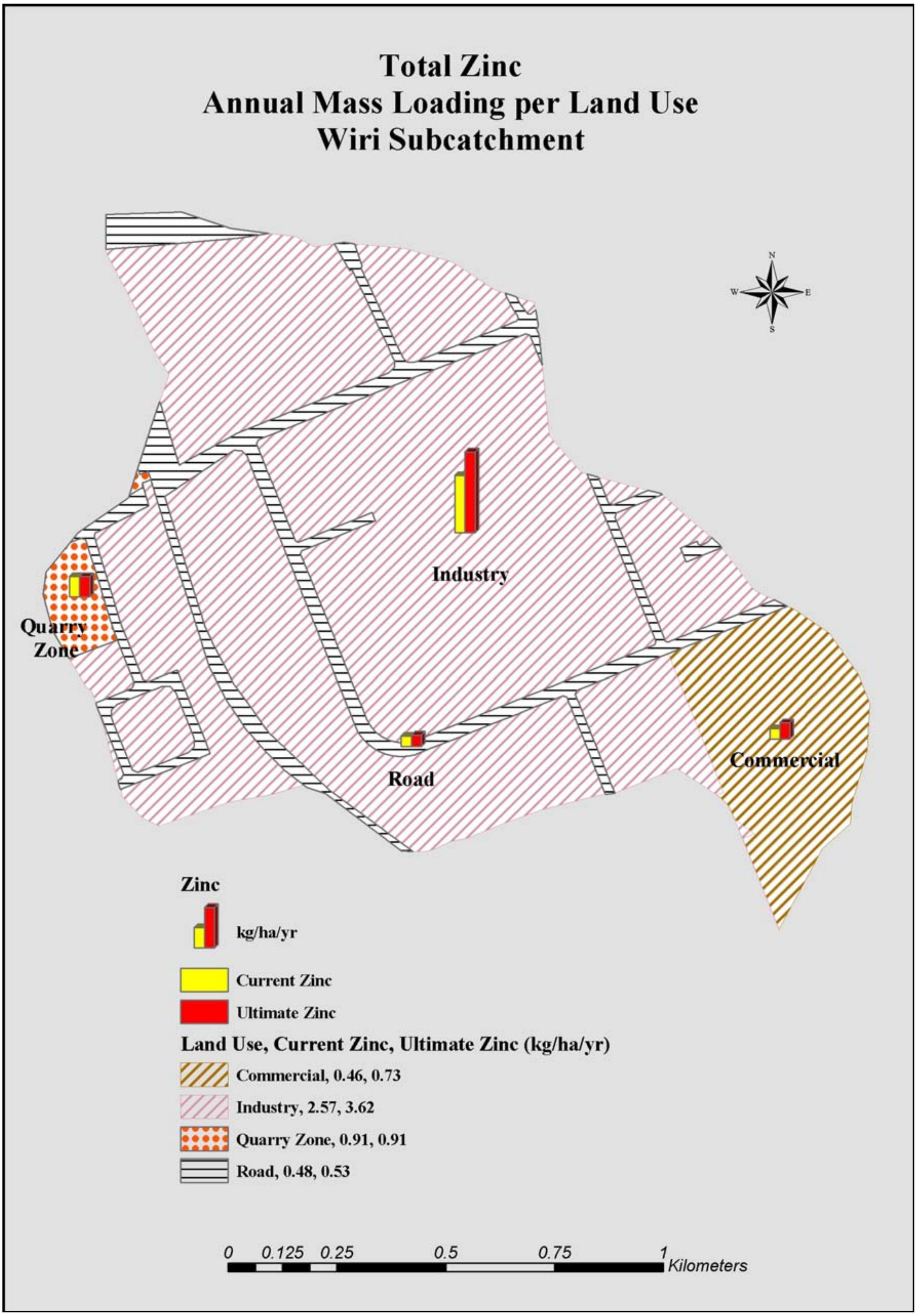


Figure A II.63: Total Kjeldahl Nitrogen annual mass loading (kg/ha/yr) per land use – Wiri subcatchment

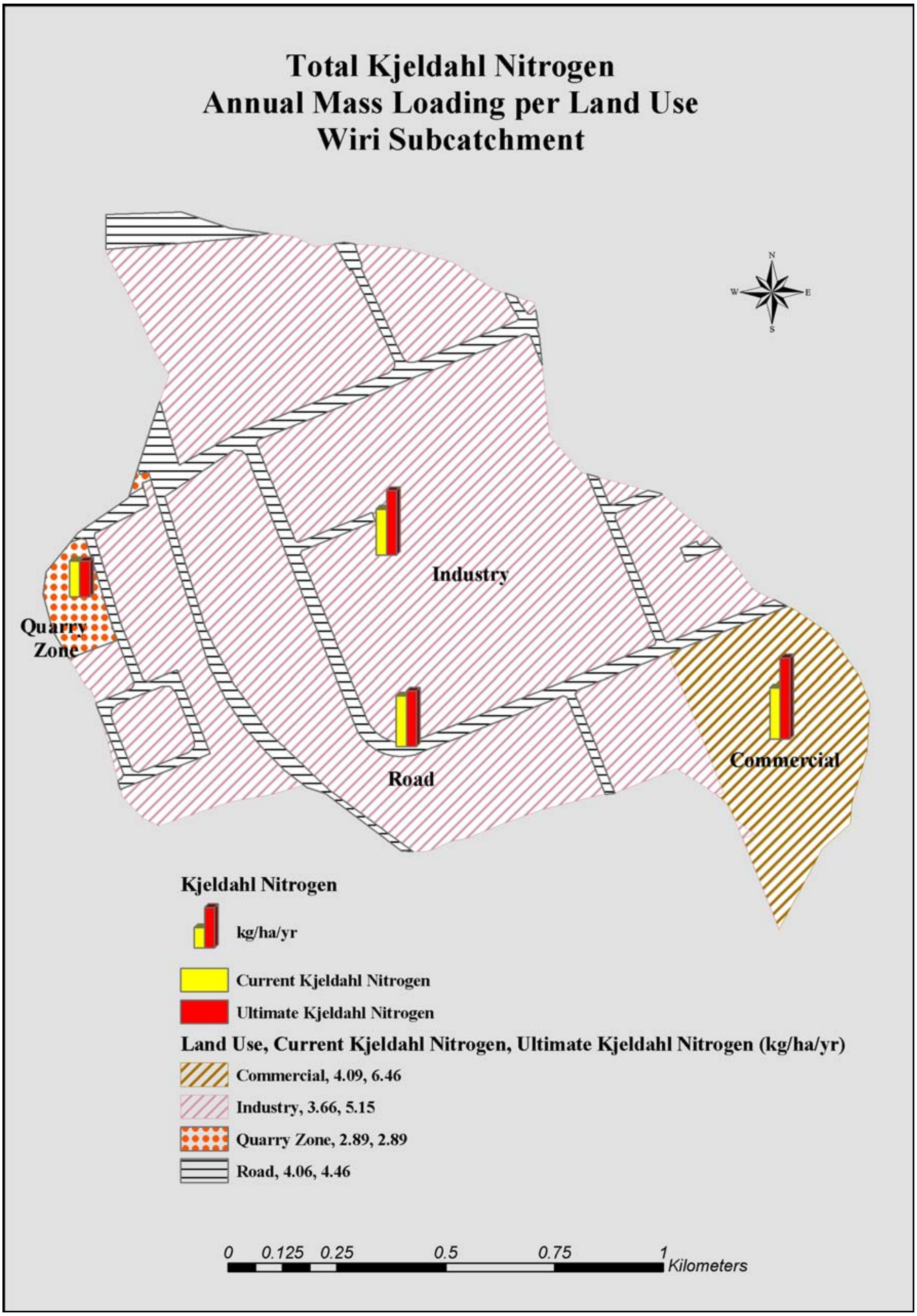
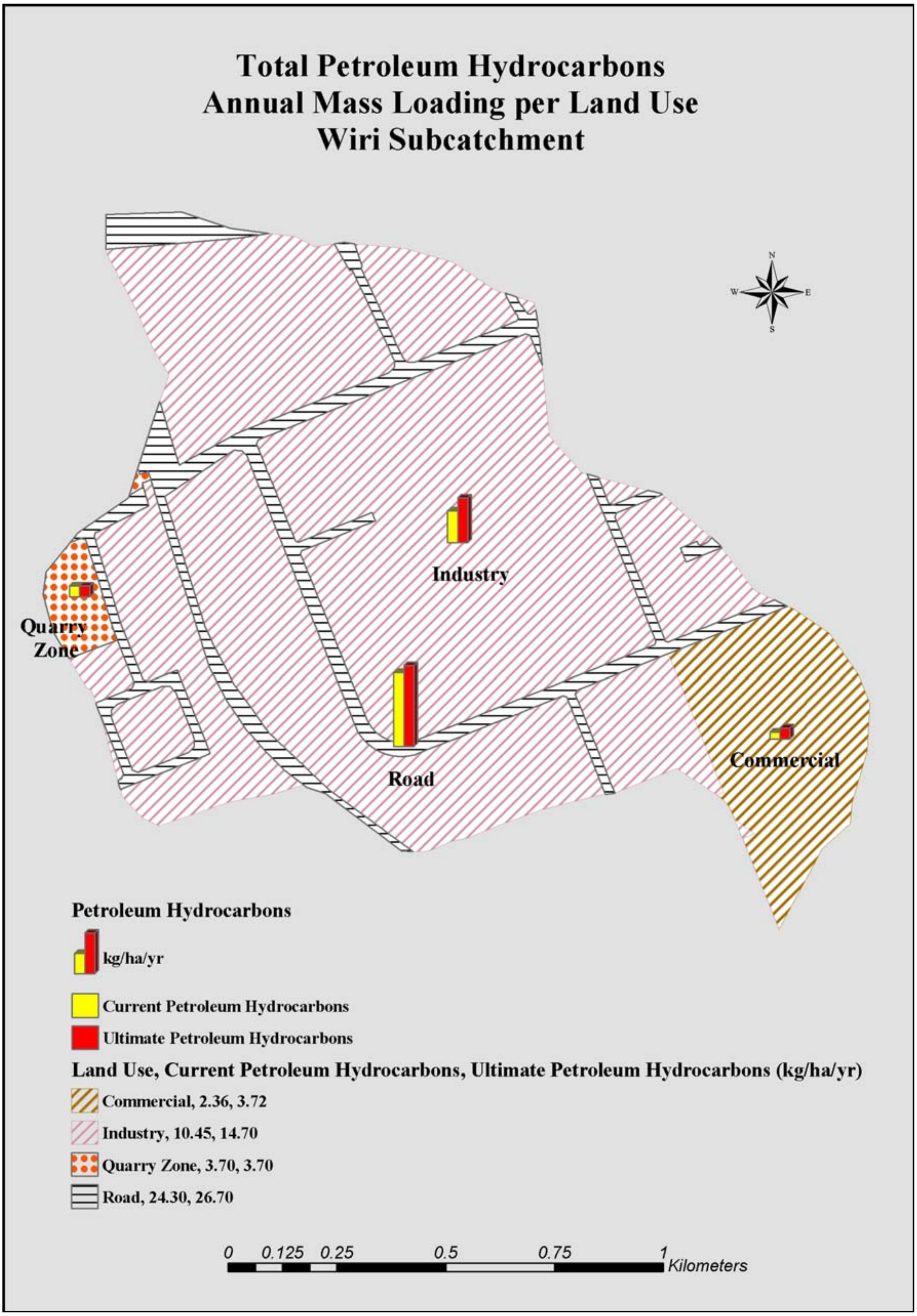


Figure A II.64: Total Petroleum Hydrocarbons annual mass loading (kg/ha/yr) per land use – Wiri subcatchment



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Appendix I: VBA Code

Intersection codes:

Public Sub Intersect_Comm()

```
Intersect_Commercial
MoveLayer
End Sub
```

Public Sub Intersect_Commercial()

```
' Get the input layer and feature class
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
' Use the Itable interface from the Layer (not from the FeatureClass)
Dim pInputTable As ITable
Set pInputTable = pLayer
' Get the input feature class.
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
'Get the selected layer
Set pMxDoc = Application.Document
If pMxDoc.SelectedItem Is Nothing Then Exit Sub
If Not TypeOf pMxDoc.SelectedItem Is IFeatureLayer Then Exit Sub
Set pFeatureLayer = pMxDoc.SelectedItem
'Set pOutFeatureClass = pFeatureLayer.FeatureClass
Dim pOverlayTable As ITable
Set pOverlayTable = pFeatureLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
```

```
End If
If pOverlayTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Define the output feature class name and shape type (taken from the
' properties of the input feature class)
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID =
"esriCore.ShapeFileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Comm_Imp"
Set pDatasetName.WorkspaceName = pNewWSName
' Set the tolerance.
Dim tol As Double
tol = 0#
' Perform the intersect
Dim pBGP As IBasicGeoprocessor
Set pBGP = New BasicGeoprocessor
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pBGP.Intersect(pInputTable, False, pOverlayTable, False, _
tol, pFeatClassName)
' Add the output layer to the map
Dim pOutputFeatLayer As IFeatureLayer
```

```
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMxDoc.FocusMap.AddLayer pOutputFeatLayer
End Sub
```

Public Sub MoveLayer()

```
Dim pMxDocument As IMxDocument
Dim pMap As IMap
Dim pLayer As ILayer
Set pMxDocument = Application.Document
Set pMap = pMxDocument.FocusMap
Set pLayer = pMxDocument.FocusMap.Layer(0)
pMap.MoveLayer pLayer, pMap.LayerCount - 1
End Sub
```

Public Sub Intersect_Ind()

```
Intersect_Industry
MoveLayer1
End Sub
```

Public Sub Intersect_Industry()

```
' Get the input layer and feature class
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
' Use the Itable interface from the Layer (not from the FeatureClass)
Dim pInputTable As ITable
Set pInputTable = pLayer
' Get the input feature class.
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
```

```
'Get the selected layer
Set pMxDoc = Application.Document
If pMxDoc.SelectedItem Is Nothing Then Exit Sub
If Not TypeOf pMxDoc.SelectedItem Is IFeatureLayer Then Exit Sub
Set pFeatureLayer = pMxDoc.SelectedItem
Dim pOverlayTable As ITable
Set pOverlayTable = pFeatureLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
If pOverlayTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Define the output feature class name and shape type
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapeFileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Ind_Imp"
Set pDatasetName.WorkspaceName = pNewWSName
' Set the tolerance.
Dim tol As Double
```

```
tol = 0#
' Perform the intersect
Dim pBGP As IBasicGeoprocessor
Set pBGP = New BasicGeoprocessor
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pBGP.Intersect(pInputTable, False, pOverlayTable, False, _
tol, pFeatClassName)
' Add the output layer to the map
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMxDoc.FocusMap.AddLayer pOutputFeatLayer
End Sub
```

Public Sub MoveLayer1()

```
Dim pMxDocument As IMxDocument
Dim pMap As IMap
Dim pLayer As ILayer
Set pMxDocument = Application.Document
Set pMap = pMxDocument.FocusMap
Set pLayer = pMxDocument.FocusMap.Layer(0)
pMap.MoveLayer pLayer, pMap.LayerCount - 1
End Sub
```

Public Sub Intersect_O_Space()

```
Intersect_Open_Space
MoveLayer2
End Sub
```

Public Sub Intersect_Open_Space()

```
' Get the input layer and feature class
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
```

```
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
' Use the Itable interface from the Layer (not from the FeatureClass)
Dim pInputTable As ITable
Set pInputTable = pLayer
' Get the input feature class.
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
'Get the selected layer
Set pMxDoc = Application.Document
If pMxDoc.SelectedItem Is Nothing Then Exit Sub
If Not TypeOf pMxDoc.SelectedItem Is IFeatureLayer Then Exit Sub
Set pFeatureLayer = pMxDoc.SelectedItem
Dim pOverlayTable As ITable
Set pOverlayTable = pFeatureLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
If pOverlayTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Define the output feature class name and shape
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and feature class name
Dim pNewWSName As IWorkspaceName
```

```
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapeFileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Ospc_Imp"
Set pDatasetName.WorkspaceName = pNewWSName
' Set the tolerance.
Dim tol As Double
tol = 0#
' Perform the intersect
Dim pBGP As IBasicGeoprocessor
Set pBGP = New BasicGeoprocessor
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pBGP.Intersect(pInputTable, False, pOverlayTable, False, _
tol, pFeatClassName)
' Add the output layer to the map
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMxDoc.FocusMap.AddLayer pOutputFeatLayer
End Sub
```

Public Sub MoveLayer2()

```
Dim pMxDocument As IMxDocument
Dim pMap As IMap
Dim pLayer As ILayer
Set pMxDocument = Application.Document
Set pMap = pMxDocument.FocusMap
Set pLayer = pMxDocument.FocusMap.Layer(0)
pMap.MoveLayer pLayer, pMap.LayerCount - 1
End Sub
```

Public Sub Intersect_Road()

```
Intersect_Road_LU
MoveLayer2
End Sub
```

Public Sub Intersect_Road_LU()

```
' Get the input layer and feature class
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
' Use the Itable interface from the Layer (not from the FeatureClass)
Dim pInputTable As ITable
Set pInputTable = pLayer
' Get the input feature class.
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
'Get the selected layer
Set pMxDoc = Application.Document
If pMxDoc.SelectedItem Is Nothing Then Exit Sub
If Not TypeOf pMxDoc.SelectedItem Is IFeatureLayer Then Exit Sub
Set pFeatureLayer = pMxDoc.SelectedItem
'Set pOutFeatureClass = pFeatureLayer.FeatureClass
' Get the overlay layer
Dim pOverlayTable As ITable
Set pOverlayTable = pFeatureLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
If pOverlayTable Is Nothing Then
MsgBox "Table QI failed"
```

```
Exit Sub
End If
' Define the output feature class name and shape type
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapeFileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Rd_Imp"
Set pDatasetName.WorkspaceName = pNewWSName
' Set the tolerance.
Dim tol As Double
tol = 0#
' Perform the intersect
Dim pBGP As IBasicGeoprocessor
Set pBGP = New BasicGeoprocessor
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pBGP.Intersect(pInputTable, False, pOverlayTable, False, _
tol, pFeatClassName)
' Add the output layer to the map
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMxDoc.FocusMap.AddLayer pOutputFeatLayer
End Sub
```

Public Sub MoveLayer3()

```
Dim pMxDocument As IMxDocument
Dim pMap As IMap
Dim pLayer As ILayer
Set pMxDocument = Application.Document
Set pMap = pMxDocument.FocusMap
Set pLayer = pMxDocument.FocusMap.Layer(0)
pMap.MoveLayer pLayer, pMap.LayerCount - 1
End Sub
```

Public Sub Intersect_Quarry()

```
Intersect_Quarry_Zone
MoveLayer4
End Sub
```

Public Sub Intersect_Quarry_Zone()

```
' Get the input layer and feature class
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
' Use the Itable interface from the Layer (not from the FeatureClass)
Dim pInputTable As ITable
Set pInputTable = pLayer
' Get the input feature class.
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
'Get the selected layer
Set pMxDoc = Application.Document
If pMxDoc.SelectedItem Is Nothing Then Exit Sub
If Not TypeOf pMxDoc.SelectedItem Is IFeatureLayer Then Exit Sub
Set pFeatureLayer = pMxDoc.SelectedItem
'Set pOutFeatureClass = pFeatureLayer.FeatureClass
```

```
' Get the overlay layer
Dim pOverlayTable As ITable
Set pOverlayTable = pFeatureLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
If pOverlayTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Define the output feature class name and shape type
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapeFileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Quarry_Imp"
Set pDatasetName.WorkspaceName = pNewWSName
' Set the tolerance.
Dim tol As Double
tol = 0#
' Perform the intersect
Dim pBGP As IBasicGeoprocessor
Set pBGP = New BasicGeoprocessor
```

```
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pBGP.Intersect(pInputTable, False, pOverlayTable, False, _
tol, pFeatClassName)
' Add the output layer to the map
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMxDoc.FocusMap.AddLayer pOutputFeatLayer
End Sub
```

Public Sub MoveLayer4()

```
Dim pMxDocument As IMxDocument
Dim pMap As IMap
Dim pLayer As ILayer
Set pMxDocument = Application.Document
Set pMap = pMxDocument.FocusMap
Set pLayer = pMxDocument.FocusMap.Layer(0)
pMap.MoveLayer pLayer, pMap.LayerCount - 1
End Sub
```

Public Sub Intersect_Res()

```
Intersect_Residential
MoveLayer5
End Sub
```

Public Sub Intersect_Residential()

```
' Get the input layer and feature class
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
' Use the Itable interface from the Layer (not from the FeatureClass)
```

```
Dim pInputTable As ITable
Set pInputTable = pLayer
' Get the input feature class.
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
'Get the selected layer
Set pMxDoc = Application.Document
If pMxDoc.SelectedItem Is Nothing Then Exit Sub
If Not TypeOf pMxDoc.SelectedItem Is IFeatureLayer Then Exit Sub
Set pFeatureLayer = pMxDoc.SelectedItem
'Set pOutFeatureClass = pFeatureLayer.FeatureClass
' Get the overlay layer
Dim pOverlayTable As ITable
Set pOverlayTable = pFeatureLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
If pOverlayTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Define the output feature class name and shape type
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapeFileWorkspaceFactory.1"
```

```
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Res_Imp"
Set pDatasetName.WorkspaceName = pNewWSName
' Set the tolerance.
Dim tol As Double
tol = 0#
' Perform the intersect
Dim pBGP As IBasicGeoprocessor
Set pBGP = New BasicGeoprocessor
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pBGP.Intersect(pInputTable, False, pOverlayTable, False, _
tol, pFeatClassName)
' Add the output layer to the map
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMxDoc.FocusMap.AddLayer pOutputFeatLayer
End Sub
```

Public Sub MoveLayer5()

```
Dim pMxDocument As IMxDocument
Dim pMap As IMap
Dim pLayer As ILayer
Set pMxDocument = Application.Document
Set pMap = pMxDocument.FocusMap
Set pLayer = pMxDocument.FocusMap.Layer(0)
pMap.MoveLayer pLayer, pMap.LayerCount - 1
End Sub
```

Public Sub Intersect_Rural()

```
Intersect_Rural_imp
MoveLayer6
```

```
End Sub
```

Public Sub Intersect_Rural_imp()

```
' Get the input layer and feature class
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
' Use the Itable interface from the Layer (not from the FeatureClass)
Dim pInputTable As ITable
Set pInputTable = pLayer
' Get the input feature class.
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
'Get the selected layer
Set pMxDoc = Application.Document
If pMxDoc.SelectedItem Is Nothing Then Exit Sub
If Not TypeOf pMxDoc.SelectedItem Is IFeatureLayer Then Exit Sub
Set pFeatureLayer = pMxDoc.SelectedItem
'Set pOutFeatureClass = pFeatureLayer.FeatureClass
' Get the overlay layer
Dim pOverlayTable As ITable
Set pOverlayTable = pFeatureLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
If pOverlayTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Define the output feature class name and shape type
```

```
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapeFileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Rural_Imp"
Set pDatasetName.WorkspaceName = pNewWSName
' Set the tolerance.
Dim tol As Double
tol = 0#
' Perform the intersect
Dim pBGP As IBasicGeoprocessor
Set pBGP = New BasicGeoprocessor
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pBGP.Intersect(pInputTable, False, pOverlayTable, False, _
tol, pFeatClassName)
' Add the output layer to the map
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMxDoc.FocusMap.AddLayer pOutputFeatLayer
End Sub
```

Public Sub MoveLayer6()

```
Dim pMxDocument As IMxDocument
```

```
Dim pMap As IMap
Dim pLayer As ILayer
Set pMxDocument = Application.Document
Set pMap = pMxDocument.FocusMap
Set pLayer = pMxDocument.FocusMap.Layer(0)
pMap.MoveLayer pLayer, pMap.LayerCount - 1
End Sub
```

Sub Create Intersect Menu()

```
' Find the MainMenuBar.
Dim pMainMenuBar As ICommandBar
SetpMainMenuBar= Application.Document.CommandBars.Find(ArcID.MainMenu)
' Create the new menu called "Intersect" on the MainMenuBar.
Dim pNewMenu As ICommandBar
Set pNewMenu = pMainMenuBar.CreateMenu("Intersect")
' Add a macro to the new menu.
pNewMenu.CreateMacroItem"Intersect_Comm",31,
"Project.Intersect.Intersect_Comm"
pNewMenu.CreateMacroItem"Intersect_Ind",31, "Project.Intersect.Intersect_Ind"
pNewMenu.CreateMacroItem"Intersect_O_Space",31,
"Project.Intersect.Intersect_O_Space"
pNewMenu.CreateMacroItem"Intersect_Road",31, "Project.Intersect.Intersect_Road"
pNewMenu.CreateMacroItem"Intersect_Quarry",31,
"Project.Intersect.Intersect_Quarry"
pNewMenu.CreateMacroItem"Intersect_Res",31, "Project.Intersect.Intersect_Res"
pNewMenu.CreateMacroItem"Intersect_Rural",31,"Project.Intersect.Intersect_Rural"
End Sub
```

Aggregation codes:

Public Sub Agg_Comm()

```
Aggregate_Comm
add_field_Land_use
calculate_field
End Sub
```

Public Sub Aggregate_Comm()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
Dim pMap As IMap
Set pMap = pDoc.FocusMap
' Find the layer
Dim pLayer As ILayer
Dim pInputFeatLayer As IFeatureLayer
Dim intCount As Integer
For intCount = 0 To pMap.LayerCount - 1
Set pLayer = pMap.Layer(intCount)
If TypeOf pLayer Is IFeatureLayer Then
If pLayer.Name = "Comm_Imp" Then
Set pInputFeatLayer = pLayer
Exit For
End If
End If
Next
If pLayer Is Nothing Then
MsgBox "The Comm_Imp layer was not found"
Exit Sub
End If
' Get input table
Dim pInputTable As ITable
Set pInputTable = pInputFeatLayer
' Error checking
If pInputTable Is Nothing Then
```

```
MsgBox "Table QI failed"
Exit Sub
End If
' Make sure there is a field called Land_use in the input layer
If pInputTable.FindField("Land_use") = -1 Then
MsgBox "There must be a field named Land_use"
Exit Sub
End If
' Get the feature class properties needed for the output
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and output feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapefileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Comm_Agg"
Set pDatasetName.WorkspaceName = pNewWSName
' Perform the dissolve.
Dim iBGP As IBasicGeoprocessor
Set iBGP = New BasicGeoprocessor
Dim pOutputTable As ITable
Set pOutputTable = iBGP.Dissolve(pInputTable, False, "Land_use", _
"Dissolve.Shape", _
pDatasetName)
' Add the output to the map
```

```
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pOutputTable
' Error checking
If pOutputFeatClass Is Nothing Then
MsgBox "FeatureClass QI Failed"
Exit Sub
End If
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMap.AddLayer pOutputFeatLayer
End Sub
```

Sub add_field_Land_use()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
Dim pFc As IFeatureClass
Set pFc = pInputFeatLayer.FeatureClass
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
With pFieldEdit
.Name = "Land_use"
.Type = esriFieldTypeString
.Length = 20
End With
pFc.AddField pField
End Sub
```

Sub calculate_field()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
' Get the layer
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pMxDoc.FocusMap.Layer(0)
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim txtLand_useRFld As String
txtLand_useRFld = pUpdateFeatures.FindField("Land_use")
Dim pFeature As IFeature
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
pFeature.Value(txtLand_useRFld) = "Commercial"
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Public Sub Agg_Ind()

```
Aggregate_Ind
add_f_Land_use
calc_field
End Sub
```

Public Sub Aggregate_Ind()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
```

```
Dim pMap As IMap
Set pMap = pDoc.FocusMap
' Find the layer named Ind_Imp
Dim pLayer As ILayer
Dim pInputFeatLayer As IFeatureLayer
Dim intCount As Integer
For intCount = 0 To pMap.LayerCount - 1
Set pLayer = pMap.Layer(intCount)
If TypeOf pLayer Is IFeatureLayer Then
If pLayer.Name = "Ind_Imp" Then
Set pInputFeatLayer = pLayer
Exit For
End If
End If
Next
If pLayer Is Nothing Then
MsgBox "The Ind_Imp layer was not found"
Exit Sub
End If
' Get input table
Dim pInputTable As ITable
Set pInputTable = pInputFeatLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Make sure there is a field called Land_use in the input layer
If pInputTable.FindField("Land_use") = -1 Then
MsgBox "There must be a field named Land_use"
Exit Sub
End If
' Get the feature class properties needed for the output
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
```

```
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and output feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapefileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Ind_Agg"
Set pDatasetName.WorkspaceName = pNewWSName
' Perform the dissolve.
Dim iBGP As IBasicGeoprocessor
Set iBGP = New BasicGeoprocessor
Dim pOutputTable As ITable
Set pOutputTable = iBGP.Dissolve(pInputTable, False, "Land_use", _
"Dissolve.Shape", _
pDatasetName)
' Add the output to the map
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pOutputTable
' Error checking
If pOutputFeatClass Is Nothing Then
MsgBox "FeatureClass QI Failed"
Exit Sub
End If
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
```

```
pMap.AddLayer pOutputFeatLayer
End Sub
```

Sub add_f_Land_use()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
Dim pFc As IFeatureClass
Set pFc = pInputFeatLayer.FeatureClass
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
With pFieldEdit
.Name = "Land_use"
.Type = esriFieldTypeString
.Length = 20
End With
pFc.AddField pField
End Sub
```

Sub calc_field()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
' Get the layer that is selected in the TOC
' it must be a polygon layer
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pMxDoc.FocusMap.Layer(0)
```

```
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim txtLand_useRFld As String
txtLand_useRFld = pUpdateFeatures.FindField("Land_use")
Dim pFeature As IFeature
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
pFeature.Value(txtLand_useRFld) = "Industry"
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Public Sub Agg_Open_sp()

```
Aggregate_Opensp
add_f_Land_use2
calc_field2
End Sub
```

Public Sub Aggregate_Opensp()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
Dim pMap As IMap
Set pMap = pDoc.FocusMap
' Find the layer named Ospc_Imp
Dim pLayer As ILayer
Dim pInputFeatLayer As IFeatureLayer
Dim intCount As Integer
For intCount = 0 To pMap.LayerCount - 1
Set pLayer = pMap.Layer(intCount)
If TypeOf pLayer Is IFeatureLayer Then
If pLayer.Name = "Ospc_Imp" Then
Set pInputFeatLayer = pLayer
```

```
Exit For
End If
End If
Next
If pLayer Is Nothing Then
MsgBox "The Ospc_Imp layer was not found"
Exit Sub
End If
' Get input table
Set pInputTable = pInputFeatLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Make sure there is a field called Land_use in the input layer
If pInputTable.FindField("Land_use") = -1 Then
MsgBox "There must be a field named Land_use"
Exit Sub
End If
' Get the feature class properties needed for the output
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and output feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapefileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
```

```
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Ospc_Agg"
Set pDatasetName.WorkspaceName = pNewWSName
' Perform the dissolve.
Dim iBGP As IBasicGeoprocessor
Set iBGP = New BasicGeoprocessor
Dim pOutputTable As ITable
Set pOutputTable = iBGP.Dissolve(pInputTable, False, "Land_use", _
"Dissolve.Shape", _
pDatasetName)
' Add the output to the map
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pOutputTable
' Error checking
If pOutputFeatClass Is Nothing Then
MsgBox "FeatureClass QI Failed"
Exit Sub
End If
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMap.AddLayer pOutputFeatLayer
End Sub
```

Sub add_f_Land_use2()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
Dim pFc As IFeatureClass
Set pFc = pInputFeatLayer.FeatureClass
```

```
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
With pFieldEdit
.Name = "Land_use"
.Type = esriFieldTypeString
.Length = 20
End With
pFc.AddField pField
End Sub
```

Sub calc_field2()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)

' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pMxDoc.FocusMap.Layer(0)
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim txtLand_useRFld As String
txtLand_useRFld = pUpdateFeatures.FindField("Land_use")
Dim pFeature As IFeature
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
pFeature.Value(txtLand_useRFld) = "Open space"
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
```

Loop

End Sub

Public Sub Agg_Quarry()

Aggregate_Q

add_f_Land_use4

calc_field4

End Sub

Public Sub Aggregate_Q()

Dim pDoc As IMxDocument

Set pDoc = ThisDocument

Dim pMap As IMap

Set pMap = pDoc.FocusMap

' Find the layer named Quarry_Imp

Dim pLayer As ILayer

Dim pInputFeatLayer As IFeatureLayer

Dim intCount As Integer

For intCount = 0 To pMap.LayerCount - 1

Set pLayer = pMap.Layer(intCount)

If TypeOf pLayer Is IFeatureLayer Then

If pLayer.Name = "Quarry_Imp" Then

Set pInputFeatLayer = pLayer

Exit For

End If

End If

Next

If pLayer Is Nothing Then

MsgBox "The Quarry_Imp layer was not found"

Exit Sub

End If

' Get input table

Dim pInputTable As ITable

Set pInputTable = pInputFeatLayer

' Error checking

```
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Make sure there is a field called Land_use in the input layer
If pInputTable.FindField("Land_use") = -1 Then
MsgBox "There must be a field named Land_use"
Exit Sub
End If
' Get the feature class properties needed for the output
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and output feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapefileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Q_Agg"
Set pDatasetName.WorkspaceName = pNewWSName
' Perform the dissolve.
Dim iBGP As IBasicGeoprocessor
Set iBGP = New BasicGeoprocessor
Dim pOutputTable As ITable
Set pOutputTable = iBGP.Dissolve(pInputTable, False, "Land_use", _
"Dissolve.Shape", _
pDatasetName)
```

```
' Add the output to the map
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pOutputTable
' Error checking
If pOutputFeatClass Is Nothing Then
MsgBox "FeatureClass QI Failed"
Exit Sub
End If
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMap.AddLayer pOutputFeatLayer
End Sub
```

Sub add_f_Land_use4()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
Dim pFc As IFeatureClass
Set pFc = pInputFeatLayer.FeatureClass
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
With pFieldEdit
.Name = "Land_use"
.Type = esriFieldTypeString
.Length = 20
End With
pFc.AddField pField
End Sub
```

Sub calc_field4()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pMxDoc.FocusMap.Layer(0)
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim txtLand_useRFld As String
txtLand_useRFld = pUpdateFeatures.FindField("Land_use")
Dim pFeature As IFeature
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
pFeature.Value(txtLand_useRFld) = "Quarry"
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Public Sub Agg_Rural()

```
Aggregate_Rural
add_f_Land_userural
calc_fieldrural
End Sub
```

Public Sub Aggregate_Rural()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
Dim pMap As IMap
```

```
Set pMap = pDoc.FocusMap
' Find the layer named Rural_Imp
Dim pLayer As ILayer
Dim pInputFeatLayer As IFeatureLayer
Dim intCount As Integer
For intCount = 0 To pMap.LayerCount - 1
Set pLayer = pMap.Layer(intCount)
If TypeOf pLayer Is IFeatureLayer Then
If pLayer.Name = "Rural_Imp" Then
Set pInputFeatLayer = pLayer
Exit For
End If
End If
Next
If pLayer Is Nothing Then
MsgBox "The Rural_Imp layer was not found"
Exit Sub
End If
' Get input table
Dim pInputTable As ITable
Set pInputTable = pInputFeatLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Make sure there is a field called Land_use in the input layer
If pInputTable.FindField("Land_use") = -1 Then
MsgBox "There must be a field named Land_use"
Exit Sub
End If
' Get the feature class properties needed for the output
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
Dim pFeatClassName As IFeatureClassName
```

```
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and output feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapefileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Rural_Agg"
Set pDatasetName.WorkspaceName = pNewWSName
' Perform the dissolve.
Dim iBGP As IBasicGeoprocessor
Set iBGP = New BasicGeoprocessor
Dim pOutputTable As ITable
Set pOutputTable = iBGP.Dissolve(pInputTable, False, "Land_use", _
"Dissolve.Shape", _
pDatasetName)
' Add the output to the map
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pOutputTable
' Error checking
If pOutputFeatClass Is Nothing Then
MsgBox "FeatureClass QI Failed"
Exit Sub
End If
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMap.AddLayer pOutputFeatLayer
```

End Sub

Sub add_f_Land_userural()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
Dim pFc As IFeatureClass
Set pFc = pInputFeatLayer.FeatureClass
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
With pFieldEdit
.Name = "Land_use"
.Type = esriFieldTypeString
.Length = 20
End With
pFc.AddField pField
End Sub
```

Sub calc_fieldrural()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pMxDoc.FocusMap.Layer(0)
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
```

```
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim txtLand_useRFld As String
txtLand_useRFld = pUpdateFeatures.FindField("Land_use")
Dim pFeature As IFeature
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
pFeature.Value(txtLand_useRFld) = "Rural"
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Public Sub Agg_Res()

```
Aggregate_res
add_f_Land_useres
calc_fieldres
End Sub
```

Public Sub Aggregate_res()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
Dim pMap As IMap
Set pMap = pDoc.FocusMap
' Find the layer named Res_Imp
Dim pLayer As ILayer
Dim pInputFeatLayer As IFeatureLayer
Dim intCount As Integer
For intCount = 0 To pMap.LayerCount - 1
Set pLayer = pMap.Layer(intCount)
If TypeOf pLayer Is IFeatureLayer Then
If pLayer.Name = "Res_Imp" Then
Set pInputFeatLayer = pLayer
Exit For
End If
```

```
End If
Next
If pLayer Is Nothing Then
MsgBox "The Res_Imp layer was not found"
Exit Sub
End If
' Get input table
Dim pInputTable As ITable
Set pInputTable = pInputFeatLayer
' Error checking
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Make sure there is a field called Land_use in the input layer
If pInputTable.FindField("Land_use") = -1 Then
MsgBox "There must be a field named Land_use"
Exit Sub
End If
' Get the feature class properties needed for the output
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and output feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapefileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
```

```
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Resident_Agg"
Set pDatasetName.WorkspaceName = pNewWSName
' Perform the dissolve.
Dim iBGP As IBasicGeoprocessor
Set iBGP = New BasicGeoprocessor
Dim pOutputTable As ITable
Set pOutputTable = iBGP.Dissolve(pInputTable, False, "Land_use", _
"Dissolve.Shape", _
pDatasetName)
' Add the output to the map
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pOutputTable

' Error checking
If pOutputFeatClass Is Nothing Then
MsgBox "FeatureClass QI Failed"
Exit Sub
End If
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMap.AddLayer pOutputFeatLayer
End Sub
```

Sub add_f_Land_useres()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
Dim pFc As IFeatureClass
Set pFc = pInputFeatLayer.FeatureClass
```

```
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
With pFieldEdit
.Name = "Land_use"
.Type = esriFieldTypeString
.Length = 20
End With
pFc.AddField pField
End Sub
```

Sub calc_fieldres()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pMxDoc.FocusMap.Layer(0)
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim txtLand_useRFld As String

txtLand_useRFld = pUpdateFeatures.FindField("Land_use")
Dim pFeature As IFeature
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
pFeature.Value(txtLand_useRFld) = "Residential"
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
```

Loop

End Sub

Public Sub Agg_Road()

Aggregate_Rd

add_f_Land_useRd

calc_fieldRd

End Sub

Public Sub Aggregate_Rd()

Dim pDoc As IMxDocument

Set pDoc = ThisDocument

Dim pMap As IMap

Set pMap = pDoc.FocusMap

' Find the layer named Rd_Imp

Dim pLayer As ILayer

Dim pInputFeatLayer As IFeatureLayer

Dim intCount As Integer

For intCount = 0 To pMap.LayerCount - 1

Set pLayer = pMap.Layer(intCount)

If TypeOf pLayer Is IFeatureLayer Then

If pLayer.Name = "Rd_Imp" Then

Set pInputFeatLayer = pLayer

Exit For

End If

End If

Next

If pLayer Is Nothing Then

MsgBox "The Rd_Imp layer was not found"

Exit Sub

End If

' Get input table

Dim pInputTable As ITable

Set pInputTable = pInputFeatLayer

' Error checking

```
If pInputTable Is Nothing Then
MsgBox "Table QI failed"
Exit Sub
End If
' Make sure there is a field called Land_use in the input layer
If pInputTable.FindField("Land_use") = -1 Then
MsgBox "There must be a field named Land_use"
Exit Sub
End If
' Get the feature class properties needed for the output
Dim pInputFeatClass As IFeatureClass
Set pInputFeatClass = pInputFeatLayer.FeatureClass
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pInputFeatClass.ShapeType
End With
' Set output location and output feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
pNewWSName.WorkspaceFactoryProgID = "esriCore.ShapefileWorkspaceFactory.1"
pNewWSName.PathName = "c:\puhinui\Puhinui_Stream"
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Road_Agg"
Set pDatasetName.WorkspaceName = pNewWSName
' Perform the dissolve.
Dim iBGP As IBasicGeoprocessor
Set iBGP = New BasicGeoprocessor
Dim pOutputTable As ITable
Set pOutputTable = iBGP.Dissolve(pInputTable, False, "Land_use", _
"Dissolve.Shape", _
pDatasetName)
```

```
' Add the output to the map
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pOutputTable
' Error checking
If pOutputFeatClass Is Nothing Then
MsgBox "FeatureClass QI Failed"
Exit Sub
End If
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pMap.AddLayer pOutputFeatLayer
End Sub
```

Sub add_f_Land_useRd()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
Dim pInputFeatLayer As IFeatureLayer
Set pInputFeatLayer = pLayer
Dim pFc As IFeatureClass
Set pFc = pInputFeatLayer.FeatureClass
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
With pFieldEdit
.Name = "Land_use"
.Type = esriFieldTypeString
.Length = 20
End With
pFc.AddField pField
End Sub
```

Sub calc_fieldRd()

```
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pLayer As ILayer
Set pLayer = pMxDoc.FocusMap.Layer(0)
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pMxDoc.FocusMap.Layer(0)
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim txtLand_useRFld As String
txtLand_useRFld = pUpdateFeatures.FindField("Land_use")
Dim pFeature As IFeature
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
pFeature.Value(txtLand_useRFld) = "Road"
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_ImpArea()

```
add_field_ImpArea
Imp_Area
End Sub
```

Sub add_field_ImpArea()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
```

```
'Get the selected layer
Dim pFLayer As IFeatureLayer
Set pFLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
Set pFc = pFLayer.FeatureClass
'Check to see if layer already has an area field
If Not pFc.FindField("Imp_Area") = -1 Then
MsgBox "Imp_Area already exists"
Exit Sub
End If
'Create a field called Imp_Area
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
With pFieldEdit
.Name = "Imp_Area"
.Type = esriFieldTypeDouble
.Precision = 11
.Length = 12
.Scale = 3
End With
pFc.AddField pField
End Sub
```

Sub Imp_Area()

```
'calculate Imp_Area area
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
```

```
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit Mode "
Exit Sub
End If
' Find the field named Imp_Area
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Imp_Area")
If intFldIndex = -1 Then
MsgBox "There must be a field named Imp_Area in the Layer "
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.PreExpression = "Dim dblArea as double" & vbNewLine & _
"Set pGeomShp = [shape]" & vbNewLine & _
"Dim pArea as IArea" & vbNewLine & _
"Set pArea = [shape]" & vbNewLine & _
```

```
"dblArea = pArea.area"
.Expression = "dblArea"
.Field = "Imp_Area"
End With
pCalc.calculate
Set pCursor = Nothing
MsgBox "Imp_Area calculated"
Exit Sub
End Sub
```

Sub Calc_CtchArea()

```
add_field_CtchArea
Ctch_Area
End Sub
```

Sub add_field_CtchArea()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
'-Get the selected layer
Dim pFLayer As IFeatureLayer
Set pFLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
Set pFc = pFLayer.FeatureClass
'-- Check to see if layer already has an Ctch_Area field
If Not pFc.FindField("Ctch_Area") = -1 Then
MsgBox "Ctch_Area already exists"
Exit Sub
End If
'Create a field called Ctch_Area
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
```

```
With pFieldEdit
.Name = "Ctch_Area"
.Type = esriFieldTypeDouble
.Precision = 11
.Length = 12
.Scale = 3
End With
pFc.AddField pField
End Sub
```

Sub Ctch_Area()

```
'calculate Ctch_Area area
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit Mode "
Exit Sub
End If
' Find the field named Ctch_Area
```

```
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Ctch_Area")
If intFldIndex = -1 Then
MsgBox "There must be a field named Ctch_Area in the Layer "
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.PreExpression = "Dim dblArea as double" & vbNewLine & _
"Set pGeomShp = [shape]" & vbNewLine & _
"Dim pArea as IArea" & vbNewLine & _
"Set pArea = [shape]" & vbNewLine & _
"dblArea = pArea.area"
.Expression = "dblArea"
.Field = "Ctch_Area"
End With
pCalc.calculate
Set pCursor = Nothing
MsgBox "Ctch_Area calculated"
Exit Sub
End Sub
```

Sub CreateAggMenu()

```
' Find the MainMenuBar.
Dim pMainMenuBar As ICommandBar
Set pMainMenuBar = Application.Document.CommandBars.Find(ArcID.MainMenu)
' Create the new menu called "Aggregate" on the MainMenuBar.
```

```
Dim pNewMenu As ICommandBar
Set pNewMenu = pMainMenuBar.CreateMenu("Aggregate")
' Add a macro to the new menu.
pNewMenu.CreateMacroItem "Agg_Comm", 24, "Project.Aggregate.Agg_Comm"
pNewMenu.CreateMacroItem "Agg_Ind", 24, "Project.Aggregate.Agg_Ind"
pNewMenu.CreateMacroItem "Agg_Open_sp", 24, "Project.Aggregate.Agg_Open_sp"
pNewMenu.CreateMacroItem "Agg_Road", 24, "Project.Aggregate.Agg_Road"
pNewMenu.CreateMacroItem "Agg_Quarry", 24, "Project.Aggregate.Agg_Quarry"
pNewMenu.CreateMacroItem "Agg_Res", 24, "Project.Aggregate.Agg_Res"
pNewMenu.CreateMacroItem "Agg_Rural", 24, "Project.Aggregate.Agg_Rural"
pNewMenu.CreateMacroItem "Calculate_Imp_Area", 28,
"Project.Aggregate.Calc_ImpArea"
pNewMenu.CreateMacroItem "Calculate_Ctch_Area", 39,
"Project.Aggregate.Calc_CtchArea"
End Sub
```

Runoff coefficient codes:

Sub add_fields()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
'Get the selected layer
Dim pFLayer As IFeatureLayer
Set pFLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
Set pFc = pFLayer.FeatureClass
Dim pTable As ITable
Dim pField As IField
Dim pFields As IFields
Dim pFieldEdit As IFieldEdit
Dim pFieldsEdit As IFieldsEdit
'Create new Fields collection
Set pFields = New Fields
Set pFieldsEdit = pFields
pFieldsEdit.FieldCount = 8
'Create Area Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "Area"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(0) = pField
pFc.AddField pField
'Create Imp_Area Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "Imp_Area"
```

```
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(1) = pField
pFc.AddField pField
'Create NonImp_A Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "NonImp_A"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(2) = pField
pFc.AddField pField
'Create Imp_pc Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "Imp_pc"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(3) = pField
pFc.AddField pField
'Create Ctch_Area Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "Ctch_Area"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(4) = pField
pFc.AddField pField
'Create Current_R Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
```

```
.Name = "Current_R"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(5) = pField
pFc.AddField pField
'Create Ultimate_R Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "Ultimate_R"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(6) = pField
pFc.AddField pField
'Create NonImp_R Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "NonImp_R"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(7) = pField
pFc.AddField pField
MsgBox "Ctch_Area, Area, ImpArea, NonImp_Area, Imp_pc, UltimateR, NonImpR
and Runoff_Coeff fields added"
End Sub
```

Sub Calculate_Comm_Rc()

```
Comm_Area
NonImp_Area
Comm_Imp_pc
Comm_UltimateR
Comm_NonImp_R
Comm_Current_R
End Sub
```

Sub Comm_Area()

```
'calculate area
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit Mode "
Exit Sub
End If
' Find the field named Area
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Area")
If intFldIndex = -1 Then
MsgBox "There must be a field named Area in the Layer "
Exit Sub
```

```
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.PreExpression = "Dim dblArea as double" & vbNewLine & _
"Set pGeomShp = [shape]" & vbNewLine & _
"Dim pArea as IArea" & vbNewLine & _
"Set pArea = [shape]" & vbNewLine & _
"dblArea = pArea.area"
.Expression = "dblArea"
.Field = "Area"
End With
pCalc.calculate
Set pCursor = Nothing
MsgBox "Area calculated"
Exit Sub
End Sub
```

Sub NonImp_Area()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
```

```
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleNonImpAFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
pFeature.Value(doubleNonImpAFld) = doubleArea - doubleImpArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Non_Imp Area calculated"
End Sub
```

Sub Comm_Imp_pc()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleImpFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAFld As Double
doubleImpFld = pUpdateFeatures.FindField("Imp_pc")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpA = pFeature.Value(doubleImpAFld)
pFeature.Value(doubleImpFld) = doubleImpA / doubleArea * 100
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Impervious Percentage calculated"
End Sub
```

Sub Comm_UltimateR()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
```

```
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named Ultimate_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Ultimate_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.9"
.Field = "Ultimate_R"
End With
pCalc.calculate
Exit Sub
```

```
End Sub

Sub Comm_NonImp_R()
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named NonImp_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("NonImp_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
```

```
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.3"
.Field = "NonImp_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Comm_Current_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleCurrentRFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
```

```
Dim doubleNonImpAFld As Double
doubleCurrentRFld = pUpdateFeatures.FindField("Current_R")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
doubleNonImpRFld = pUpdateFeatures.FindField("NonImp_R")
doubleUltimateRFld = pUpdateFeatures.FindField("Ultimate_R")
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Dim doubleNonImpR As Double
Dim doubleUltimateR As Double
Dim doubleNonImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
doubleNonImpR = pFeature.Value(doubleNonImpRFld)
doubleUltimateR = pFeature.Value(doubleUltimateRFld)
doubleNonImpA = pFeature.Value(doubleNonImpAFld)
pFeature.Value(doubleCurrentRFld) = (doubleUltimateR * doubleImpArea + doubleNonImpA * doubleNonImpR) / doubleArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Current Runoff Coeficient calculated"
End Sub
```

Sub Calculate_Ind_Rc()

```
Ind_Area
Ind_NonImp_Area
Ind_Imp_pc
Ind_UltimateR
Ind_NonImp_R
Ind_Current_R
```

End Sub

Sub Ind_Area()

```
'calculate area
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit Mode "
Exit Sub
End If
' Find the field named Area
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Area")
If intFldIndex = -1 Then
MsgBox "There must be a field named Area in the Layer "
```

```
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.PreExpression = "Dim dblArea as double" & vbNewLine & _
"Set pGeomShp = [shape]" & vbNewLine & _
"Dim pArea as IArea" & vbNewLine & _
"Set pArea = [shape]" & vbNewLine & _
"dblArea = pArea.area"
.Expression = "dblArea"
.Field = "Area"
End With
pCalc.calculate
Set pCursor = Nothing
MsgBox "Area calculated"
Exit Sub
End Sub
```

Sub Ind_NonImp_Area()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
```

```
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleNonImpAFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
pFeature.Value(doubleNonImpAFld) = doubleArea - doubleImpArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Non_Imp Area calculated"
End Sub
```

Sub Ind_Imp_pc()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
```

```
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleImpFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAFld As Double
doubleImpFld = pUpdateFeatures.FindField("Imp_pc")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpA = pFeature.Value(doubleImpAFld)
pFeature.Value(doubleImpFld) = doubleImpA / doubleArea * 100
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Impervious Percentage calculated"
End Sub
```

Sub Ind_UltimateR()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
```

```
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named Ultimate_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Ultimate_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.9"
.Field = "Ultimate_R"
End With
pCalc.calculate
```

```
Exit Sub
End Sub
```

Sub Ind_NonImp_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named NonImp_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("NonImp_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
```

```
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.3"
.Field = "NonImp_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Ind_Current_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleCurrentRFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
```

```
Dim doubleUltimateRFld As Double
Dim doubleNonImpAFld As Double
doubleCurrentRFld = pUpdateFeatures.FindField("Current_R")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
doubleNonImpRFld = pUpdateFeatures.FindField("NonImp_R")
doubleUltimateRFld = pUpdateFeatures.FindField("Ultimate_R")
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Dim doubleNonImpR As Double
Dim doubleUltimateR As Double
Dim doubleNonImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
doubleNonImpR = pFeature.Value(doubleNonImpRFld)
doubleUltimateR = pFeature.Value(doubleUltimateRFld)
doubleNonImpA = pFeature.Value(doubleNonImpAFld)
pFeature.Value(doubleCurrentRFld) = (doubleUltimateR * doubleImpArea +
doubleNonImpA * doubleNonImpR) / doubleArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Current Runoff Coeficient calculated"
End Sub
```

Sub Calculate_Ospc_Rc()

```
Ospc_Area
Ospc_NonImp_Area
Ospc_Imp_pc
Ospc_UltimateR
Ospc_NonImp_R
```

```
Ospc_Current_R
End Sub
```

Sub Ospc_Area()

```
'calculate area
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit Mode "
Exit Sub
End If
' Find the field named Area
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Area")
If intFldIndex = -1 Then
```

```
MsgBox "There must be a field named Area in the Layer "
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.PreExpression = "Dim dblArea as double" & vbNewLine & _
"Set pGeomShp = [shape]" & vbNewLine & _
"Dim pArea as IArea" & vbNewLine & _
"Set pArea = [shape]" & vbNewLine & _
"dblArea = pArea.area"
.Expression = "dblArea"
.Field = "Area"
End With
pCalc.calculate
Set pCursor = Nothing
MsgBox "Area calculated"
Exit Sub
End Sub
```

Sub Ospc_NonImp_Area()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
```

```
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleNonImpAFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
pFeature.Value(doubleNonImpAFld) = doubleArea - doubleImpArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Non_Imp Area calculated"
End Sub
```

Sub Ospc_Imp_pc()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
```

```
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleImpFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAFld As Double
doubleImpFld = pUpdateFeatures.FindField("Imp_pc")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpA = pFeature.Value(doubleImpAFld)
pFeature.Value(doubleImpFld) = doubleImpA / doubleArea * 100
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Impervious Percentage calculated"
End Sub
```

Sub Ospc_UltimateR()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
```

```
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named Ultimate_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Ultimate_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.3"
.Field = "Ultimate_R"
End With
```

```
pCalc.calculate
Exit Sub
End Sub
```

Sub Ospc_NonImp_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named NonImp_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("NonImp_R")
If intFldIndex = -1 Then
```

```
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.3"
.Field = "NonImp_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Ospc_Current_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleCurrentRFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
```

```
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
Dim doubleNonImpAFld As Double
doubleCurrentRFld = pUpdateFeatures.FindField("Current_R")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
doubleNonImpRFld = pUpdateFeatures.FindField("NonImp_R")
doubleUltimateRFld = pUpdateFeatures.FindField("Ultimate_R")
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Dim doubleNonImpR As Double
Dim doubleUltimateR As Double
Dim doubleNonImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
doubleNonImpR = pFeature.Value(doubleNonImpRFld)
doubleUltimateR = pFeature.Value(doubleUltimateRFld)
doubleNonImpA = pFeature.Value(doubleNonImpAFld)
pFeature.Value(doubleCurrentRFld) = (doubleUltimateR * doubleImpArea +
doubleNonImpA * doubleNonImpR) / doubleArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Current Runoff Coeficient calculated"
End Sub
```

Sub Calculate_Quarry_Rc()

```
Q_Area
Q_NonImp_Area
Q_Imp_pc
Q_UltimateR
```

Q_NonImp_R

Q_Current_R

End Sub

Sub Q_Area()

'calculate area

Dim pDoc As IMxDocument

Set pDoc = ThisDocument

' Get the layer that is selected in the TOC

Dim pFeatLayer As IFeatureLayer

Dim pFeatClass As IFeatureClass

Dim pUnknown As IUnknown

Set pUnknown = pDoc.SelectedLayer

If pUnknown Is Nothing Then

MsgBox "Must have a layer selected in the table of contents."

Exit Sub

End If

Set pFeatLayer = pUnknown

Set pFeatClass = pFeatLayer.FeatureClass

' This calculation is to be done outside of an edit session.

Dim pEditor As IEditor

Dim pID As New UID

pID = "esriCore.Editor"

Set pEditor = Application.FindExtensionByCLSID(pID)

If pEditor.EditState = esriStateEditing Then

MsgBox "This sample requires that ArcMap is not in edit Mode "

Exit Sub

End If

' Find the field named Area

Dim pCalc As ICalculator

Dim pTable As ITable

Dim pField As IField

Dim intFldIndex As Integer

Set pTable = pFeatClass

intFldIndex = pTable.FindField("Area")

```
If intFldIndex = -1 Then
MsgBox "There must be a field named Area in the Layer "
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.PreExpression = "Dim dblArea as double" & vbNewLine & _
"Set pGeomShp = [shape]" & vbNewLine & _
"Dim pArea as IArea" & vbNewLine & _
"Set pArea = [shape]" & vbNewLine & _
"dblArea = pArea.area"
.Expression = "dblArea"
.Field = "Area"
End With
pCalc.calculate
Set pCursor = Nothing
MsgBox "Area calculated"
Exit Sub
End Sub
```

Sub Q_NonImp_Area()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleNonImpAFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
pFeature.Value(doubleNonImpAFld) = doubleArea - doubleImpArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Non_Imp Area calculated"
End Sub
```

Sub Q_Imp_pc()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
```

```
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleImpFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAFld As Double
doubleImpFld = pUpdateFeatures.FindField("Imp_pc")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpA = pFeature.Value(doubleImpAFld)
pFeature.Value(doubleImpFld) = doubleImpA / doubleArea * 100
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Impervious Percentage calculated"
End Sub
```

Sub Q_UltimateR()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
```

```
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named Ultimate_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Ultimate_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.2"
.Field = "Ultimate_R"
```

```
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Q_NonImp_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named NonImp_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("NonImp_R")
```

```
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.3"
.Field = "NonImp_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Q_Current_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleCurrentRFld As Double
Dim doubleAreaFld As Double
```

```
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
Dim doubleNonImpAFld As Double
doubleCurrentRFld = pUpdateFeatures.FindField("Current_R")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
doubleNonImpRFld = pUpdateFeatures.FindField("NonImp_R")
doubleUltimateRFld = pUpdateFeatures.FindField("Ultimate_R")
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Dim doubleNonImpR As Double
Dim doubleUltimateR As Double
Dim doubleNonImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
doubleNonImpR = pFeature.Value(doubleNonImpRFld)
doubleUltimateR = pFeature.Value(doubleUltimateRFld)
doubleNonImpA = pFeature.Value(doubleNonImpAFld)
pFeature.Value(doubleCurrentRFld) = (doubleUltimateR * doubleImpArea +
doubleNonImpA * doubleNonImpR) / doubleArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Current Runoff Coeficient calculated"
End Sub
```

Sub Calculate_Rd_Rc()

```
Rd_Area
Rd_NonImp_Area
Rd_Imp_pc
```

```
Rd_UltimateR
Rd_NonImp_R
Rd_Current_R
End Sub
```

Sub Rd_Area()

```
'calculate area
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit Mode "
Exit Sub
End If
' Find the field named Area
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
```

```
intFldIndex = pTable.FindField("Area")
If intFldIndex = -1 Then
MsgBox "There must be a field named Area in the Layer "
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.PreExpression = "Dim dblArea as double" & vbNewLine & _
"Set pGeomShp = [shape]" & vbNewLine & _
"Dim pArea as IArea" & vbNewLine & _
"Set pArea = [shape]" & vbNewLine & _
"dblArea = pArea.area"
.Expression = "dblArea"
.Field = "Area"
End With
pCalc.calculate
Set pCursor = Nothing
MsgBox "Area calculated"
Exit Sub
End Sub
```

Sub Rd_NonImp_Area()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
```

```
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleNonImpAFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
pFeature.Value(doubleNonImpAFld) = doubleArea - doubleImpArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Non_Imp Area calculated"
End Sub
```

Sub Rd_Imp_pc()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
' it must be a polygon layer
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
```

```
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleImpFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAFld As Double
doubleImpFld = pUpdateFeatures.FindField("Imp_pc")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpA = pFeature.Value(doubleImpAFld)
pFeature.Value(doubleImpFld) = doubleImpA / doubleArea * 100
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Impervious Percentage calculated"
End Sub
```

Sub Rd_UltimateR()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
```

```
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named Ultimate_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Ultimate_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
```

```
.Expression = "0.66"
.Field = "Ultimate_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Rd_NonImp_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named NonImp_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
```

```
Set pTable = pFeatClass
intFldIndex = pTable.FindField("NonImp_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.3"
.Field = "NonImp_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Rd_Current_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
' it must be a polygon layer
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
```

```
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleCurrentRFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
Dim doubleNonImpAFld As Double
doubleCurrentRFld = pUpdateFeatures.FindField("Current_R")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
doubleNonImpRFld = pUpdateFeatures.FindField("NonImp_R")
doubleUltimateRFld = pUpdateFeatures.FindField("Ultimate_R")
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Dim doubleNonImpR As Double
Dim doubleUltimateR As Double
Dim doubleNonImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
doubleNonImpR = pFeature.Value(doubleNonImpRFld)
doubleUltimateR = pFeature.Value(doubleUltimateRFld)
doubleNonImpA = pFeature.Value(doubleNonImpAFld)
pFeature.Value(doubleCurrentRFld) = (doubleUltimateR * doubleImpArea +
doubleNonImpA * doubleNonImpR) / doubleArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Current Runoff Coeficient calculated"
End Sub
```

Sub Res_Area()

```
'calculate area
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit Mode "
Exit Sub
End If
' Find the field named Area
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Area")
If intFldIndex = -1 Then
MsgBox "There must be a field named Area in the Layer "
Exit Sub
End If
' Perform the calculation.
```

```
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.PreExpression = "Dim dblArea as double" & vbNewLine & _
"Set pGeomShp = [shape]" & vbNewLine & _
"Dim pArea as IArea" & vbNewLine & _
"Set pArea = [shape]" & vbNewLine & _
"dblArea = pArea.area"
.Expression = "dblArea"
.Field = "Area"
End With
pCalc.calculate
Set pCursor = Nothing
MsgBox "Area calculated"
Exit Sub
End Sub
```

Sub Res_NonImp_Area()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
```

```
Dim doubleNonImpAFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
pFeature.Value(doubleNonImpAFld) = doubleArea - doubleImpArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Non_Imp Area calculated"
End Sub
```

Sub Res_Imp_pc()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
```

```
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleImpFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAFld As Double
doubleImpFld = pUpdateFeatures.FindField("Imp_pc")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpA = pFeature.Value(doubleImpAFld)
pFeature.Value(doubleImpFld) = doubleImpA / doubleArea * 100
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Impervious Percentage calculated"
End Sub
```

Sub Res_UltimateR()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
```

```
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named Ultimate_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Ultimate_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.7"
.Field = "Ultimate_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Res_NonImp_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named NonImp_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("NonImp_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
```

```
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.3"
.Field = "NonImp_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Res_Current_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleCurrentRFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
Dim doubleNonImpAFld As Double
doubleCurrentRFld = pUpdateFeatures.FindField("Current_R")
```

```
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
doubleNonImpRFld = pUpdateFeatures.FindField("NonImp_R")
doubleUltimateRFld = pUpdateFeatures.FindField("Ultimate_R")
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Dim doubleNonImpR As Double
Dim doubleUltimateR As Double
Dim doubleNonImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
doubleNonImpR = pFeature.Value(doubleNonImpRFld)
doubleUltimateR = pFeature.Value(doubleUltimateRFld)
doubleNonImpA = pFeature.Value(doubleNonImpAFld)
pFeature.Value(doubleCurrentRFld) = (doubleUltimateR * doubleImpArea +
doubleNonImpA * doubleNonImpR) / doubleArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Current Runoff Coeficient calculated"
End Sub
```

Sub Calculate_Rural_Rc()

```
Rural_Area
Rural_NonImp_Area
Rural_Imp_pc
Rural_UltimateR
Rural_NonImp_R
Rural_Current_R
End Sub
```

Sub Rural_Area()

```
'calculate area
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit Mode "
Exit Sub
End If
' Find the field named Area
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Area")
If intFldIndex = -1 Then
MsgBox "There must be a field named Area in the Layer "
Exit Sub
End If
```

```
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.PreExpression = "Dim dblArea as double" & vbNewLine & _
"Set pGeomShp = [shape]" & vbNewLine & _
"Dim pArea as IArea" & vbNewLine & _
"Set pArea = [shape]" & vbNewLine & _
"dblArea = pArea.area"
.Expression = "dblArea"
.Field = "Area"
End With
pCalc.calculate
Set pCursor = Nothing
MsgBox "Area calculated"
Exit Sub
End Sub
```

Sub Rural_NonImp_Area()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
```

```
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleNonImpAFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
pFeature.Value(doubleNonImpAFld) = doubleArea - doubleImpArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Non_Imp Area calculated"
End Sub
```

Sub Rural_Imp_pc()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
```

```
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleImpFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAFld As Double
doubleImpFld = pUpdateFeatures.FindField("Imp_pc")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAFld = pUpdateFeatures.FindField("Imp_Area")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpA = pFeature.Value(doubleImpAFld)
pFeature.Value(doubleImpFld) = doubleImpA / doubleArea * 100
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Impervious Percentage calculated"
End Sub
```

Sub Rural_UltimateR()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named Ultimate_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Ultimate_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.3"
.Field = "Ultimate_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Rural_NonImp_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named NonImp_R
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("NonImp_R")
If intFldIndex = -1 Then
MsgBox "There must be a field named AreaCalc in the layer"
Exit Sub
End If
```

```
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.3"
.Field = "NonImp_R"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Rural_Current_R()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleCurrentRFld As Double
Dim doubleAreaFld As Double
Dim doubleImpAreaFld As Double
Dim doubleNonImpRFld As Double
Dim doubleUltimateRFld As Double
Dim doubleNonImpAFld As Double
```

```
doubleCurrentRFld = pUpdateFeatures.FindField("Current_R")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleImpAreaFld = pUpdateFeatures.FindField("Imp_Area")
doubleNonImpRFld = pUpdateFeatures.FindField("NonImp_R")
doubleUltimateRFld = pUpdateFeatures.FindField("Ultimate_R")
doubleNonImpAFld = pUpdateFeatures.FindField("NonImp_A")
Dim pFeature As IFeature
Dim doubleArea As Double
Dim doubleImpArea As Double
Dim doubleNonImpR As Double
Dim doubleUltimateR As Double
Dim doubleNonImpA As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleArea = pFeature.Value(doubleAreaFld)
doubleImpArea = pFeature.Value(doubleImpAreaFld)
doubleNonImpR = pFeature.Value(doubleNonImpRFld)
doubleUltimateR = pFeature.Value(doubleUltimateRFld)
doubleNonImpA = pFeature.Value(doubleNonImpAFld)
pFeature.Value(doubleCurrentRFld) = (doubleUltimateR * doubleImpArea +
doubleNonImpA * doubleNonImpR) / doubleArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Current Runoff Coeficient calculated"
End Sub
```

Sub MenuCreate_Runoff_C()

```
' Find the MainMenuBar.
Dim pMainMenuBar As ICommandBar
Set pMainMenuBar = Application.Document.CommandBars.Find(ArcID.MainMenu)
' Create the new menu called "Runoff_Coefficient" on the MainMenuBar.
Dim pNewMenu As ICommandBar
Set pNewMenu = pMainMenuBar.CreateMenu("Runoff_Coefficient")
' Add a macro to the new menu.
```

```
pNewMenu.CreateMacroItem "Add_Required_Fields", 46,
"Project.Runoff_coef.add_fields"
pNewMenu.CreateMacroItem "Calculate_Comm_Rc", 23,
"Project.Runoff_coef.Calculate_Comm_Rc"
pNewMenu.CreateMacroItem "Calculate_Ind_Rc", 23,
"Project.Runoff_coef.Calculate_Ind_Rc"
pNewMenu.CreateMacroItem "Calculate_Ospc_Rc", 23,
"Project.Runoff_coef.Calculate_Ospc_Rc"
pNewMenu.CreateMacroItem "Calculate_Quarry_Rc", 23,
"Project.Runoff_coef.Calculate_Quarry_Rc"
pNewMenu.CreateMacroItem "Calculate_Rd_Rc", 23,
"Project.Runoff_coef.Calculate_Rd_Rc"
pNewMenu.CreateMacroItem "Calculate_Res_Rc", 23,
"Project.Runoff_coef.Calculate_Res_Rc"
pNewMenu.CreateMacroItem "Calculate_Rural_Rc", 23,
"Project.Runoff_coef.Calculate_Rural_Rc"
End Sub
```

Annual Runoff Volume codes:

Sub MenuRunoffV()

```
' Find the MainMenuBar.
Dim pMainMenuBar As ICommandBar
Set pMainMenuBar = Application.Document.CommandBars.Find(ArcID.MainMenu)
' Create the new menu called "Annual Runoff Volume" on the MainMenuBar.
Dim pNewMenu As ICommandBar
Set pNewMenu = pMainMenuBar.CreateMenu("Annual Runoff Volume")
' Add a macro to the new menu.
pNewMenu.CreateMacroItem "Add_Required_Fields", 46,
"Project.Annual_Runoff_Volume.Add_f"
pNewMenu.CreateMacroItem "Evap_Factor", 12,
"Project.Annual_Runoff_Volume.calc_Evap_F"
pNewMenu.CreateMacroItem "Runoff_Volume", 13,
"Project.Annual_Runoff_Volume.calc_RunoffV"
pNewMenu.CreateMacroItem "Utimate_Runoff_Volume", 14,
"Project.Annual_Runoff_Volume.calc_Utimate_RunoffV"
End Sub
```

Sub Add_f()

```
add_fields
calc_rain_d
calc_Evap
End Sub
```

Sub add_fields()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
'-- Get the selected layer
Dim pFLayer As IFeatureLayer
Set pFLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
```

```
Set pFc = pFLayer.FeatureClass
Dim pTable As ITable
Dim pField As IField
Dim pFields As IFields
Dim pFieldEdit As IFieldEdit
Dim pFieldsEdit As IFieldsEdit
'Create new Fields collection
Set pFields = New Fields
Set pFieldsEdit = pFields
pFieldsEdit.FieldCount = 5
'Create Rain_D Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "Rain_D"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(0) = pField
pFc.AddField pField
'Create Evap Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "Evap"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(1) = pField
pFc.AddField pField
'Create Evap_f Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "Evap_f"
.Type = esriFieldTypeDouble
End With
```

```
Set pFieldsEdit.Field(2) = pField
pFc.AddField pField
'Create RunoffV Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "RunoffV"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(3) = pField
pFc.AddField pField
'Create F_RunoffV Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "U_RunoffV"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(4) = pField
pFc.AddField pField
MsgBox "Anual Rainfall depth, Evap, Evap factor, Runoff Volume and Ultimate Runoff Volume fields added"
End Sub
```

Sub calc_rain_d()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
' it must be a polygon layer
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
```

```
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named Rain_D
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Rain_D")
If intFldIndex = -1 Then
MsgBox "There must be a field named Rain_D in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "1.127"
.Field = "Rain_D"
End With
pCalc.calculate
Exit Sub
```

```
End Sub
```

Sub calc_Evap()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named Evap
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("Evap")
If intFldIndex = -1 Then
MsgBox "There must be a field named Evap in the layer"
Exit Sub
```

```
End If
' Perform the calculation. Make sure to use an update cursor when
' editing outside of an edit session.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.964"
.Field = "Evap"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub calc_Evap_F()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
' it must be a polygon layer
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleEvap_fFld As Double
Dim doubleEvapFld As Double
Dim doubleImp_pcFld As Double
```

```
doubleEvap_fFld = pUpdateFeatures.FindField("Evap_f")
doubleEvapFld = pUpdateFeatures.FindField("Evap")
doubleImp_pcFld = pUpdateFeatures.FindField("Imp_pc")
Dim pFeature As IFeature
Dim doubleEvap As Double
Dim doubleImp_pc As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleEvap = pFeature.Value(doubleEvapFld)
doubleImp_pc = pFeature.Value(doubleImp_pcFld)
pFeature.Value(doubleEvap_fFld) = ((doubleEvap * doubleImp_pc / 100) * 0.7) +
(doubleEvap * (1 - doubleImp_pc / 100))
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Evapotranspiration/Evaporation factor calculated"
End Sub
```

Sub calc_RunoffV()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
' it must be a polygon layer
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
```

```
Dim doubleRunoffVFld As Double
Dim doubleEvap_fFld As Double
Dim doubleCurrentRFld As Double
Dim doubleAreaFld As Double
doubleRunoffVFld = pUpdateFeatures.FindField("RunoffV")
doubleEvap_fFld = pUpdateFeatures.FindField("Evap_f")
doubleCurrentRFld = pUpdateFeatures.FindField("Current_R")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleRainDFld = pUpdateFeatures.FindField("Rain_D")
Dim pFeature As IFeature
Dim doubleEvap_f As Double
Dim doubleCurrentR As Double
Dim doubleArea As Double
Dim doubleRainD As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleEvap_f = pFeature.Value(doubleEvap_fFld)
doubleCurrentR = pFeature.Value(doubleCurrentRFld)
doubleArea = pFeature.Value(doubleAreaFld)
doubleRainD = pFeature.Value(doubleRainDFld)
pFeature.Value(doubleRunoffVFld) = (doubleRainD - doubleEvap_f) * doubleCurrentR
* doubleArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
MsgBox "Annual Runoff volume calculated"
End Sub
```

Sub calc_Ultimate_RunoffV()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
' it must be a polygon layer
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
```

```
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleURunoffVFld As Double
Dim doubleEvap_fFld As Double
Dim doubleUltimateRFld As Double
Dim doubleAreaFld As Double
doubleURunoffVFld = pUpdateFeatures.FindField("U_RunoffV")
doubleEvap_fFld = pUpdateFeatures.FindField("Evap_f")
doubleUltimateRFld = pUpdateFeatures.FindField("Ultimate_R")
doubleAreaFld = pUpdateFeatures.FindField("Area")
doubleRainDFld = pUpdateFeatures.FindField("Rain_D")
Dim pFeature As IFeature
Dim doubleEvap_f As Double
Dim doubleUltimateR As Double
Dim doubleArea As Double
Dim doubleRainD As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleEvap_f = pFeature.Value(doubleEvap_fFld)
doubleUltimateR = pFeature.Value(doubleUltimateRFld)
doubleArea = pFeature.Value(doubleAreaFld)
doubleRainD = pFeature.Value(doubleRainDFld)
pFeature.Value(doubleFRunoffVFld) = (doubleRainD - doubleEvap_f) *
doubleUltimateR * doubleArea
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
```

```
MsgBox "Ultimate Annual Runoff volume calculated"
End Sub
```

Median contaminant concentration codes:

```
Sub Menu_EMC()
' Find the MainMenuBar.
Dim pMainMenuBar As ICommandBar
Set pMainMenuBar = Application.Document.CommandBars.Find(ArcID.MainMenu)
' Create the new menu called "EMC_fields" on the MainMenuBar.
Dim pNewMenu As ICommandBar
Set pNewMenu = pMainMenuBar.CreateMenu("EMC_fields")
' Add a macro to the new menu.
pNewMenu.CreateMacroItem "EMC_Comm", 29, "Project.EMC.Add_Commfields"
pNewMenu.CreateMacroItem "EMC_Res", 29, "Project.EMC_Res.Add_Resfields"
pNewMenu.CreateMacroItem "EMC_Ospc", 29, "Project.EMC_Ospc.Add_Ospcfields"
pNewMenu.CreateMacroItem "EMC_Ind", 29, "Project.EMC_Ind.Add_Indfields"
pNewMenu.CreateMacroItem "EMC_Rural", 29,
"Project.EMC_Rural.Add_Ruralfields"
pNewMenu.CreateMacroItem "EMC_Road", 29, "Project.EMC_Rd.Add_Rdfields"
pNewMenu.CreateMacroItem "EMC_Quarry", 29, "Project.EMC_Q.Add_Qfields"
End Sub

Sub Add_Comm_fields()
add_fields_comm
Comm_TSS
Comm_BOD
Comm_TPh
Comm_TCo
Comm_TL
Comm_TZ
Comm_TKjN
Comm_TPHy
MsgBox "Median Contaminant Concentration fields added"
End Sub

Sub add_fields_comm()
Dim pDoc As IMxDocument
Dim pMap As IMap
```

```
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
' Get the selected layer
Dim pFLayer As IFeatureLayer
Set pFLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
Set pFc = pFLayer.FeatureClass
Dim pTable As ITable
Dim pField As IField
Dim pFields As IFields
Dim pFieldEdit As IFieldEdit
Dim pFieldsEdit As IFieldsEdit
'Create new Fields collection
Set pFields = New Fields
Set pFieldsEdit = pFields
pFieldsEdit.FieldCount = 8
'Create TSS Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TSS"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(0) = pField
pFc.AddField pField
'Create BOD Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "BOD"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(1) = pField
pFc.AddField pField
'Create TPh Field
```

```
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TPh"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(2) = pField
pFc.AddField pField
'Create TCo Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TCo"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(3) = pField
pFc.AddField pField
'Create TL Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TL"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(4) = pField
pFc.AddField pField
'Create TZ Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TZ"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(5) = pField
pFc.AddField pField
```

```
'Create TKjN Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TKjN"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(6) = pField
pFc.AddField pField
'Create TPHy Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TPHy"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(7) = pField
pFc.AddField pField
End Sub
```

Sub Comm_TSS()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
```

```
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named TSS
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("TSS")
If intFldIndex = -1 Then
MsgBox "There must be a field named TSS in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "55.6"
.Field = "TSS"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Comm_BOD()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
```

```
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named BOD
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("BOD")
If intFldIndex = -1 Then
MsgBox "There must be a field named BOD in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
```

```
With pCalc
Set .Cursor = pCursor
.Expression = "8.7"
.Field = "BOD"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Comm_TPh()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named TPh
Dim pCalc As ICalculator
Dim pTable As ITable
```

```
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("TPh")
If intFldIndex = -1 Then
MsgBox "There must be a field named TPh in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.28"
.Field = "TPh"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Comm_TCo()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
```

```
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named TCo
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("TCo")
If intFldIndex = -1 Then
MsgBox "There must be a field named TCo in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.05"
.Field = "TCo"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Comm_TL()

```
Dim pDoc As IMxDocument
```

```
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named TL
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("TL")
If intFldIndex = -1 Then
MsgBox "There must be a field named TL in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
```

```
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.155"
.Field = "TL"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Comm_TZ()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named TZ
Dim pCalc As ICalculator
```

```
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("TZ")
If intFldIndex = -1 Then
MsgBox "There must be a field named TZ in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "0.278"
.Field = "TZ"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Comm_TKjN()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
```

```
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named TKjN
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("TKjN")
If intFldIndex = -1 Then
MsgBox "There must be a field named TKjN in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "2.45"
.Field = "TKjN"
End With
pCalc.calculate
Exit Sub
End Sub
```

Sub Comm_TPHy()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
' This calculation is to be done outside of an edit session.
Dim pEditor As IEditor
Dim pID As New UID
pID = "esriCore.Editor"
Set pEditor = Application.FindExtensionByCLSID(pID)
If pEditor.EditState = esriStateEditing Then
MsgBox "This sample requires that ArcMap is not in edit mode"
Exit Sub
End If
' Find the field named TPHy
Dim pCalc As ICalculator
Dim pTable As ITable
Dim pField As IField
Dim intFldIndex As Integer
Set pTable = pFeatClass
intFldIndex = pTable.FindField("TPHy")
If intFldIndex = -1 Then
MsgBox "There must be a field named TPHy in the layer"
Exit Sub
End If
' Perform the calculation.
Dim pCursor As ICursor
```

```
Set pCalc = New Calculator
Set pCursor = pFeatClass.Update(Nothing, True)
With pCalc
Set .Cursor = pCursor
.Expression = "1.41"
.Field = "TPHy"
End With
pCalc.calculate
Exit Sub
End Sub
```

Annual Mass Loading Code:

Sub Menu_Mass_Loading()

```
' Find the MainMenuBar.
Dim pMainMenuBar As ICommandBar
Set pMainMenuBar = Application.Document.CommandBars.Find(ArcID.MainMenu)
' Create the new menu called "Mass_Loading" on the MainMenuBar.
Dim pNewMenu As ICommandBar
Set pNewMenu = pMainMenuBar.CreateMenu("Mass_Loading")
' Add a macro to the new menu.
pNewMenu.CreateMacroItem "Add Required Fields", 46,
"Project.Mass_Loading_Add_field.add_fields"
pNewMenu.CreateMacroItem "Mass_Loading", 24,
"Project.Mass_Loading.CalculateML_fields"
pNewMenu.CreateMacroItem "Ultimate_Mass_Loading", 24,
"Project.Ultimate_Mass_Loading.CalculateFML_fields"
End Sub
```

Sub add_fields()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
'-- Get the selected layer
Dim pfLayer As IFeatureLayer
Set pfLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
Set pFc = pfLayer.FeatureClass
Dim pTable As ITable
Dim pField As IField
Dim pFields As IFields
Dim pFieldEdit As IFieldEdit
Dim pFieldsEdit As IFieldsEdit
'Create new Fields collection
Set pFields = New Fields
Set pFieldsEdit = pFields
```

```
pFieldsEdit.FieldCount = 16
'Create ML_TSS Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "ML_TSS"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(0) = pField
pFc.AddField pField
'Create ML_BOD Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "ML_BOD"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(1) = pField
pFc.AddField pField
'Create ML_TPh Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "ML_TPh"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(2) = pField
pFc.AddField pField
'Create ML_TCo Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "ML_TCo"
.Type = esriFieldTypeDouble
End With
```

```
Set pFieldsEdit.Field(3) = pField
pFc.AddField pField
'Create ML_TL Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "ML_TL"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(4) = pField
pFc.AddField pField
'Create ML_TZ Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "ML_TZ"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(5) = pField
pFc.AddField pField
'Create ML_TKjN Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "ML_TKjN"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(6) = pField
pFc.AddField pField
'Create ML_TPHy Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "ML_TPHy"
.Type = esriFieldTypeDouble
```

```
End With
Set pFieldsEdit.Field(7) = pField
pFc.AddField pField
'Create FML_TSS Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "FML_TSS"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(8) = pField
pFc.AddField pField
'Create FML_BOD Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "FML_BOD"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(9) = pField
pFc.AddField pField
'Create FML_TPh Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "FML_TPh"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(10) = pField
pFc.AddField pField
'Create FML_TCo Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "FML_TCo"
```

```
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(11) = pField
pFc.AddField pField
'Create FML_TL Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "FML_TL"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(12) = pField
pFc.AddField pField
'Create FML_TZ Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "FML_TZ"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(13) = pField
pFc.AddField pField
'Create FML_TKjN Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "FML_TKjN"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(14) = pField
pFc.AddField pField
'Create FML_TPHy Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
```

```
.Name = "FML_TPHy"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(15) = pField
pFc.AddField pField
End Sub
```

Sub CalculateML_fields()

```
  ML_TSS
  ML_BOD
  ML_TPh
  ML_TCo
  ML_TL
  ML_TZ
  ML_TKjN
  ML_TPHy
  MsgBox "Annual Contaminat Mass Loading Calculated"
  End Sub
```

Sub ML_TSS()

```
  Dim pDoc As IMxDocument
  Set pDoc = ThisDocument
  ' Get the layer that is selected in the TOC
  Dim pFeatLayer As IFeatureLayer
  Dim pFeatClass As IFeatureClass
  Dim pUnknown As IUnknown
  Set pUnknown = pDoc.SelectedLayer
  If pUnknown Is Nothing Then
    MsgBox "Must have a layer selected in the table of contents."
    Exit Sub
  End If
  Set pFeatLayer = pUnknown
  Set pFeatClass = pFeatLayer.FeatureClass
  Dim pUpdateFeatures As IFeatureCursor
  Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
```

```
Dim doubleML_TSSFld As Double
Dim doubleRunoffVFld As Double
Dim doubleTSSFld As Double
doubleML_TSSFld = pUpdateFeatures.FindField("ML_TSS")
doubleRunoffVFld = pUpdateFeatures.FindField("RunoffV")
doubleTSSFld = pUpdateFeatures.FindField("TSS")
Dim pFeature As IFeature
Dim doubleRunoffV As Double
Dim doubleTSS As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
  doubleRunoffV = pFeature.Value(doubleRunoffVFld)
  doubleTSS = pFeature.Value(doubleTSSFld)
  pFeature.Value(doubleML_TSSFld) = doubleRunoffV * doubleTSS
  pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub ML_BOD()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
  MsgBox "Must have a layer selected in the table of contents."
  Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
```

```
Dim doubleML_TSSAFld As Double
Dim doubleRunoffVFld As Double
Dim doubleTSSFld As Double
doubleML_BODFld = pUpdateFeatures.FindField("ML_BOD")
doubleRunoffVFld = pUpdateFeatures.FindField("RunoffV")
doubleBODFld = pUpdateFeatures.FindField("BOD")
Dim pFeature As IFeature
Dim doubleRunoffV As Double
Dim doubleBOD As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
  doubleRunoffV = pFeature.Value(doubleRunoffVFld)
  doubleBOD = pFeature.Value(doubleBODFld)
  pFeature.Value(doubleML_BODFld) = doubleRunoffV * doubleBOD
  pUpdateFeatures.UpdateFeature pFeature

Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub ML_TPh()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
  MsgBox "Must have a layer selected in the table of contents."
  Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
 Dim pUpdateFeatures As IFeatureCursor
```

```
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
 Dim doubleML_TPhFld As Double
Dim doubleRunoffVFld As Double
Dim doubleTPhFld As Double
doubleML_TPhFld = pUpdateFeatures.FindField("ML_TPh")
doubleRunoffVFld = pUpdateFeatures.FindField("RunoffV")
doubleTPhFld = pUpdateFeatures.FindField("TPh")
Dim pFeature As IFeature
Dim doubleRunoffV As Double
Dim doubleTPh As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
  doubleRunoffV = pFeature.Value(doubleRunoffVFld)
  doubleTPh = pFeature.Value(doubleTPhFld)
  pFeature.Value(doubleML_TPhFld) = doubleRunoffV * doubleTPh
  pUpdateFeatures.UpdateFeature pFeature
   Set pFeature = pUpdateFeatures.NextFeature
Loop
  End Sub
```

Sub ML_TCo()

```
   Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
  MsgBox "Must have a layer selected in the table of contents."
  Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
```

```
 Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
 Dim doubleML_TCoFld As Double
Dim doubleRunoffVFld As Double
Dim doubleTCoFld As Double
'Dim doubleCtch_AreaFld As Double
 doubleML_TCoFld = pUpdateFeatures.FindField("ML_TCo")
doubleRunoffVFld = pUpdateFeatures.FindField("RunoffV")
doubleTCoFld = pUpdateFeatures.FindField("TCo")
 Dim pFeature As IFeature
Dim doubleRunoffV As Double
Dim doubleTCo As Double
'Dim doubleCtch_Area As Double
 Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
  doubleRunoffV = pFeature.Value(doubleRunoffVFld)
  doubleTCo = pFeature.Value(doubleTCoFld)
  pFeature.Value(doubleML_TCoFld) = doubleRunoffV * doubleTCo
  pUpdateFeatures.UpdateFeature pFeature
   Set pFeature = pUpdateFeatures.NextFeature
Loop
  End Sub
```

Sub ML_TL()

```
   Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
  MsgBox "Must have a layer selected in the table of contents."
  Exit Sub
End If
```

```
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
 Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
 Dim doubleML_TLFld As Double
Dim doubleRunoffVFld As Double
Dim doubleTLFld As Double
'Dim doubleCtch_AreaFld As Double
 doubleML_TLFld = pUpdateFeatures.FindField("ML_TL")
doubleRunoffVFld = pUpdateFeatures.FindField("RunoffV")
doubleTLFld = pUpdateFeatures.FindField("TL")
'doubleCtch_AreaFld = pUpdateFeatures.FindField("Ctch_Area")
 Dim pFeature As IFeature
Dim doubleRunoffV As Double
Dim doubleTL As Double
'Dim doubleCtch_Area As Double
 Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
  doubleRunoffV = pFeature.Value(doubleRunoffVFld)
  doubleTL = pFeature.Value(doubleTLFld)
  'doubleCtch_Area = pFeature.Value(doubleCtch_AreaFld)
  pFeature.Value(doubleML_TLFld) = doubleRunoffV * doubleTL
  pUpdateFeatures.UpdateFeature pFeature
   Set pFeature = pUpdateFeatures.NextFeature
Loop
   End Sub
```

Sub ML_TZ()

```
   Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
```

```
If pUnknown Is Nothing Then
  MsgBox "Must have a layer selected in the table of contents."
  Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
 Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
 Dim doubleML_TZFld As Double
Dim doubleRunoffVFld As Double
Dim doubleTZFld As Double
'Dim doubleCtch_AreaFld As Double
 doubleML_TZFld = pUpdateFeatures.FindField("ML_TZ")
doubleRunoffVFld = pUpdateFeatures.FindField("RunoffV")
doubleTZFld = pUpdateFeatures.FindField("TZ")
'doubleCtch_AreaFld = pUpdateFeatures.FindField("Ctch_Area")
 Dim pFeature As IFeature
Dim doubleRunoffV As Double
Dim doubleTZ As Double
'Dim doubleCtch_Area As Double
 Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
  doubleRunoffV = pFeature.Value(doubleRunoffVFld)
  doubleTZ = pFeature.Value(doubleTZFld)
  'doubleCtch_Area = pFeature.Value(doubleCtch_AreaFld)
  pFeature.Value(doubleML_TZFld) = doubleRunoffV * doubleTZ
  pUpdateFeatures.UpdateFeature pFeature
    Set pFeature = pUpdateFeatures.NextFeature
Loop
   End Sub
```

Sub ML_TKjN()

```
   Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
```

```
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
  MsgBox "Must have a layer selected in the table of contents."
  Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
 Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
 Dim doubleML_TKjNFld As Double
Dim doubleRunoffVFld As Double
Dim doubleTKjNFld As Double
'Dim doubleCtch_AreaFld As Double
 doubleML_TKjNFld = pUpdateFeatures.FindField("ML_TKjN")
doubleRunoffVFld = pUpdateFeatures.FindField("RunoffV")
doubleTKjNFld = pUpdateFeatures.FindField("TKjN")
'doubleCtch_AreaFld = pUpdateFeatures.FindField("Ctch_Area")
 Dim pFeature As IFeature
Dim doubleRunoffV As Double
Dim doubleTKjN As Double
'Dim doubleCtch_Area As Double
 Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
  doubleRunoffV = pFeature.Value(doubleRunoffVFld)
  doubleTKjN = pFeature.Value(doubleTKjNFld)
  'doubleCtch_Area = pFeature.Value(doubleCtch_AreaFld)
  pFeature.Value(doubleML_TKjNFld) = doubleRunoffV * doubleTKjN
  pUpdateFeatures.UpdateFeature pFeature
   Set pFeature = pUpdateFeatures.NextFeature
Loop
 End Sub
```

Sub ML_TPHy()

```
 Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
  MsgBox "Must have a layer selected in the table of contents."
  Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
 Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
 Dim doubleML_TPHyFld As Double
Dim doubleRunoffVFld As Double
Dim doubleTPHyFld As Double
'Dim doubleCtch_AreaFld As Double
 doubleML_TPHyFld = pUpdateFeatures.FindField("ML_TPHy")
doubleRunoffVFld = pUpdateFeatures.FindField("RunoffV")
doubleTPHyFld = pUpdateFeatures.FindField("TPHy")
'doubleCtch_AreaFld = pUpdateFeatures.FindField("Ctch_Area")
 Dim pFeature As IFeature
Dim doubleRunoffV As Double
Dim doubleTPHy As Double
'Dim doubleCtch_Area As Double
 Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
  doubleRunoffV = pFeature.Value(doubleRunoffVFld)
  doubleTPHy = pFeature.Value(doubleTPHyFld)
  'doubleCtch_Area = pFeature.Value(doubleCtch_AreaFld)
  pFeature.Value(doubleML_TPHyFld) = doubleRunoffV * doubleTPHy
  pUpdateFeatures.UpdateFeature pFeature
```

```
   Set pFeature = pUpdateFeatures.NextFeature
 Loop
  End Sub
```

Sub CalculateFML_fields()

```
FML_TSS
FML_BOD
FML_TPh
FML_TCo
FML_TL
FML_TZ
FML_TKjN
FML_TPHy
MsgBox "Ultimate Annual Contaminat Mass Loading Calculated"
End Sub
```

Sub FML_TSS()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleFML_TSSFld As Double
Dim doubleF_RunoffVFld As Double
Dim doubleTSSFld As Double
```

```
doubleFML_TSSFld = pUpdateFeatures.FindField("FML_TSS")
doubleF_RunoffVFld = pUpdateFeatures.FindField("F_RunoffV")
doubleTSSFld = pUpdateFeatures.FindField("TSS")
Dim pFeature As IFeature
Dim doubleF_RunoffV As Double
Dim doubleTSS As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleF_RunoffV = pFeature.Value(doubleF_RunoffVFld)
doubleTSS = pFeature.Value(doubleTSSFld)
pFeature.Value(doubleFML_TSSFld) = doubleF_RunoffV * doubleTSS
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub FML_BOD()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleFML_BODFld As Double
Dim doubleF_RunoffVFld As Double
Dim doubleBODFld As Double
```

```
doubleFML_BODFld = pUpdateFeatures.FindField("FML_BOD")
doubleF_RunoffVFld = pUpdateFeatures.FindField("F_RunoffV")
doubleBODFld = pUpdateFeatures.FindField("BOD")
Dim pFeature As IFeature
Dim doubleF_RunoffV As Double
Dim doubleBOD As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleF_RunoffV = pFeature.Value(doubleF_RunoffVFld)
doubleBOD = pFeature.Value(doubleBODFld)
pFeature.Value(doubleFML_BODFld) = doubleF_RunoffV * doubleBOD
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub FML_TPh()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleFML_TPhFld As Double
Dim doubleF_RunoffVFld As Double
Dim doubleTPhFld As Double
```

```
doubleFML_TPhFld = pUpdateFeatures.FindField("FML_TPh")
doubleF_RunoffVFld = pUpdateFeatures.FindField("F_RunoffV")
doubleTPhFld = pUpdateFeatures.FindField("TPh")
Dim pFeature As IFeature
Dim doubleF_RunoffV As Double
Dim doubleTPh As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleF_RunoffV = pFeature.Value(doubleF_RunoffVFld)
doubleTPh = pFeature.Value(doubleTPhFld)
pFeature.Value(doubleFML_TPhFld) = doubleF_RunoffV * doubleTPh
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub FML_TCo()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleFML_TCoFld As Double
Dim doubleF_RunoffVFld As Double
Dim doubleTCoFld As Double
```

```
'Dim doubleCtch_AreaFld As Double
doubleFML_TCoFld = pUpdateFeatures.FindField("FML_TCo")
doubleF_RunoffVFld = pUpdateFeatures.FindField("F_RunoffV")
doubleTCoFld = pUpdateFeatures.FindField("TCo")
Dim pFeature As IFeature
Dim doubleF_RunoffV As Double
Dim doubleTCo As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleF_RunoffV = pFeature.Value(doubleF_RunoffVFld)
doubleTCo = pFeature.Value(doubleTCoFld)
pFeature.Value(doubleFML_TCoFld) = doubleF_RunoffV * doubleTCo
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub FML_TL()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleFML_TLFld As Double
Dim doubleF_RunoffVFld As Double
```

```
Dim doubleTLFld As Double
doubleFML_TLFld = pUpdateFeatures.FindField("FML_TL")
doubleF_RunoffVFld = pUpdateFeatures.FindField("F_RunoffV")
doubleTLFld = pUpdateFeatures.FindField("TL")
Dim pFeature As IFeature
Dim doubleF_RunoffV As Double
Dim doubleTL As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleF_RunoffV = pFeature.Value(doubleF_RunoffVFld)
doubleTL = pFeature.Value(doubleTLFld)
pFeature.Value(doubleFML_TLFld) = doubleF_RunoffV * doubleTL
pUpdateFeatures.UpdateFeature pFeature

Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub FML_TZ()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleFML_TZFld As Double
```

```
Dim doubleF_RunoffVFld As Double
Dim doubleTZFld As Double
doubleFML_TZFld = pUpdateFeatures.FindField("FML_TZ")
doubleF_RunoffVFld = pUpdateFeatures.FindField("F_RunoffV")
doubleTZFld = pUpdateFeatures.FindField("TZ")
Dim pFeature As IFeature
Dim doubleF_RunoffV As Double
Dim doubleTZ As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleF_RunoffV = pFeature.Value(doubleF_RunoffVFld)
doubleTZ = pFeature.Value(doubleTZFld)
pFeature.Value(doubleFML_TZFld) = doubleF_RunoffV * doubleTZ
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub FML_TKjN()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleFML_TKjNFld As Double
```

```
Dim doubleF_RunoffVFld As Double
Dim doubleTKjNFld As Double
doubleFML_TKjNFld = pUpdateFeatures.FindField("FML_TKjN")
doubleF_RunoffVFld = pUpdateFeatures.FindField("F_RunoffV")
doubleTKjNFld = pUpdateFeatures.FindField("TKjN")
Dim pFeature As IFeature
Dim doubleF_RunoffV As Double
Dim doubleTKjN As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleF_RunoffV = pFeature.Value(doubleF_RunoffVFld)
doubleTKjN = pFeature.Value(doubleTKjNFld)
pFeature.Value(doubleFML_TKjNFld) = doubleF_RunoffV * doubleTKjN
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub FML_TPHy()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleFML_TPHyFld As Double
```

```
Dim doubleF_RunoffVFld As Double
Dim doubleTPHyFld As Double
doubleFML_TPHyFld = pUpdateFeatures.FindField("FML_TPHy")
doubleF_RunoffVFld = pUpdateFeatures.FindField("F_RunoffV")
doubleTPHyFld = pUpdateFeatures.FindField("TPHy")
Dim pFeature As IFeature
Dim doubleF_RunoffV As Double
Dim doubleTPHy As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleF_RunoffV = pFeature.Value(doubleF_RunoffVFld)
doubleTPHy = pFeature.Value(doubleTPHyFld)
pFeature.Value(doubleFML_TPHyFld) = doubleF_RunoffV * doubleTPHy
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sum Mass Loading Code

Sub MenuSum_Mass_Loading()

```
' Find the MainMenuBar.
Dim pMainMenuBar As ICommandBar
Set pMainMenuBar = Application.Document.CommandBars.Find(ArcID.MainMenu)
' Create the new menu called "Sum_Mass_Loading" on the MainMenuBar.
Dim pNewMenu As ICommandBar
Set pNewMenu = pMainMenuBar.CreateMenu("Sum_Mass_Loading")
' Add a macro to the new menu.
pNewMenu.CreateMacroItem "Merge_Layers", 31,
"Project.Merge.GetLayerByNameandmerge"
pNewMenu.CreateMacroItem "Mass_Loading_Sum", 31,
"Project.Mass_Loading_Sum.Sum"
pNewMenu.CreateMacroItem "Ultimate_Mass_Loading_Sum", 31,
"Project.Ultimate_Mass_Loading_Sum.Ultimate_Sum"
pNewMenu.CreateMacroItem "Add_Current_Fields", 38,
"Project.Add_kg_ha_yr_fields_current.Add_kg_ha_yr_current"
pNewMenu.CreateMacroItem "Add_Ultimate_Fields", 38,
"Project.Add_kg_ha_yr_fields_ultimate.Add_kg_ha_yr_ultimate"
pNewMenu.CreateMacroItem "Current_kg_ha_yr", 39,
"Project.Mass_Loading_current_kg_ha_yr.Current_kg_ha_yr"
pNewMenu.CreateMacroItem "Ultimate_kg_ha_yr", 39,
"Project.Mass_Loading_ultimate_kg_ha_yr.Ultimate_kg_ha_yr"
End Sub
```

Sub GetLayerByNameandmerge()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get all the layers in the Map
Dim pEnumLayer As IEnumLayer
Set pEnumLayer = pDoc.FocusMap.Layers
' Loop through all the layers
Dim pfLayer As ILayer
Set pfLayer = pEnumLayer.Next
```

```
Do Until pfLayer Is Nothing
If pfLayer.Name = "Commercial" Then
Exit Do
End If
Set pfLayer = pEnumLayer.Next
Loop
' Loop through all the layers
Dim psLayer As ILayer
Set psLayer = pEnumLayer.Next
Do Until psLayer Is Nothing
If psLayer.Name = "Industry" Then
Exit Do
End If
Set psLayer = pEnumLayer.Next
Loop
' Loop through all the layers
Dim ptLayer As ILayer
Set ptLayer = pEnumLayer.Next
Do Until ptLayer Is Nothing
If ptLayer.Name = "Quarry_Zone" Then
Exit Do
End If
Set ptLayer = pEnumLayer.Next
Loop
' Loop through all the layers
Dim pftLayer As ILayer
Set pftLayer = pEnumLayer.Next
Do Until pftLayer Is Nothing
If pftLayer.Name = "Open_Space" Then
Exit Do
End If
Set pftLayer = pEnumLayer.Next
Loop
' Loop through all the layers
Dim pffLayer As ILayer
```

```
Set pffLayer = pEnumLayer.Next
Do Until pffLayer Is Nothing
If pffLayer.Name = "Residential" Then
Exit Do
End If
Set pffLayer = pEnumLayer.Next
Loop
' Loop through all the layers
Dim psxLayer As ILayer
Set psxLayer = pEnumLayer.Next
Do Until psxLayer Is Nothing
If psxLayer.Name = "Road" Then
Exit Do
End If
Set psxLayer = pEnumLayer.Next
Loop
' Loop through all the layers
Dim psvLayer As ILayer
Set psvLayer = pEnumLayer.Next
Do Until psvLayer Is Nothing
If psvLayer.Name = "Rural" Then
Exit Do
End If
Set psvLayer = pEnumLayer.Next
Loop
Dim pFeatLayer As IFeatureLayer
Set pFeatLayer = pfLayer
Dim pFirstFeatClass As IFeatureClass
Set pFirstFeatClass = pFeatLayer.FeatureClass
' Get the first layer's table
Dim pFirstTable As ITable
Set pFirstTable = pfLayer
' Get the second layer and its table
'Set pLayer = pMxDoc.FocusMap.Layer(1)
Dim pSecondTable As ITable
```

```
Set pSecondTable = psLayer
Dim pThirdTable As ITable
Set pThirdTable = ptLayer
Dim pFourTable As ITable
Set pFourTable = pftLayer
Dim pFiveTable As ITable
Set pFiveTable = pffLayer
Dim pSixTable As ITable
Set pSixTable = psxLayer
Dim pSevenTable As ITable
Set pSevenTable = psvLayer
' Error checking
If pFirstTable Is Nothing Then
MsgBox "Table1 QI failed"
Exit Sub
End If
If pSecondTable Is Nothing Then
MsgBox "Table2 QI failed"
Exit Sub
End If
If pThirdTable Is Nothing Then
MsgBox "Table3 QI failed"
Exit Sub
End If
If pFourTable Is Nothing Then
MsgBox "Table4 QI failed"
Exit Sub
End If
If pFiveTable Is Nothing Then
MsgBox "Table5 QI failed"
Exit Sub
End If
If pSixTable Is Nothing Then
MsgBox "Table6 QI failed"
Exit Sub
```

```
End If
If pSevenTable Is Nothing Then
MsgBox "Table7 QI failed"
Exit Sub
End If
' Define the output feature class name and shape type
Dim pFeatClassName As IFeatureClassName
Set pFeatClassName = New FeatureClassName
With pFeatClassName
.FeatureType = esriFTSimple
.ShapeFieldName = "Shape"
.ShapeType = pFirstFeatClass.ShapeType
End With
' Set the output location and feature class name
Dim pNewWSName As IWorkspaceName
Set pNewWSName = New WorkspaceName
With pNewWSName
.WorkspaceFactoryProgID = "esriCore.ShapefileWorkspaceFactory.1"
.PathName = "C:\Puhinui\Puhinui_Stream"
End With
Dim pDatasetName As IDatasetName
Set pDatasetName = pFeatClassName
pDatasetName.Name = "Puhinui_Stream_Mass_Loading"
Set pDatasetName.WorkspaceName = pNewWSName
' Build the input set/array - these are the layers to be merged
Dim inputArray As IArray
Set inputArray = New esriCore.Array
inputArray.Add pFirstTable
inputArray.Add pSecondTable
inputArray.Add pThirdTable
inputArray.Add pFourTable
inputArray.Add pFiveTable
inputArray.Add pSixTable
inputArray.Add pSevenTable
' Perform the merge
```

```
Dim pBGP As IBasicGeoprocessor
Set pBGP = New BasicGeoprocessor
Dim pOutputFeatClass As IFeatureClass
Set pOutputFeatClass = pBGP.merge(inputArray, pFirstTable, pFeatClassName)
' Add the output to the map
Dim pOutputFeatLayer As IFeatureLayer
Set pOutputFeatLayer = New FeatureLayer
Set pOutputFeatLayer.FeatureClass = pOutputFeatClass
pOutputFeatLayer.Name = pOutputFeatClass.AliasName
pDoc.FocusMap.AddLayer pOutputFeatLayer
End Sub
```

Public Sub Sum()

```
add_field
calculate_field
CreateSummaryTable
AddShapeFile
MsgBox "Summary Mass Loading Layer Created"
End Sub
```

Sub add_field()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
Dim pMap As IMap
Set pMap = pDoc.FocusMap
'Find the layer named Puhinui_Stream_Mass_Loading
Dim pLayer As ILayer
Dim pFeatLayer As IFeatureLayer
Dim intCount As Integer
For intCount = 0 To pMap.LayerCount - 1
Set pLayer = pMap.Layer(intCount)
If TypeOf pLayer Is IFeatureLayer Then
If pLayer.Name = "Puhinui_Stream_Mass_Loading" Then
Set pFeatLayer = pLayer
Exit For
```

```
End If
End If
Next
If pFeatLayer Is Nothing Then
MsgBox "The Puhinui_Stream_Mass_Loading layer was not found"
Exit Sub
End If
Dim pFc As IFeatureClass
Set pFc = pFeatLayer.FeatureClass
Dim pField As IField
Set pField = New Field
Dim pFieldEdit As IFieldEdit
Set pFieldEdit = pField
With pFieldEdit
.Name = "Ctch"
.Type = esriFieldTypeString
.Length = 20
End With
pFc.AddField pField
End Sub

Sub calculate_field()
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
Dim pMap As IMap
Set pMap = pDoc.FocusMap
'Find the layer named Puhinui_Stream_Mass_Loading
Dim pLayer As ILayer
Dim pFeatLayer As IFeatureLayer
Dim intCount As Integer
For intCount = 0 To pMap.LayerCount - 1
Set pLayer = pMap.Layer(intCount)
If TypeOf pLayer Is IFeatureLayer Then
If pLayer.Name = "Puhinui_Stream_Mass_Loading" Then
Set pFeatLayer = pLayer
```

```
Exit For
End If
End If
Next
If pFeatLayer Is Nothing Then
MsgBox "The Puhinui_Stream_Mass_Loading layer was not found"
Exit Sub
End If
Dim pFeatClass As IFeatureClass
Set pFeatLayer = pLayer
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim txtCtchRFld As String
txtCtchRFld = pUpdateFeatures.FindField("Ctch")
Dim pFeature As IFeature
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
pFeature.Value(txtCtchRFld) = "Puhinui_Stream"
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Public Sub CreateSummaryTable()

```
On Error GoTo EH
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
Dim pMap As IMap
Set pMap = pDoc.FocusMap
'Find the layer named Puhinui_Stream_Mass_Loading
Dim pLayer As ILayer
Dim pFeatLayer As IFeatureLayer
Dim intCount As Integer
For intCount = 0 To pMap.LayerCount - 1
```

```
Set pLayer = pMap.Layer(intCount)
If TypeOf pLayer Is IFeatureLayer Then
If pLayer.Name = "Puhinui_Stream_Mass_Loading" Then
Set pFeatLayer = pLayer
Exit For
End If
End If
Next
If pFeatLayer Is Nothing Then
MsgBox "The Puhinui_Stream_Mass_Loading layer was not found"
Exit Sub
End If
' Get the workspace of the Puhinui_Stream_Mass_Loading layer
Dim pFeatClass As IFeatureClass
Dim pTable As ITable
Dim pDataSet As IDataset
Dim pWkSpDS As IDataset
Dim pWkSpName As IName
Set pFeatClass = pFeatLayer.FeatureClass
Set pTable = pFeatClass
Set pDataSet = pTable
Set pWkSpDS = pDataSet.Workspace
Set pWkSpName = pWkSpDS.FullName
' Set up the output table
Dim pOutTabName As ITableName
Dim pOutDatasetName As IDatasetName
Set pOutTabName = New TableName
Set pOutDatasetName = pOutTabName
pOutDatasetName.Name = "Sum_Puhinui_Stream_Mass_Loading"
Set pOutDatasetName.WorkspaceName = pWkSpName
' Make sure there is a field called Ctch in the layer
If pTable.FindField("Ctch") = -1 Then
MsgBox "There must be a field named Ctch in Sum_Puhinui_Stream_Mass_Loading"
Exit Sub
End If
```

```
' Perform the summarize.
Dim pGeoProc As IBasicGeoprocessor
Dim pSumTable As ITable
Set pGeoProc = New BasicGeoprocessor
Set pSumTable = pGeoProc.Dissolve(pTable, False, "Ctch", _
"Minimum.Ctch, Dissolve.Shape, Minimum.Ctch_Area, Sum.ML_TSS, Sum.ML_BOD, Sum.ML_TPh," & _
"Sum.ML_TCo, Sum.ML_TL, Sum.ML_TZ, Sum.ML_TKjN, Sum.ML_TPHy, Sum.ML_Ecol, Sum.ML_Entrc, Sum.ML_FCol", _
pOutDatasetName)
' add the table to map
Dim pStTab As IStandaloneTable
Set pStTab = New StandaloneTable
Set pStTab.Table = pSumTable
Dim pStTabColl As IStandaloneTableCollection
Set pStTabColl = pMap
pStTabColl.AddStandaloneTable pStTab
' Refresh the TOC
pDoc.UpdateContents
Exit Sub
EH:
MsgBox Err.Number & " " & Err.Description
End Sub
```

Public Sub AddShapeFile()

```
Dim pWorkspaceFactory As IWorkspaceFactory
Dim pFeatureWorkspace As IFeatureWorkspace
Dim pFeatureLayer As IFeatureLayer
Dim pMxDocument As IMxDocument
Dim pMap As IMap
'Create a new ShapefileWorkspaceFactory object and open a shapefile folder
Set pWorkspaceFactory = New ShapefileWorkspaceFactory
Set pFeatureWorkspace =
pWorkspaceFactory.OpenFromFile("c:\Puhinui\Puhinui_Stream", 0)
'Create a new FeatureLayer and assign a shapefile to it
```

```
Set pFeatureLayer = New FeatureLayer
Set pFeatureLayer.FeatureClass =
pFeatureWorkspace.OpenFeatureClass("Sum_Puhinui_Stream_Mass_Loading")
pFeatureLayer.Name = pFeatureLayer.FeatureClass.AliasName
'Add the FeatureLayer to the focus map
Set pMxDocument = Application.Document
Set pMap = pMxDocument.FocusMap
pMap.AddLayer pFeatureLayer
' Refresh the TOC
pMxDocument.UpdateContents
End Sub
```

Public Sub Ultimate_Sum()

```
CreateSummaryTable
AddShapeFile
MsgBox "Summary Ultimate Mass Loading Layer Created"
End Sub
Public Sub CreateSummaryTable()
On Error GoTo EH
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
Dim pMap As IMap
Set pMap = pDoc.FocusMap
'Find the layer named Puhinui_Stream_Mass_Loading
Dim pLayer As ILayer
Dim pFeatLayer As IFeatureLayer
Dim intCount As Integer
For intCount = 0 To pMap.LayerCount - 1
Set pLayer = pMap.Layer(intCount)
If TypeOf pLayer Is IFeatureLayer Then
If pLayer.Name = "Puhinui_Stream_Mass_Loading" Then
Set pFeatLayer = pLayer
Exit For
End If
End If
```

```
Next
If pFeatLayer Is Nothing Then
MsgBox "The Puhinui_Stream_Mass_Loading layer was not found"
Exit Sub
End If
' Get the workspace of the Puhinui_Stream_Mass_Loading layer
Dim pFeatClass As IFeatureClass
Dim pTable As ITable
Dim pDataSet As IDataset
Dim pWkSpDS As IDataset
Dim pWkSpName As IName
Set pFeatClass = pFeatLayer.FeatureClass
Set pTable = pFeatClass
Set pDataSet = pTable
Set pWkSpDS = pDataSet.Workspace
Set pWkSpName = pWkSpDS.FullName
' Set up the output table
Dim pOutTabName As ITableName
Dim pOutDatasetName As IDatasetName
Set pOutTabName = New TableName
Set pOutDatasetName = pOutTabName
pOutDatasetName.Name = "Sum_F_Puhinui_Stream_Mass_Loading"
Set pOutDatasetName.WorkspaceName = pWkSpName
' Make sure there is a field called Ctch in the layer
If pTable.FindField("Ctch") = -1 Then
MsgBox "There must be a field named Ctch in
Sum_F_Puhinui_Stream_Mass_Loading"
Exit Sub
End If
' Perform the summarize.
Dim pGeoProc As IBasicGeoprocessor
Dim pSumTable As ITable
Set pGeoProc = New BasicGeoprocessor
Set pSumTable = pGeoProc.Dissolve(pTable, False, "Ctch", _
```

```
"Minimum.Ctch, Dissolve.Shape, Minimum.Ctch_Area, Sum.FML_TSS, Sum.FML_BOD, Sum.FML_TPh," & _
"Sum.FML_TCo, Sum.FML_TL, Sum.FML_TZ, Sum.FML_TKjN, Sum.FML_TPHy, Sum.FML_Ecol, Sum.FML_Entrc, Sum.FML_FCol", _
pOutDatasetName)
' add the table to map
Dim pStTab As IStandaloneTable
Set pStTab = New StandaloneTable
Set pStTab.Table = pSumTable
Dim pStTabColl As IStandaloneTableCollection
Set pStTabColl = pMap
pStTabColl.AddStandaloneTable pStTab
' Refresh the TOC
pDoc.UpdateContents
Exit Sub
EH:
MsgBox Err.Number & " " & Err.Description
End Sub
```

Public Sub AddShapeFile()

```
Dim pWorkspaceFactory As IWorkspaceFactory
Dim pFeatureWorkspace As IFeatureWorkspace
Dim pFeatureLayer As IFeatureLayer
Dim pMxDocument As IMxDocument
Dim pMap As IMap
'Create a new ShapefileWorkspaceFactory object and open a shapefile folder
Set pWorkspaceFactory = New ShapefileWorkspaceFactory
Set pFeatureWorkspace = pWorkspaceFactory.OpenFromFile("c:\Puhinui\Puhinui_Stream", 0)
'Create a new FeatureLayer and assign a shapefile to it
Set pFeatureLayer = New FeatureLayer
Set pFeatureLayer.FeatureClass = pFeatureWorkspace.OpenFeatureClass("Sum_F_Puhinui_Stream_Mass_Loading")
pFeatureLayer.Name = pFeatureLayer.FeatureClass.AliasName
'Add the FeatureLayer to the focus map
```

```
Set pMxDocument = Application.Document
Set pMap = pMxDocument.FocusMap
pMap.AddLayer pFeatureLayer
' Refresh the TOC
pMxDocument.UpdateContents
End Sub
```

Sub Add_kg_ha_yr_current()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
'-- Get the selected layer
Dim pfLayer As IFeatureLayer
Set pfLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
Set pFc = pfLayer.FeatureClass
Dim pTable As ITable
Dim pField As IField
Dim pFields As IFields
Dim pFieldEdit As IFieldEdit
Dim pFieldsEdit As IFieldsEdit
'Create new Fields collection
Set pFields = New Fields
Set pFieldsEdit = pFields
pFieldsEdit.FieldCount = 8
'Create TSS Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TSS_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(0) = pField
pFc.AddField pField
```

```
'Create BOD Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "BOD_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(1) = pField
pFc.AddField pField
'Create TPh Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TPh_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(2) = pField
pFc.AddField pField
'Create TCo Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TCo_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(3) = pField
pFc.AddField pField
'Create TL Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TL_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(4) = pField
```

```
pFc.AddField pField
'Create TZ Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TZ_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(5) = pField
pFc.AddField pField
'Create TKjN Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TKjN_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(6) = pField
pFc.AddField pField
'Create TPHy Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TPHy_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(7) = pField
pFc.AddField pField
```

Sub Add_kg_ha_yr_ultimate()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
'-- Get the selected layer
```

```
Dim pfLayer As IFeatureLayer
Set pfLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
Set pFc = pfLayer.FeatureClass
Dim pTable As ITable
Dim pField As IField
Dim pFields As IFields
Dim pFieldEdit As IFieldEdit
Dim pFieldsEdit As IFieldsEdit
'Create new Fields collection
Set pFields = New Fields
Set pFieldsEdit = pFields
pFieldsEdit.FieldCount = 8
'Create UTSS_kg Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTSS_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(0) = pField
pFc.AddField pField
'Create UBOD_kg Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UBOD_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(1) = pField
pFc.AddField pField
'Create UTPh_kg Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
```

```
.Name = "UTPh_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(2) = pField
pFc.AddField pField
'Create UTCo_kg Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTCo_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(3) = pField
pFc.AddField pField
'Create UTL_kg Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTL_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(4) = pField
pFc.AddField pField

'Create UTZ_kg Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTZ_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(5) = pField
pFc.AddField pField
'Create UTKjN_kg Field
Set pField = New Field
```

```
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTKjN_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(6) = pField
pFc.AddField pField
'Create UTPHy_kg Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTPHy_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(7) = pField
pFc.AddField pField
End Sub
```

Public Sub Current_kg_ha_yr()

```
Calc_TSS_kg
Calc_BOD_kg
Calc_TPh_kg
Calc_TCo_kg
Calc_TL_kg
Calc_TZ_kg
Calc_TKjN_kg
Calc_TPHy_kg
MsgBox "Current fields calculated"
End Sub
```

Sub Calc_TSS_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
```

```
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTSS_kgFld As Double
Dim doubleSum_ML_TSSFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_ML_TSSFld = pUpdateFeatures.FindField("Sum_ML_TSS")
doubleTSS_kgFld = pUpdateFeatures.FindField("TSS_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_ML_TSS As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_ML_TSS = pFeature.Value(doubleSum_ML_TSSFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleTSS_kgFld) = (doubleSum_ML_TSS / doubleMin_Ctch_A) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_BOD_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
```

```
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleBOD_kgFld As Double
Dim doubleSum_ML_BODFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_ML_BODFld = pUpdateFeatures.FindField("Sum_ML_BOD")
doubleBOD_kgFld = pUpdateFeatures.FindField("BOD_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_ML_BOD As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_ML_BOD = pFeature.Value(doubleSum_ML_BODFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleBOD_kgFld) = (doubleSum_ML_BOD / doubleMin_Ctch_A) *
10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TPh_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
```

```
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTPh_kgFld As Double
Dim doubleSum_ML_TPhFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_ML_TPhFld = pUpdateFeatures.FindField("Sum_ML_TPh")
doubleTPh_kgFld = pUpdateFeatures.FindField("TPh_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_ML_TPh As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_ML_TPh = pFeature.Value(doubleSum_ML_TPhFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleTPh_kgFld) = (doubleSum_ML_TPh / doubleMin_Ctch_A) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TCo_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
```

```
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTCo_kgFld As Double
Dim doubleSum_ML_TCoFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_ML_TCoFld = pUpdateFeatures.FindField("Sum_ML_TCo")
doubleTCo_kgFld = pUpdateFeatures.FindField("TCo_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_ML_TCo As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_ML_TCo = pFeature.Value(doubleSum_ML_TCoFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleTCo_kgFld) = (doubleSum_ML_TCo / doubleMin_Ctch_A) *
10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TL_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
```

```
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTL_kgFld As Double
Dim doubleSum_ML_TLFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_ML_TLFld = pUpdateFeatures.FindField("Sum_ML_TL")
doubleTL_kgFld = pUpdateFeatures.FindField("TL_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_ML_TL As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_ML_TL = pFeature.Value(doubleSum_ML_TLFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleTL_kgFld) = (doubleSum_ML_TL / doubleMin_Ctch_A) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TZ_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
```

```
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTZ_kgFld As Double
Dim doubleSum_ML_TZFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_ML_TZFld = pUpdateFeatures.FindField("Sum_ML_TZ")
doubleTZ_kgFld = pUpdateFeatures.FindField("TZ_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_ML_TZ As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_ML_TZ = pFeature.Value(doubleSum_ML_TZFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleTZ_kgFld) = (doubleSum_ML_TZ / doubleMin_Ctch_A) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TKjN_kg()

```
Dim pDoc As IMxDocument
```

```
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTKjN_kgFld As Double
Dim doubleSum_ML_TKjFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_ML_TKjFld = pUpdateFeatures.FindField("Sum_ML_TKj")
doubleTKjN_kgFld = pUpdateFeatures.FindField("TKjN_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_ML_TKj As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_ML_TKj = pFeature.Value(doubleSum_ML_TKjFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleTKjN_kgFld) = (doubleSum_ML_TKj / doubleMin_Ctch_A) *
10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TPHy_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTPHy_kgFld As Double
Dim doubleSum_ML_T_1Fld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_ML_T_1Fld = pUpdateFeatures.FindField("Sum_ML_T_1")
doubleTPHy_kgFld = pUpdateFeatures.FindField("TPHy_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_ML_T_1 As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_ML_T_1 = pFeature.Value(doubleSum_ML_T_1Fld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleTPHy_kgFld) = (doubleSum_ML_T_1 / doubleMin_Ctch_A) *
10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Public Sub Ultimate_kg_ha_yr()

```
Calc_UTSS_kg
Calc_UBOD_kg
Calc_UTPh_kg
Calc_UTCo_kg
Calc_UTL_kg
Calc_UTZ_kg
Calc_UTKjN_kg
Calc_UTPHy_kg
MsgBox "Ultimate fields calculated"
End Sub
```

Sub Calc_UTSS_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTSS_kgFld As Double
Dim doubleSum_FML_TSFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_FML_TSFld = pUpdateFeatures.FindField("Sum_FML_TS")
doubleUTSS_kgFld = pUpdateFeatures.FindField("UTSS_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
```

```
Dim doubleSum_FML_TS As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_FML_TS = pFeature.Value(doubleSum_FML_TSFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleUTSS_kgFld) = (doubleSum_FML_TS / doubleMin_Ctch_A) *
10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UBOD_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUBOD_kgFld As Double
Dim doubleSum_FML_BOFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_FML_BOFld = pUpdateFeatures.FindField("Sum_FML_BO")
doubleUBOD_kgFld = pUpdateFeatures.FindField("UBOD_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
```

```
Dim pFeature As IFeature
Dim doubleSum_FML_BO As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_FML_BO = pFeature.Value(doubleSum_FML_BOFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleUBOD_kgFld) = (doubleSum_FML_BO / doubleMin_Ctch_A)
* 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTPh_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTPh_kgFld As Double
Dim doubleSum_FML_TPFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_FML_TPFld = pUpdateFeatures.FindField("Sum_FML_TP")
doubleUTPh_kgFld = pUpdateFeatures.FindField("UTPh_kg")
```

```
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_FML_TP As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_FML_TP = pFeature.Value(doubleSum_FML_TPFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleUTPh_kgFld) = (doubleSum_FML_TP / doubleMin_Ctch_A) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTCo_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTCo_kgFld As Double
Dim doubleSum_FML_TCFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_FML_TCFld = pUpdateFeatures.FindField("Sum_FML_TC")
```

```
doubleUTCo_kgFld = pUpdateFeatures.FindField("UTCo_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_FML_TC As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_FML_TC = pFeature.Value(doubleSum_FML_TCFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleUTCo_kgFld) = (doubleSum_FML_TC / doubleMin_Ctch_A) *
10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTL_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTL_kgFld As Double
Dim doubleSum_FML_TLFld As Double
Dim doubleMin_Ctch_AFld As Double
```

```
doubleSum_FML_TLFld = pUpdateFeatures.FindField("Sum_FML_TL")
doubleUTL_kgFld = pUpdateFeatures.FindField("UTL_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_FML_TL As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_FML_TL = pFeature.Value(doubleSum_FML_TLFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleUTL_kgFld) = (doubleSum_FML_TL / doubleMin_Ctch_A) *
10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTZ_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTZ_kgFld As Double
Dim doubleSum_FML_TZFld As Double
```

```
Dim doubleMin_Ctch_AFld As Double
doubleSum_FML_TZFld = pUpdateFeatures.FindField("Sum_FML_TZ")
doubleUTZ_kgFld = pUpdateFeatures.FindField("UTZ_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_FML_TZ As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_FML_TZ = pFeature.Value(doubleSum_FML_TZFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleUTZ_kgFld) = (doubleSum_FML_TZ / doubleMin_Ctch_A) *
10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTKjN_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTKjN_kgFld As Double
```

```
Dim doubleSum_FML_TKFld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_FML_TKFld = pUpdateFeatures.FindField("Sum_FML_TK")
doubleUTKjN_kgFld = pUpdateFeatures.FindField("UTKjN_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_FML_TK As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_FML_TK = pFeature.Value(doubleSum_FML_TKFld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleUTKjN_kgFld) = (doubleSum_FML_TK / doubleMin_Ctch_A) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTPHy_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
```

```
Dim doubleUTPHy_kgFld As Double
Dim doubleSum_FML__1Fld As Double
Dim doubleMin_Ctch_AFld As Double
doubleSum_FML__1Fld = pUpdateFeatures.FindField("Sum_FML__1")
doubleUTPHy_kgFld = pUpdateFeatures.FindField("UTPHy_kg")
doubleMin_Ctch_AFld = pUpdateFeatures.FindField("Min_Ctch_A")
Dim pFeature As IFeature
Dim doubleSum_FML__1 As Double
Dim doubleMin_Ctch_A As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleSum_FML__1 = pFeature.Value(doubleSum_FML__1Fld)
doubleMin_Ctch_A = pFeature.Value(doubleMin_Ctch_AFld)
pFeature.Value(doubleUTPHy_kgFld) = (doubleSum_FML__1 / doubleMin_Ctch_A) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Menu_Mass_Loading_Per_Land_Use()

```
' Find the MainMenuBar.
Dim pMainMenuBar As ICommandBar
Set pMainMenuBar = Application.Document.CommandBars.Find(ArcID.MainMenu)
' Create the new menu called "Land Use Mass Load" on the MainMenuBar.
Dim pNewMenu As ICommandBar
Set pNewMenu = pMainMenuBar.CreateMenu("LU_Mass_Load")
' Add a macro to the new menu.
pNewMenu.CreateMacroItem "Add Required Fields", 46,
"Project.Land_Use_Mass_Loading.Add_Required_Fields"
pNewMenu.CreateMacroItem "Land_Use_kg_ha_yr", 6,
"Project.Land_Use_Mass_Loading.Loading_kg_ha"
End Sub
```

Sub Add_Required_Fields()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
'-- Get the selected layer
Dim pfLayer As IFeatureLayer
Set pfLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
Set pFc = pfLayer.FeatureClass
Dim pTable As ITable
Dim pField As IField
Dim pFields As IFields
Dim pFieldEdit As IFieldEdit
Dim pFieldsEdit As IFieldsEdit
'Create new Fields collection
Set pFields = New Fields
Set pFieldsEdit = pFields
pFieldsEdit.FieldCount = 16
'Create TSS Field
Set pField = New Field
```

```
Set pFieldEdit = pField
With pFieldEdit
.Name = "TSS_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(0) = pField
pFc.AddField pField
'Create BOD Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "BOD_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(1) = pField
pFc.AddField pField
'Create TPh Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TPh_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(2) = pField
pFc.AddField pField
'Create TCo Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TCo_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(3) = pField
pFc.AddField pField
'Create TL Field
```

```
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TL_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(4) = pField
pFc.AddField pField
'Create TZ Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TZ_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(5) = pField
pFc.AddField pField
'Create TKjN Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TKjN_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(6) = pField
pFc.AddField pField
'Create TPHy Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "TPHy_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(7) = pField
pFc.AddField pField
```

```
'Create TSS Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTSS_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(8) = pField
pFc.AddField pField
'Create BOD Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UBOD_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(9) = pField
pFc.AddField pField
'Create TPh Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTPh_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(10) = pField
pFc.AddField pField
'Create TCo Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTCo_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(11) = pField
```

```
pFc.AddField pField
'Create TL Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTL_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(12) = pField
pFc.AddField pField
'Create TZ Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTZ_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(13) = pField
pFc.AddField pField
'Create TKjN Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTKjN_kg"
.Type = esriFieldTypeDouble
End With
Set pFieldsEdit.Field(14) = pField
pFc.AddField pField
'Create TPHy Field
Set pField = New Field
Set pFieldEdit = pField
With pFieldEdit
.Name = "UTPHy_kg"
.Type = esriFieldTypeDouble
End With
```

```
Set pFieldsEdit.Field(15) = pField
pFc.AddField pField
End Sub
```

Public Sub Loading_kg_ha()

```
Calc_TSS_kg
Calc_BOD_kg
Calc_TPh_kg
Calc_TCo_kg
Calc_TL_kg
Calc_TZ_kg
Calc_TKjN_kg
Calc_TPHy_kg
Calc_UTSS_kg
Calc_UBOD_kg
Calc_UTPh_kg
Calc_UTCo_kg
Calc_UTL_kg
Calc_UTZ_kg
Calc_UTKjN_kg
Calc_UTPHy_kg
MsgBox "Annual Mass Loading per Land Use calculated"
End Sub
```

Sub Calc_TSS_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTSS_kgFld As Double
Dim doubleML_TSSFld As Double
Dim doubleAreaFld As Double
doubleML_TSSFld = pUpdateFeatures.FindField("ML_TSS")
doubleTSS_kgFld = pUpdateFeatures.FindField("TSS_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleML_TSS As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleML_TSS = pFeature.Value(doubleML_TSSFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleTSS_kgFld) = (doubleML_TSS / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_BOD_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleBOD_kgFld As Double
Dim doubleML_BODFld As Double
Dim doubleAreaFld As Double
doubleML_BODFld = pUpdateFeatures.FindField("ML_BOD")
doubleBOD_kgFld = pUpdateFeatures.FindField("BOD_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleML_BOD As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleML_BOD = pFeature.Value(doubleML_BODFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleBOD_kgFld) = (doubleML_BOD / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TPh_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTPh_kgFld As Double
Dim doubleML_TPhFld As Double
Dim doubleAreaFld As Double
doubleML_TPhFld = pUpdateFeatures.FindField("ML_TPh")
doubleTPh_kgFld = pUpdateFeatures.FindField("TPh_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleML_TPh As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleML_TPh = pFeature.Value(doubleML_TPhFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleTPh_kgFld) = (doubleML_TPh / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TCo_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTCo_kgFld As Double
Dim doubleML_TCoFld As Double
Dim doubleAreaFld As Double
doubleML_TCoFld = pUpdateFeatures.FindField("ML_TCo")
doubleTCo_kgFld = pUpdateFeatures.FindField("TCo_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleML_TCo As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleML_TCo = pFeature.Value(doubleML_TCoFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleTCo_kgFld) = (doubleML_TCo / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TL_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTL_kgFld As Double
Dim doubleML_TLFld As Double
Dim doubleAreaFld As Double
doubleML_TLFld = pUpdateFeatures.FindField("ML_TL")
doubleTL_kgFld = pUpdateFeatures.FindField("TL_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleML_TL As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleML_TL = pFeature.Value(doubleML_TLFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleTL_kgFld) = (doubleML_TL / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TZ_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTZ_kgFld As Double
Dim doubleML_TZFld As Double
Dim doubleAreaFld As Double
doubleML_TZFld = pUpdateFeatures.FindField("ML_TZ")
doubleTZ_kgFld = pUpdateFeatures.FindField("TZ_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleML_TZ As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleML_TZ = pFeature.Value(doubleML_TZFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleTZ_kgFld) = (doubleML_TZ / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TKjN_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTKjN_kgFld As Double
Dim doubleML_TKjNFld As Double
Dim doubleAreaFld As Double
doubleML_TKjNFld = pUpdateFeatures.FindField("ML_TKjN")
doubleTKjN_kgFld = pUpdateFeatures.FindField("TKjN_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleML_TKjN As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleML_TKjN = pFeature.Value(doubleML_TKjNFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleTKjN_kgFld) = (doubleML_TKjN / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_TPHy_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
```

```
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleTPHy_kgFld As Double
Dim doubleML_T_1Fld As Double
Dim doubleAreaFld As Double
doubleML_TPHyFld = pUpdateFeatures.FindField("ML_TPHy")
doubleTPHy_kgFld = pUpdateFeatures.FindField("TPHy_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleML_TPHy As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleML_TPHy = pFeature.Value(doubleML_TPHyFld)
doubleArea = pFeature.Value(doubleAreaFld)

pFeature.Value(doubleTPHy_kgFld) = (doubleML_TPHy / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTSS_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
```

```
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTSS_kgFld As Double
Dim doubleFML_TSSFld As Double
Dim doubleAreaFld As Double
doubleFML_TSSFld = pUpdateFeatures.FindField("FML_TSS")
doubleUTSS_kgFld = pUpdateFeatures.FindField("UTSS_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleFML_TSS As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleFML_TSS = pFeature.Value(doubleFML_TSSFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleUTSS_kgFld) = (doubleFML_TSS / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UBOD_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
```

```
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUBOD_kgFld As Double
Dim doubleFML_BODFld As Double
Dim doubleAreaFld As Double
doubleFML_BODFld = pUpdateFeatures.FindField("FML_BOD")
doubleUBOD_kgFld = pUpdateFeatures.FindField("UBOD_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleFML_BOD As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleFML_BOD = pFeature.Value(doubleFML_BODFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleUBOD_kgFld) = (doubleFML_BOD / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTPh_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
```

```
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTPh_kgFld As Double
Dim doubleFML_TPhFld As Double
Dim doubleAreaFld As Double
doubleFML_TPhFld = pUpdateFeatures.FindField("FML_TPh")
doubleUTPh_kgFld = pUpdateFeatures.FindField("UTPh_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleFML_TPh As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleFML_TPh = pFeature.Value(doubleFML_TPhFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleUTPh_kgFld) = (doubleFML_TPh / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTCo_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
MsgBox "Must have a layer selected in the table of contents."
```

```
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTCo_kgFld As Double
Dim doubleFML_TCoFld As Double
Dim doubleAreaFld As Double

doubleFML_TCoFld = pUpdateFeatures.FindField("FML_TCo")
doubleUTCo_kgFld = pUpdateFeatures.FindField("UTCo_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleFML_TCo As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleFML_TCo = pFeature.Value(doubleFML_TCoFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleUTCo_kgFld) = (doubleFML_TCo / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTL_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
```

```
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTL_kgFld As Double
Dim doubleFML_TLFld As Double
Dim doubleAreaFld As Double
doubleFML_TLFld = pUpdateFeatures.FindField("FML_TL")
doubleUTL_kgFld = pUpdateFeatures.FindField("UTL_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleFML_TL As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleFML_TL = pFeature.Value(doubleFML_TLFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleUTL_kgFld) = (doubleFML_TL / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTZ_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
```

```
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTZ_kgFld As Double
Dim doubleFML_TZFld As Double
Dim doubleAreaFld As Double
doubleFML_TZFld = pUpdateFeatures.FindField("FML_TZ")
doubleUTZ_kgFld = pUpdateFeatures.FindField("UTZ_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleFML_TZ As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleFML_TZ = pFeature.Value(doubleFML_TZFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleUTZ_kgFld) = (doubleFML_TZ / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTKjN_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
```

```
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTKjN_kgFld As Double
Dim doubleFML_TKjNFld As Double
Dim doubleAreaFld As Double
doubleFML_TKjNFld = pUpdateFeatures.FindField("FML_TKjN")
doubleUTKjN_kgFld = pUpdateFeatures.FindField("UTKjN_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleFML_TKjN As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleFML_TKjN = pFeature.Value(doubleFML_TKjNFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleUTKjN_kgFld) = (doubleFML_TKjN / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Sub Calc_UTPHy_kg()

```
Dim pDoc As IMxDocument
Set pDoc = ThisDocument
' Get the layer that is selected in the TOC
Dim pFeatLayer As IFeatureLayer
Dim pFeatClass As IFeatureClass
Dim pUnknown As IUnknown
Set pUnknown = pDoc.SelectedLayer
If pUnknown Is Nothing Then
```

```
MsgBox "Must have a layer selected in the table of contents."
Exit Sub
End If
Set pFeatLayer = pUnknown
Set pFeatClass = pFeatLayer.FeatureClass
Dim pUpdateFeatures As IFeatureCursor
Set pUpdateFeatures = pFeatClass.Update(Nothing, True)
Dim doubleUTPHy_kgFld As Double
Dim doubleFML_TPHyFld As Double
Dim doubleAreaFld As Double
doubleFML_TPHyFld = pUpdateFeatures.FindField("FML_TPHy")
doubleUTPHy_kgFld = pUpdateFeatures.FindField("UTPHy_kg")
doubleAreaFld = pUpdateFeatures.FindField("Area")
Dim pFeature As IFeature
Dim doubleFML_TPHy As Double
Dim doubleArea As Double
Set pFeature = pUpdateFeatures.NextFeature
Do Until pFeature Is Nothing
doubleFML_TPHy = pFeature.Value(doubleFML_TPHyFld)
doubleArea = pFeature.Value(doubleAreaFld)
pFeature.Value(doubleUTPHy_kgFld) = (doubleFML_TPHy / doubleArea) * 10
pUpdateFeatures.UpdateFeature pFeature
Set pFeature = pUpdateFeatures.NextFeature
Loop
End Sub
```

Helpful Tools codes:

Sub CreateHelp_ToolMenu()

```
' Find the MainMenuBar.
Dim pMainMenuBar As ICommandBar
Set pMainMenuBar = Application.Document.CommandBars.Find(ArcID.MainMenu)
' Create the new menu called "Helpful_Tools" on the MainMenuBar.
Dim pNewMenu As ICommandBar
Set pNewMenu = pMainMenuBar.CreateMenu("Helpful_Tools")
' Add a macro to the new menu.
pNewMenu.CreateMacroItem "Delete_Layer", 10, "Project.Helpful_Tools.delete_layer"
pNewMenu.CreateMacroItem "Open_Table", 47, "Project.Helpful_Tools.open_table"
pNewMenu.CreateMacroItem "Selected_Area", 18,
"Project.Helpful_Tools.Selected_Area"
pNewMenu.CreateMacroItem "Selected_Length", 4,
"Project.Helpful_Tools.Selected_Length"
End Sub
```

Sub delete_layer()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
'-- Get the selected layer
Dim pfLayer As IFeatureLayer
Set pfLayer = pDoc.SelectedLayer
Dim pFc As IFeatureClass
Set pFc = pfLayer.FeatureClass
pMap.DeleteLayer pfLayer
MsgBox "Selected Layer Deleted"
End Sub
```

Sub open_table()

```
Dim pMxDoc As IMxDocument
Dim pUnknown As IUnknown
```

```
Dim pLayer As ILayer
Dim pStandaloneTable As IStandaloneTable
Dim pTableWindow2 As ITableWindow2
Dim pExistingTableWindow As ITableWindow
Dim SetProperties As Boolean
'Get the selected item from the current contents view
Set pMxDoc = ThisDocument
Set pTableWindow2 = New TableWindow
Set pUnknown = pMxDoc.SelectedItem
If TypeOf pUnknown Is IFeatureLayer Then 'A FeatureLayer
Set pLayer = pUnknown
Set pExistingTableWindow = _
pTableWindow2.FindViaLayer(pLayer)
' Check if a table already exists; if not create one
If pExistingTableWindow Is Nothing Then
Set pTableWindow2.Layer = pLayer
SetProperties = True
End If
ElseIf TypeOf pUnknown Is IStandaloneTable Then
' A standalone table
Set pStandaloneTable = pUnknown
Set pExistingTableWindow = _
pTableWindow2.FindViaStandaloneTable(pStandaloneTable)
' Check if a table already exists; if not, create one
If pExistingTableWindow Is Nothing Then
Set pTableWindow2.StandaloneTable = pStandaloneTable
SetProperties = True
End If
End If
If SetProperties Then
pTableWindow2.TableSelectionAction = esriSelectFeatures
pTableWindow2.ShowSelected = False
pTableWindow2.ShowAliasNamesInColumnHeadings = True
Set pTableWindow2.Application = Application
Else
```

```
Set pTableWindow2 = pExistingTableWindow
End If
' Ensure Table Is Visible
If Not pTableWindow2.IsVisible Then pTableWindow2.Show True
End Sub
```

Public Sub Selected_Area()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
Dim pEnumFeat As IEnumFeature
Dim pFeat As IFeature
Dim pArea As IArea
Dim pFeature As IFeature
Dim dtotArea As Double
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
Set pEnumFeat = pMap.FeatureSelection
Set pFeat = pEnumFeat.Next
dtotArea = 0#
If pFeat Is Nothing Then
MsgBox "No feature is selected"
End If
Do While (Not pFeat Is Nothing)
If pFeat.Shape.GeometryType = esriGeometryPolygon Then
Set pArea = pFeat.Shape
End If
Set pFeat = pEnumFeat.Next
dtotArea = dtotArea + pArea.Area
Loop
MsgBox "Total Area = " & (dtotArea) & " square meters"
End Sub
```

Public Sub Selected_Length()

```
Dim pDoc As IMxDocument
Dim pMap As IMap
```

```
Dim pEnumFeat As IEnumFeature
Dim pFeat As IFeature
Dim pPolyline As IPolyline
Dim dtotLength As Double
Set pDoc = ThisDocument
Set pMap = pDoc.FocusMap
Set pEnumFeat = pMap.FeatureSelection
Set pFeat = pEnumFeat.Next
dtotLength = 0#
If pFeat Is Nothing Then
MsgBox "No feature is selected"
End If
Do While (Not pFeat Is Nothing)
If pFeat.Shape.GeometryType = esriGeometryPolyline Then
Set pPolyline = pFeat.Shape
End If
Set pFeat = pEnumFeat.Next
dtotLength = dtotLength + pPolyline.Length
Loop
MsgBox "Total Length = " & (dtotLength) & " meters"
End Sub
```