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4.8 WATER RESOURCES AND WATER QUALITY

INTRODUCTION

This section summarizes the current conditions of the water resources within the study area, including surface water, groundwater, and the drainage system and the potential impacts from the build alternatives and the No Action Alternative (see **Northwest Corridor Supporting Technical Document-Water Resources**).

The federal Clean Water Act and CDOT's Municipal Separate Storm Sewer System (MS4) permit require the analysis and management of water quality for roadway improvement projects.

The primary regulation that manages and specifies water quality is the federal Clean Water Act. This Act was first established in 1972 and is administered by USEPA and USACE. It not only regulates surface water, but also groundwater and wetlands. This discussion focuses on its applicability to surface water resources. The Clean Water Act requires that designated uses and water quality standards be established for every segment of waters of the United States. Water Quality Standards were developed to determine if designated uses are being attained in the surface waters of the state. The designated uses for the streams in the study area vary considerably.

CDOT has received authorization from the CDPHE Water Quality Control Division (WQCD) in the form of an MS4 permit to discharge stormwater. CDOT has submitted an application to WQCD for the inclusion of Phase II Areas in its MS4 permit, that is, those areas with a population greater than 50,000. Because much of the study area lies within such communities and because of the overall sensitivity of the water resources in the study area, the entire study area will comply with provisions in the MS4 permit.

The permit requires areas with large redevelopment or new development of roadways to include permanent and/or administrative stormwater best management practices (BMPs) to protect surface water. A permanent BMP can be a detention pond, a grassy swale, or an artificial wetland. Administrative BMPs can be a designated work practice that protects water quality or other non-structural components (CDOT, 2004a). To comply with the MS4 permit, the BMPs identified for the build alternatives will offer collective and passive treatment of stormwater currently discharged directly into existing water systems.

Information used in this discussion originated from published documents, public documents, reports, and discussions with water quality professionals from municipalities and other governmental agencies. Additionally, a focus group composed of officials from CDOT, CDPHE-WQCD, and private consultants convened on multiple occasions to discuss and approve the methodology and information used in this section. Requests for inclusion of information from citizen working groups were also included in this analysis, as appropriate.

Public concerns expressed through the public involvement process regarding water resources include impacts from sediment and chemicals coming from the roadway into Clear Creek and other streams, impacts to drinking water storage facilities, aerial deposition of contaminants, and impacts to groundwater. These concerns are addressed in **Section 4.8.2**.

4.8.1 AFFECTED ENVIRONMENT

4.8.1.1 SURFACE WATER

This section describes the major surface water resources in the study area (see **Figure 4.8-1**, **Figure 4.8-2**, and **Figure 4.8-3**).

Basin and Watershed Descriptions

The study area lies within the middle portion of the South Platte River Basin. The Platte River Basin, a sub-basin of the Missouri River Basin, covers approximately 21,000 square miles of northeastern Colorado, or approximately one-fifth of the state. Water flows from the Continental Divide to the eastern high plains. The South Platte River Basin, a sub-basin of the Platte River Basin, has the largest human population in Colorado within the Platte River Basin, almost 3 million people (CDPHE, 2004). The major tributaries of the South Platte River that either are in or receive water from the study area are Boulder Creek, Big Dry Creek, and Clear Creek (see **Figure 4.8-4**). Smaller level watersheds (Hydrologic Unit Code [HUC] 6) within each of the three major watersheds are briefly discussed. Water diversion by means of extensive alterations to the natural hydrologic condition helps the prevention of flooding and maintains the required water supply (CDPHE, 2002).

Boulder/St. Vrain Creek Watershed

Only a small area in the northwestern portion of the study area lies within the Boulder/St. Vrain Creek Watershed. Water generally flows in a northeasterly direction toward the confluence of Boulder Creek. The natural waterbodies in the study area that eventually flow into Boulder Creek are Coal Creek and Rock Creek.

The Rock Creek watershed is the only Boulder/St. Vrain Creek HUC 6 watershed in the study area (see **Figure 4.8-4**). The area that the alternative alignments traverse in the Rock Creek watershed is primarily characterized by the commercial shopping areas of Interlocken/Flatiron Crossing and extends north to the Northwest Parkway.

Big Dry Creek Watershed

The Big Dry Creek Watershed is located south of the Boulder/St. Vrain Creek watershed in the middle of the study area. The watershed (also a HUC 6 watershed) originates approximately 0.5 miles west of SH 93 and the Rocky Flats National Wildlife Refuge. Numerous drainages feed the Big Dry Creek Watershed, of which Big Dry Creek, Little Dry Creek, Walnut Creek, and Woman Creek are the major streams. Flows for these streams fluctuate depending on the season and amount of precipitation. The major reservoirs in the Big Dry Creek Watershed are Great Western Reservoir, Standley Lake, Welton Reservoir, Woman Creek Reservoir, and Upper Twin Lake.

One of the primary water quality concerns in the Big Dry Creek Watershed is the potential contamination of water resources resulting from activities associated with the Rocky Flats National Wildlife Refuge. However, "four years of fish and benthic invertebrate data collected (2000 through 2003) show no discernable water quality impacts attributable to the periodic releases from the Rocky Flats Area" (Aquatic Associates, Inc., 2005).

Clear Creek Watershed

The Clear Creek Watershed encompasses the southern portion of the study area and has a complex distribution of water. Clear Creek originates near the Continental Divide and flows east through many mining areas, passes through Golden and eventually into the South Platte River. The majority of water from Clear Creek (approximately 85 percent [Arbogast et al. 2002]) is a source of drinking water for nearly 350,000 people and provides recreational opportunities for rafters, kayakers, and fishermen (USEPA/CDPHE, 1997).

Six HUC 6 watersheds are in the larger Clear Creek Watershed (Leyden Creek, Ralston Creek, Van Bibber Creek, Clear Creek (Beaver Brook to South Table Mountain), Clear Creek (South Table Mountain to Denver), and Clear Creek (Denver to Mouth). Below is a brief description of each watershed.

Leyden Creek

The Leyden Creek watershed extends from west of SH 93 through the study area. West of Indiana Street, the watershed is currently undeveloped. The BFI solid waste landfill is located east of SH 93 and north of Leyden Road. Development east of Indiana Street is primarily residential, with increasing density from west to east.

Ralston Creek

Four major reservoirs primarily characterize the Ralston Creek watershed: Ralston, Upper and Lower Long Lake, and Arvada-Blunn, all located in the western portion of the watershed. The areas surrounding these reservoirs are undeveloped rangeland or open space. East of the Arvada-Blunn Reservoir is dense residential development.

Van Bibber Creek

The Van Bibber watershed is south of the Ralston Creek watershed and north of the City of Golden. West of SH 93, this watershed primarily consists of undeveloped land with some areas of historic mining. The area east of SH 93 is being developed for residences. As with the Leyden and Ralston creek watersheds, the density of residential development increases from west to east.

Clear Creek (Beaver Brook to South Table Mountain)

The Clear Creek (Beaver Brook to South Table Mountain) watershed encompasses the City of Golden and ends on the western edges of North and South Table Mountains. It extends outside of the study area to the west through Clear Creek Canyon. The City of Golden lies primarily along the eastern edge of SH 93, with pockets of residential development along the western edges of SH 93. Clear Creek traverses this watershed.

Clear Creek (South Table Mountain to Denver)

The Clear Creek (South Table Mountain to Denver) watershed begins on the eastern border of the Clear Creek (Beaver Brook to South Table Mountain) watershed and continues east past the study area. This watershed has dense industrial and residential developments, with the exception of the tops of North and South Table Mountains. Coors Brewing Company is located in this watershed.

Clear Creek Watershed (Denver to Mouth)

Only a very small portion of the Clear Creek (Denver to Mouth) watershed occurs in the study area along Indiana Street. Residential development is growing within this watershed.

Major streams and rivers in the Clear Creek Watershed are as follows:

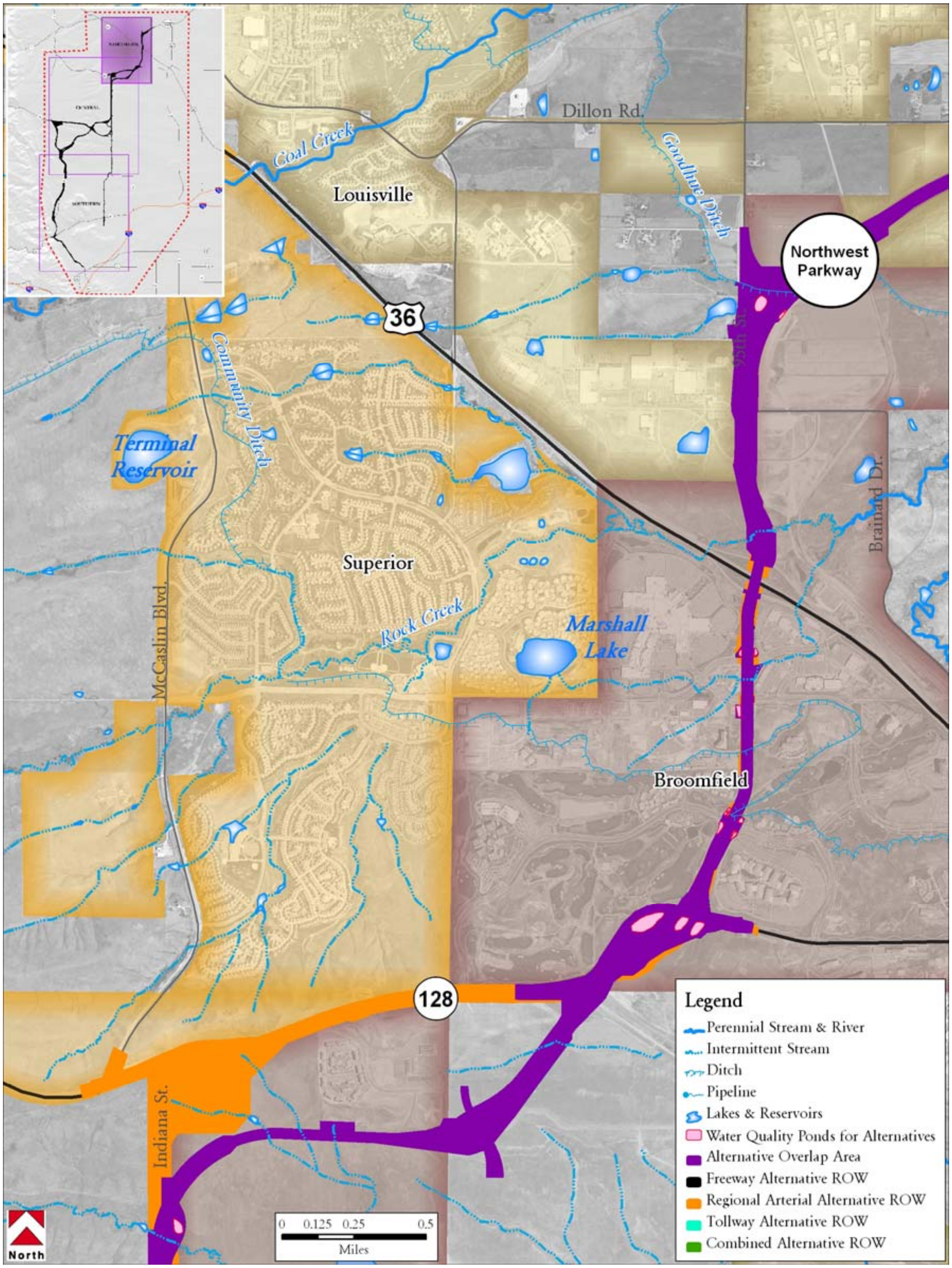
- **Van Bibber Creek** (Intermittent Stream)
- **Cressmans Gulch** (Intermittent Stream)
- **Tucker Gulch** (Intermittent Stream)
- **Clear Creek** (Perennial Stream)
- **Chimney Gulch** (Intermittent Stream)
- **Kinney Run** (Intermittent Stream)
- **Kinney Creek** (Intermittent Stream)
- **Indian Gulch** (Intermittent Stream)
- **Leyden Creek (**Intermittent Stream)
- **Ralston Creek** (Intermittent Stream-along SH 93; Perennial Stream-along Indiana Street

The major reservoirs in the Clear Creek Watershed and within the study area are Arvada-Blunn Reservoir, Leyden Lake, Ralston Reservoir, Upper and Lower Long Lakes, and Hyatt Lake. These reservoirs are drinking water supplies for the City of Arvada and the City and County of Denver.

There are also three prominent ditches/canals (Church Ditch, Croke Canal, and the Farmers Highline Canal) that divert water north from Clear Creek and into Arvada-Blunn Reservoir and Standley Lake (in the Big Dry Creek Watershed). Denver Water also has a water conduit (Conduit 16) that transects the watershed from the northwest to the southeast. Impacts on Clear Creek are extensive due to historic mining activities. One segment of Clear Creek in the study area (at US 6/SH 93) is considered impaired by the WQCD because of the presence of cadmium, lead, and zinc. Additionally, downstream from the project area (at I-70/SH 58), Clear Creek is impaired by organic sediment and requires a total maximum daily load (TMDL). Ralston Creek, below Arvada Reservoir, also has a TMDL for e. coli (CDPHE, 2006).

Northwest Corridor
A TRANSPORTATION ENVIRONMENTAL STUDY

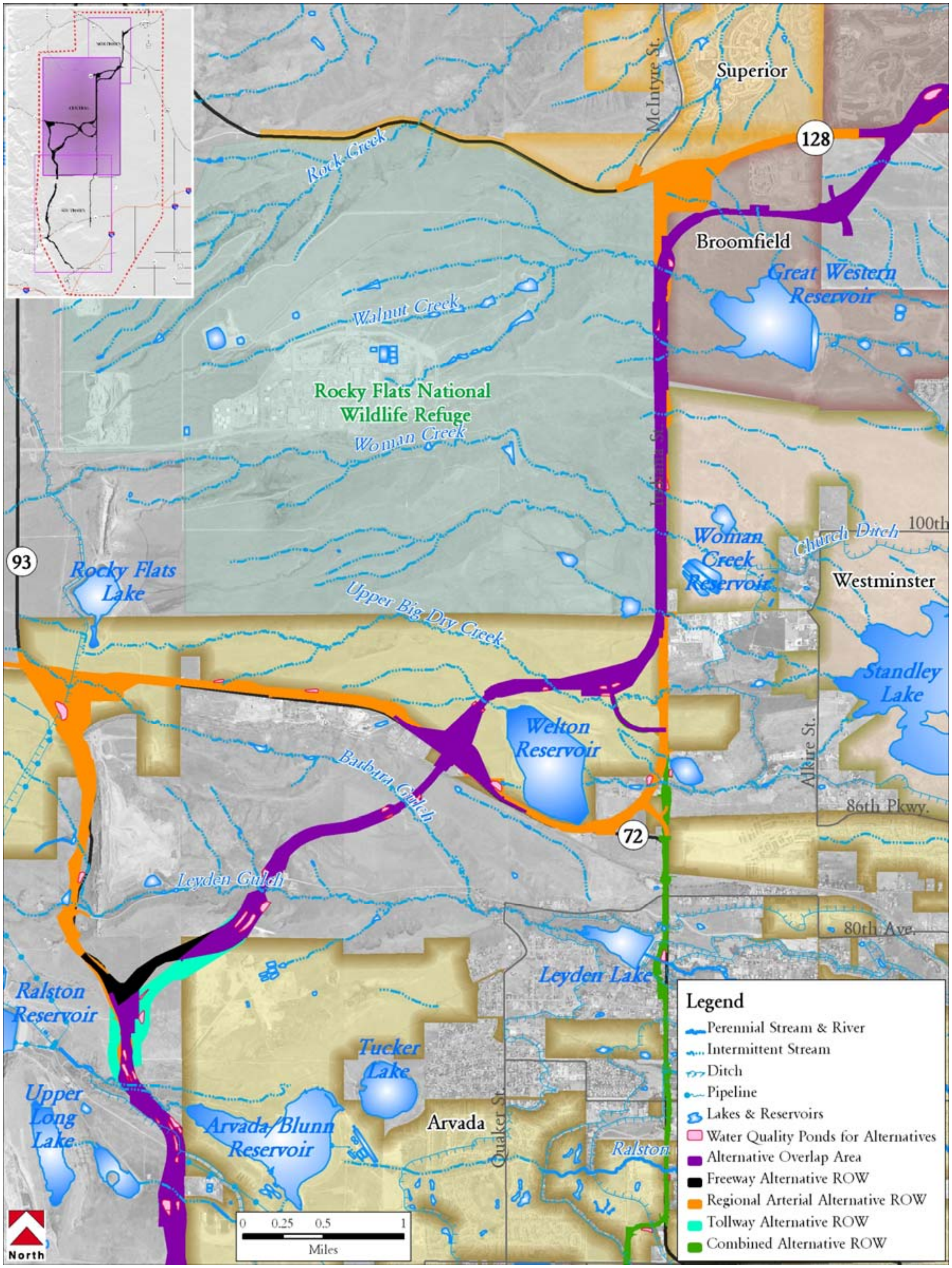
Figure 4.8-1 Water Resources-Northern Portion



Source: Colorado Division of Wildlife Natural Diversity Information System. 2006. http://ndis.nrel.colostate.edu/ftp/index.html (accessed: March, 2005).

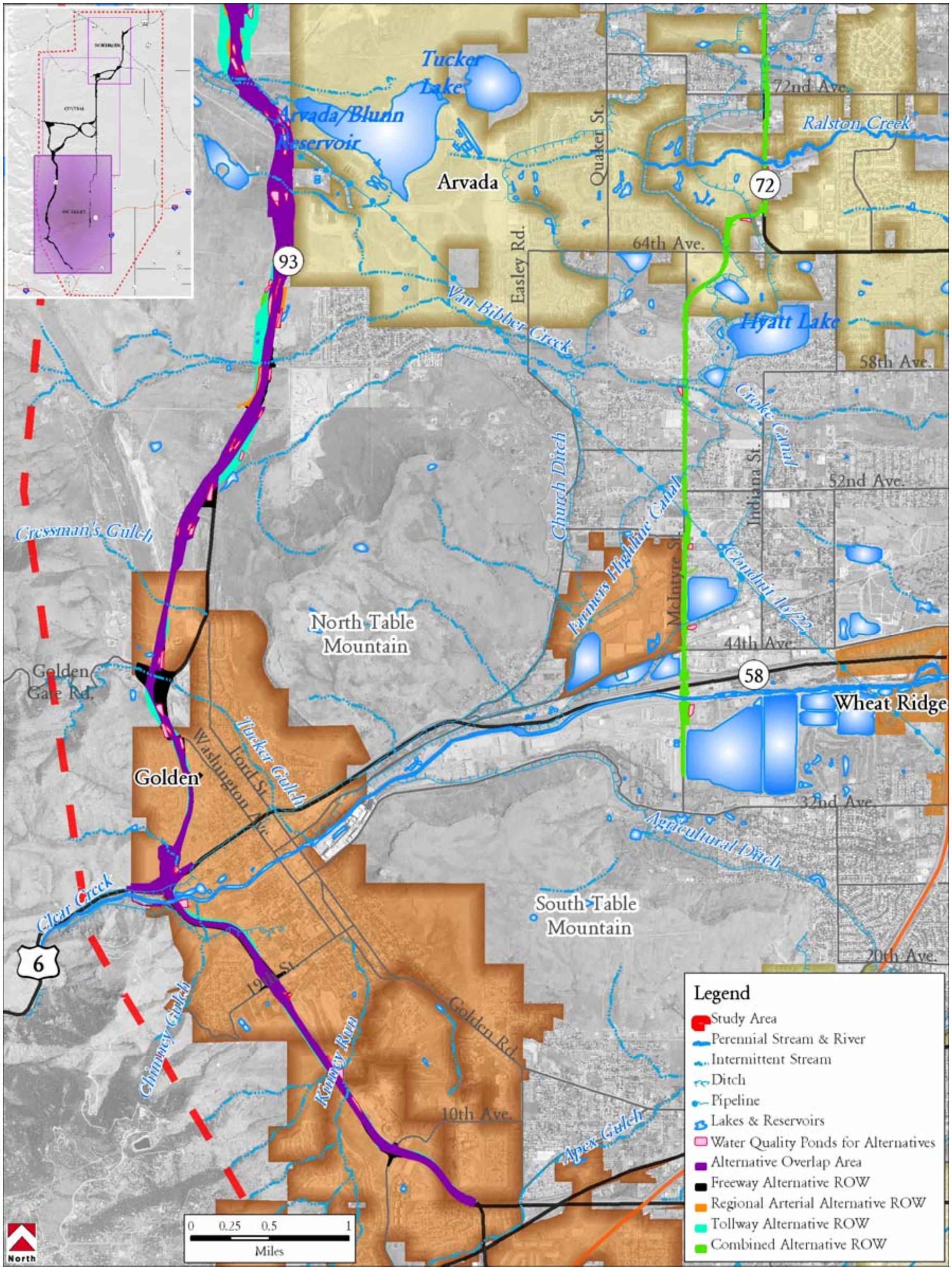
Northwest Corridor
A TRANSPORTATION ENVIRONMENTAL STUDY

Figure 4.8-2 Water Resources-Central Portion



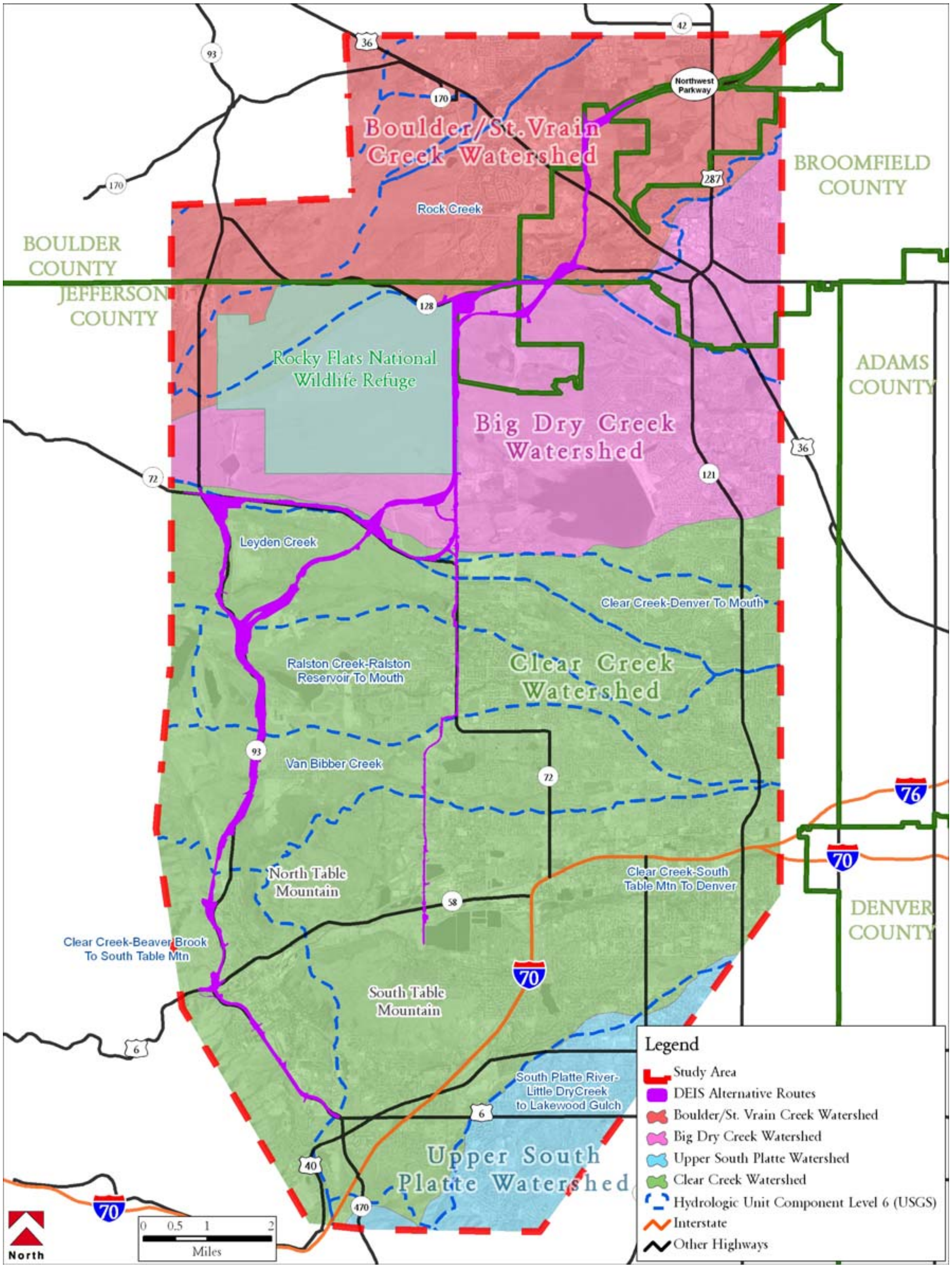
Source: Colorado Division of Wildlife Natural Diversity Information System. 2006. http://ndis.nrel.colostate.edu/ftp/index.html (accessed: March, 2005).

Figure 4.8-3 Water Resources-Southern Portion



Source: Colorado Division of Wildlife Natural Diversity Information System. 2006. http://ndis.nrel.colostate.edu/ftp/index.html (accessed: March, 2005).

Figure 4.8-4 Sub-Watersheds in the Study Area



Source: U.S. Geological Survey, 2005. Hydrologic Map Units, 1:250K
http://ndis.nrel.colostate.edu/ftp/index.html (accessed: August, 2006).

4.8.1.2 GROUNDWATER

This section provides information on existing hydrogeologic conditions in the study area. Relevant publications examined included maps, documents, records, and reports from the U.S. Geological Survey, Colorado Division of Water Resources, CDPHE, Colorado Office of the State Engineer, and consulting firms. Engineers and other water supply specialists from city and county public works and engineering offices within the municipalities of the study area held water supply and water quality discussions.

MAJOR AQUIFERS

Within the study area, groundwater is typically found in both shallow aquifers and in deeper bedrock aquifers (Flynn, 2003; Topper et al., 2003). The shallow aquifers consist of one or more of the following: largely unconsolidated alluvium, weathered fractured bedrock at or near the ground surface, and other permeable surficial deposits such as colluvium or landslide deposits, all of which may be hydraulically connected (RFETS, 2002; Flynn, 2003). In general, groundwater in the study area flows from west to east.

Alluvial Aquifers

Shallow alluvial aquifers are formed by water introduced at or near the surface by precipitation, irrigation, and so on. This water infiltrates downward through the alluvium until it reaches less permeable bedrock. The bedrock impedes the downward movement, resulting in accumulation of water within the alluvium (Robson, 1996). This accumulation is a water table.

Largely unconsolidated alluvial aquifers have relatively high proportions of coarse material, including boulders, cobbles, pebbles, granules, and sand. These deposits range from less than 10 feet to as much as 60 feet thick and extend along the floodplains of modern streams such as Clear Creek, Van Bibber Creek, Ralston Creek, Leyden Creek, Woman Creek, Rock Creek, and Coal Creek (Van Horn, 1972; Trimble and Fitch, 1974; Robson, 1996). Clear Creek and Coal Creek have particularly well developed alluvial deposits (Trimble and Fitch, 1974).

Bedrock Aquifers (Based on Topper et al. 2003, except as noted)

Bedrock aquifers in the study area are sedimentary units, including the Tertiary/Cretaceous Denver Formation, the Cretaceous Arapahoe Formation, the lower part of the Cretaceous Laramie Formation, and the Cretaceous Fox Hills Sandstone (see **Figure 4.8-5**)

- The Denver Formation is 800 to 1,000 feet thick, with interbedded shale, silty claystone, and sandstone, as well as thin beds of coal and carbonaceous siltstone; it contains a high proportion of volcanic clasts. It is the least permeable of the aquifers in the area; yielding as much as 200 gallons per minute (gpm) from a saturated thickness of up to 350 feet. Lower yields of 20 to 50 gpm are more typical (VanSlyke, 2004).
- The Arapahoe Formation is the most permeable aquifer in the area, with 400 to 700 feet of sandstone and conglomeratic sandstone interbedded with shale and siltstone. It yields up to 700 gpm, from a saturated thickness of up to 400 feet. High-yield wells are common (VanSlyke, 2004a).
- The Laramie-Fox Hills aquifer is moderately permeable, with a combined thickness of up to 250 to 300 feet in sandstone and shale of the lower Laramie Formation and sandstone, siltstone, and interbedded shale of the Fox Hills Sandstone. Yields are up to 350 gpm. (Van Horn, 1972; VanSlyke, 2004).

The Denver Formation has an exposure of small and scattered outcrops south of Van Bibber Creek and east of SH 93, notably around North and South Table mountains. The Arapahoe Formation has an exposure of small and scattered outcrops in the area east of SH 93 and north to approximately Rock Creek. Both formations remain covered by colluvium and/or alluvium over much of the area where they would otherwise crop out.

SH 93 crosses the discontinuous, faulted, steeply dipping outcrops of the Laramie Formation and Fox Hills Sandstone repeatedly; both formations remain covered with colluvium and/or alluvium in most of the areas.

Depth to Groundwater

Depth to groundwater in the study area ranges from 2 feet to 924 feet in a sample of just less than 5 percent of its groundwater wells in all but its southernmost edge. Depth to groundwater is five feet or less in at least some wells in the study area (Colorado Office of the State Engineer, 2005).

Groundwater existed in 20 of 58 test holes drilled in conjunction with construction of interchanges east and west of the US 36/96th Street interchange at the Flatiron Crossing mall. The depth to water table varied from 4 feet to 33 feet below ground level in those holes (GROUND Engineering Consultants, 1999).

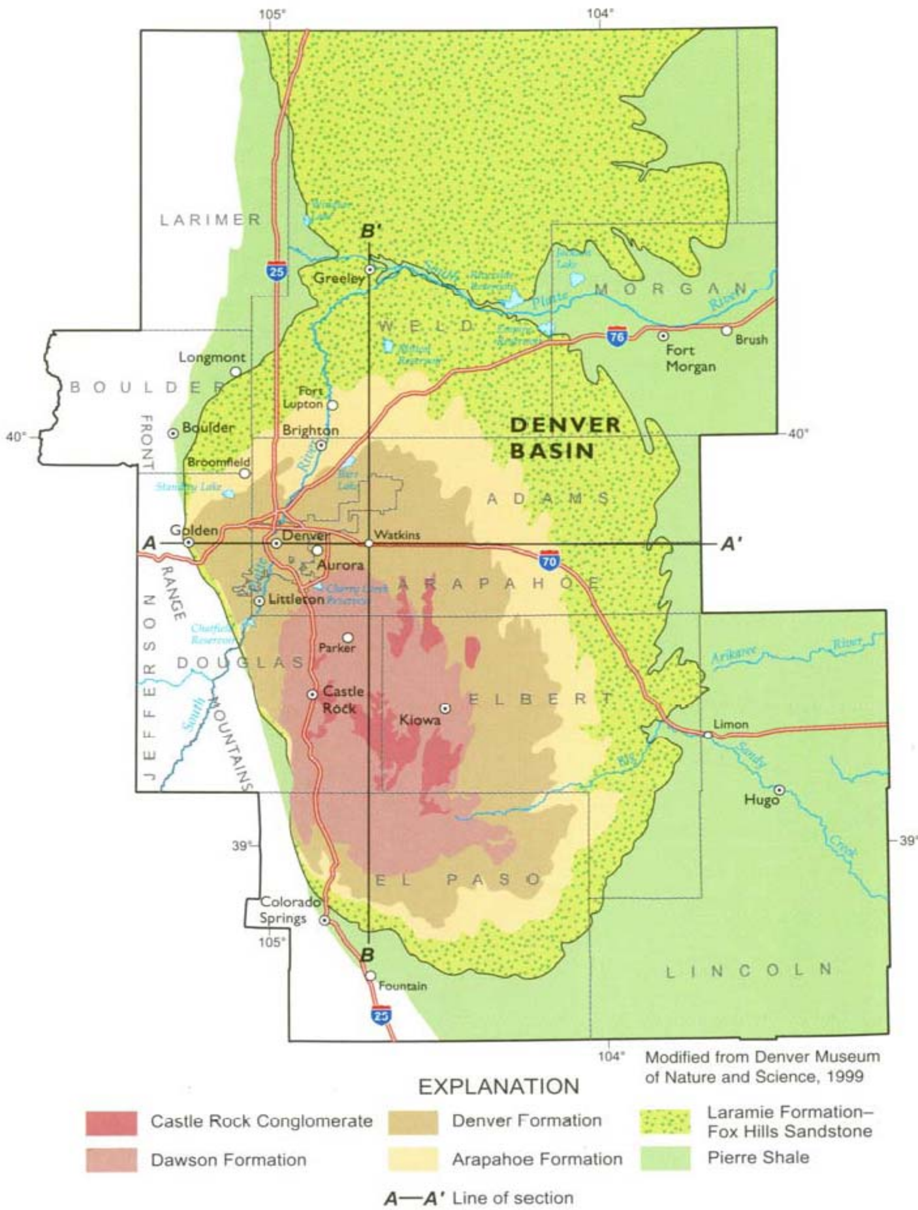
Seeps and springs, often with seasonal flow, occur on both sides of the Golden Fault just west of SH 93 north of the intersection with SH 58 (CTL/Thompson, 1992). The seasonally high water table and groundwater movement along the Golden Fault may have contributed to the landslide that developed at that location from 1991 to 1993 during construction of the Golden Bypass (personal communication, Yehle, 2004).

Recharge of Aquifers

Alluvial or shallow aquifers primarily recharge by infiltration of precipitation and snowmelt, inflow from tributaries, leakage from streams and canals, infiltration from naturally and artificially ponded water, and infiltration of urban and agricultural irrigation water (RFETS, 2002; Flynn, 2003; Topper et al., 2003). Recharge zones for alluvial aquifers will be in and near surface water features like streams and reservoirs.

Shallow bedrock aquifers underlying alluvium can be recharged by hydraulic connection with the alluvial aquifers (Topper et al. 2003). They also can be recharged through overlying colluvium, landslide deposits, or windblown deposits (Hillier et al. 1983). Soils and surficial materials in the Denver Basin typically are sufficiently permeable to allow percolation into underlying bedrock aquifers (Topper et al., 2003). Because of the large size and depth of the bedrock aquifers, major recharge zones occur along their western edge. In general, the recharge zones for the deep, bedrock aquifers occur in areas of outcroppings and at the edge of the foothills and the plains.

Figure 4.8-5 Generalized Bedrock Geology for the Denver Basin



Note: Younger rock units form the surficial bedrock around the center of the basin; older rock units crop out closer to the edges of the basin. Bedrock aquifers are recharged in outcrop areas by infiltration of the precipitation and snowmelt and by infiltration through overlying permeable soils or surficial deposits. Bedrock aquifers also can be recharged by groundwater migrating from overlying and/or underlying aquifers (Topper et al, 2003;Robson and Banta 1995).

Sources: Topper, R., K.L. Spray, W.H. Bellis, J.L. Hamilton, and P.E. Barkmann. 2003. Groundwater Atlas of Colorado. Colorado Geological Survey Special Publication 53, Fig. 6.1-2, p. 86

OUTCROPPING OF BEDROCK AQUIFERS

In general, younger bedrock units are exposed at or just below the ground surface toward the center of the Denver Basin and older bedrock units are exposed around the basin margin. This results in younger bedrock aquifers being exposed mostly in the central, eastern, and southern portions of the study area and older bedrock units being exposed mostly along its western and northern portions. These areas are covered by colluvium and/or alluvium over much of the area where they would otherwise crop out (Van Horn, 1972, Lindvall, 1978; Lindvall, 1979).

DISCHARGE OF AQUIFERS

Groundwater in the study area typically is discharged through wells, leakage between aquifers, hillside seeps, outcrops of permeable rock, subsurface foundation drains, and evapotranspiration from plants (Robson and Banta, 1995; Robson, 1996; Kaiser-Hill, 2004).

GROUNDWATER CONTAMINATED AREAS

Groundwater quality generally decreases downstream through the South Platte River Basin as both surface water and groundwater move through urban and agricultural areas (Dennehy et al. 1998). Contamination of shallow aquifers results from urban, industrial, and agricultural runoff, such as runoff from impermeable surfaces, infiltration from agricultural and urban sources, wastewater discharge, sewage and disposal systems, and from fluids associated with oil and gas wells (Flynn, 2003).

A persistent perchlorate contamination plume occurs in groundwater beneath downtown Golden, in the vicinity of 13th Street and Washington Street, and migrates generally east northeastward. Interceptor wells have been installed on Ford Street to divert contaminated groundwater before it reaches the Coors brewery wells. The contamination point source is believed to be a laundromat that was closed at least 20 years ago (personal communication, Hartman, 2005).

There is shallow groundwater contamination at the Rocky Flats National Wildlife Refuge, but this contamination is not anticipated to move offsite (CDPHE, 2005b). Two contamination plumes carrying volatile organic compounds and radionuclides have been identified at the Rocky Flats Industrial Park site approximately two miles south of the Rocky Flats National Wildlife Refuge (Engineering Management Support Inc., 1999).

Naturally occurring uranium and radon derived from bedrock are present in high concentrations in alluvial groundwater within much of the South Platte River Basin (Dennehy et al., 1998).

4.8.1.3 WATER QUALITY/USES

STREAMS

While only a few of the streams in the study area have surface flows year-round, all of the streams, including ephemeral and intermittent streams, have designated uses that the stream must attain. Clear Creek is an exception to this general description because it receives substantial flows throughout the year making it the only true perennial stream in the study area. The only other perennial stream in the study area is a segment of Ralston Creek that crosses Indiana Street.

In general, the surface waters in the study area support warm water aquatic life, are suitable for secondary recreation contact (e.g., wading, fishing, and other streamside or lakeside recreation), are suitable for irrigation or livestock consumption, and can be used as a potable water supply after receiving standard water treatment. Determining if a designated use is being met is measured through a comparison of water quality standards.

LAKES/RESERVOIRS

All of the major lakes and reservoirs in the study area are man made. The largest of the lakes and reservoirs in the study area are used for municipal drinking water sources (Standley Lake, Arvada Reservoir, Ralston Reservoir, Upper and Lower Long Lake, and Welton Reservoir). The designated uses for the lakes and reservoirs vary within the study area.

CANALS

One of the unique surface water characteristics of the study area is the abundance of irrigation canals. The three main canals (Church Ditch, Croke Canal, and Farmers Highline Canal) divert water from Clear Creek and convey the water throughout the study area, providing water for drinking water supplies, other reservoirs, and agricultural purposes outside of the study area.

The irrigation canals in the study area are waters of the State of Colorado. Based on CRS 25-8-103 (19), state waters are defined to be any and all surface and subsurface waters that are contained in or flow through the state, including streams, rivers, lakes, drainage ditches, storm drains, ground water, and wetlands, but not including waters in sewage systems, waters in treatment works or disposal systems, waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed. Not all waters of the state have designated uses, which are used to develop water quality standards for determining compliance with the CWA. Despite the importance of the canals in the study area and the Colorado Front Range, irrigation canals do not have designated uses as do natural watercourses. According to State of Colorado code (C.R.S. § 25-8-203(2)(f)), "Waters in ditches and other man-made conveyance structures shall not be classified [with designated uses], and water quality standards shall ***not*** be applied to them but may be utilized for purposes of discharge permits" (emphasis added [CDPHE, 2003]).

GROUNDWATER USES

No municipalities within the study area use groundwater as a supply of potable water (personal communications, Coufal, 2005; Duffin, 2005; Elliott, 2005; Hartman, 2005; Honer, 2005; Strietelmeier, 2005). Some municipalities use well water for irrigation (personal communications, Elliott, 2005; Honer, 2005). The Coors brewery in Golden uses groundwater as the water source for their beverage products (personal communication, Hartman, 2005). The City of Arvada is storing municipal potable water in the abandoned Leyden coal mines located east of SH 93 between Ralston Creek and SH 72 (personal communication, Honer, 2005).

Some residents in older municipal areas (e.g., old town Superior) and unincorporated areas (e.g., rural Jefferson County north of Golden and Broomfield County near Indiana Street and SH 128) reportedly use individual groundwater wells for domestic water supplies (personal communications, Elliott, 2005; Hartman, 2005; Schnoor, 2005).

ROCKY FLATS NATIONAL WILDLIFE REFUGE

The 6,240-acre Rocky Flats National Wildlife Refuge is located in the central portion of the study area. The site is currently being cleaned up and converted into a National Wildlife Refuge operated by the U.S. Fish and Wildlife Service (see **Northwest Corridor Supporting Technical Document-Modified Environmental Site Assessment**). The surface waterbodies that occur on the Rocky Flats National Wildlife Refuge are Rock Creek, Walnut Creek, Woman Creek, and a series of man-made ditches with holding ponds along their length.

In 1996, Woman Creek Reservoir was completed to capture water from the Industrial Area of the Rocky Flats Facility and divert it from flowing into Standley Lake. It is located near the southeast corner of the Rocky Flats National Wildlife Refuge on the east side of Indiana Street. The South Interceptor Ditch is located between the Industrial Area and Woman Creek. It collects stormwater runoff from the south side of the Industrial Area and feeds Woman Creek Reservoir. Three main chambers in the reservoir are used to allow sediments to settle. The reservoir is only used in high flow events. When full, the water is tested and then pumped north to Walnut Creek below Great Western Reservoir (USFWS, 2004).

IMPAIRED STREAMS

There are three stream segments in the study area that do not meet their designated uses and have been identified as requiring TMDL. A TMDL is an analysis and allotment of loads to sources of water discharge in a watershed that will assist in improving the water quality of a stream so that the designated uses can be met. The TMDL process is undertaken by the CDPHE. A segment of Clear Creek from the Argo Tunnel to Farmers Highline Canal requires a TMDL for cadmium, lead, and zinc. Currently, it is a high priority for the CDPHE to develop a TMDL for this segment (CDPHE, 2006). The segment of Clear Creek is crossed at approximately the US 6/SH 93/SH 58 intersection in the City of Golden. The CDPHE has called for a TMDL to be developed for Ralston Creek below the Arvada Reservoir because of impairments from e. coli (CDPHE, 2006). Indiana Street is the only street in the study area that crosses this segment. A segment of the downstream segment of Clear Creek, which is outside of the alternatives' footprint but within the study area, requires a TMDL for organic sediment (CDPHE, 2006). This segment occurs at approximately I-70 and SH 58.

A segment of Rock Creek has been placed on the Monitoring and Evaluation List for the State of Colorado because of potential contamination from iron, selenium, and e. coli (CDPHE, 2006). The Monitoring and Evaluation List is a list of stream segments that are likely to show impairments. However, the data behind these conclusions or reason for impairment is uncertain and further study is needed to determine if a TMDL should be completed.

4.8.1.4 Drinking Water Sources

This section describes the surface water in the study area used for domestic purposes, such as drinking water and non-potable water supplies.

Arvada

The water supply for the City of Arvada (Arvada Reservoir and Ralston Reservoir) is located in the west central portion of the study area. The City of Arvada owns Arvada Reservoir and purchases water from Denver Water (Ralston Reservoir) and from the canal companies. The canals (Church Ditch, Croke Canal, and Farmers Highline Canal) provide approximately 60 percent to 90 percent of the water in Arvada Reservoir (personal communication, McCarthy, 2004).

Arvada does not use any wells to supplement Arvada-Blunn Reservoir or for non-potable uses, such as watering golf courses or parks. The city's non-potable water source is Tucker Reservoir, which is fed from Ralston Creek (personal communication, McCarthy, 2004).

Broomfield

The City and County of Broomfield's water supply originates on the western slope of Colorado. Water is transported through the Colorado-Big Thompson (CBT)/Windy Gap system under the management of the Northern Colorado Water Conservancy District, and is stored on the eastern slope in Carter Lake in Larimer County. Broomfield also purchases potable drinking water from the Denver Water Board (City and County of Broomfield, 2004).

Golden

Clear Creek supplies the City of Golden's drinking water. Water is taken out of Clear Creek approximately one mile upstream (west) from the intersection of US 6/SH 93/SH 58 and is piped underground into two holding ponds. The ponds act as a backup water supply for Golden's drinking water plant. If the underground piping from the creek fails, the pond water can be treated until the problem is fixed. In addition, if an accident on US 6 spills contaminants into Clear Creek, the intake pipes can be closed and the plant can use the pond water until the creek is safe to use again. The holding ponds also allow much of the sand and debris to naturally settle out of the water before it reaches the plant (City of Golden, 2004).

Westminster, Northglenn, and Thornton

The water from Standley Lake Reservoir is used as a municipal water supply for the Cities of Westminster, Northglenn, and Thornton. Clear Creek supplies 96 percent of the reservoir's water via three irrigation ditches (Church Ditch, Croke Canal, or Farmers Highline Canal). The remaining 4 percent comes from Woman Creek and adjacent drainages (City of Westminster, 2004). The City of Thornton also receives drinking water from Lower Clear Creek and the South Platte River through the Lower Clear Creek, Colorado Agricultural, and Burlington Ditches (City of Thornton, 2004).

DENVER

Even though the study area is outside the City and County of Denver, Denver Water has water storage and distribution lines within the study area, most notably Ralston Reservoir. Additionally, Denver Water, along with USACE, is currently undertaking the Moffat Collection System EIS for expanding drinking water storage and/or recycling drinking water to Denver Water's customers. One alternative identified is the creation of a storage reservoir immediately west of SH 93 along Leyden Creek. According to public information about the Moffat Collection System EIS, this alternative would require the realignment of SH 93. A preferred alternative in the Denver Water EIS is not anticipated to be identified prior to completion of the Northwest Corridor study.

4.8.1.5 NON-POTABLE WATER SUPPLIES

Great Western Reservoir is the largest non-potable reservoir in the study area. Non-potable water is used for watering golf courses, parks, and so on, but is not used for drinking water or household uses. The City and County of Broomfield is currently considering the expansion of Great Western Reservoir to address the growing population in the area and their non-potable water needs.

4.8.1.6 DRAINAGE SYSTEM

Along the major roadways within the study area (US 6, SH 93, SH 72, Indiana Street, McIntyre Street, and SH 128), the existing drainage conveyance is via roadside ditches that ultimately discharge to natural water ways, irrigation ditches, or water supply ditches. The curb and gutter sections within the study area are generally located at intersections. On US 6 south of SH 58, the curb and gutter sections direct water away from the roadway into existing storm drain systems or natural drainageways. The intersections from SH 58 to 64th Parkway along SH 93 also have curb and gutter sections. These intersections drain to storm sewer systems that originate in residential areas west of SH 93. These systems have trunk lines that cross under the roadway and ultimately drain into natural drainageways on the east side of the highway. The Interlocken area is the only area that has an extensive storm sewer system. The entire area from SH 128 north to the Northwest Parkway is comprised of curb and gutter sections with inlets and subsurface conveyance.

A storm sewer typically passes the 2- or 5-year storm events. The major 100-year storm passes via a combination of the storm sewer plus street flow. Drainage facilities for water quality are rare within the study area.

4.8.1.7 CHARACTERIZATION OF TYPICAL ROADWAY RUNOFF

Characterization of stormwater discharged from a roadway is an important component of understanding the potential impacts associated with roadway runoff. Data for roadway-related constituents were obtained from the I-70 Programmatic Environmental Impact Statement (PEIS), in which the study team conducted multiyear stormwater sampling events in an effort to characterize the stormwater discharged from I-70 (see **Table 4.8-1**). The data were collected from I-70 from 2000 to 2003 (CDOT 2004b). The I-70 PEIS project collected rainfall and snowmelt data. The rainfall data was used for this analysis because the team determined that it was the best characterization of the study area and the eastern plains of Colorado.

The analysis uses I-70 data because it is the most recent and accurate Colorado data. Stormwater data from roadways in Denver are available; however, these data are not representative of current conditions because they were collected more than 30 years ago. For example, the lead data is much higher than would be expected today, because when that data was collected, leaded gasoline was used.

The constituents presented are those of concern in the study area. They were selected because there are stream impairments associated with them (cadmium and zinc), they are typically associated with roadway operation and/or winter maintenance (total suspended solids, chloride, sodium, magnesium, and copper), or are of concern to reservoirs/drinking water sources (manganese and phosphorus).

Table 4.8-1 Typical Roadway Stormwater Runoff Concentrations (mg/l)

Constituent	Minimum	Maximum	Mean	Median	Number of Samples
Total Cadmium [1]	N/A	N/A	N/A	0.019	N/A
Chloride	4	27	14.4	13.5	10
Copper	0.008	0.02	0.011375	0.01	8
Magnesium	2.3	7	4.275	3.9	8
Manganese [2]	0.0015	0.2	0.066688	0.0325	8
Sodium	2.5	9.1	6.125	6.05	8
Total Phosphorus	0.21	2.1	0.79	0.625	10
Total Suspended Solids	38	1800	548.8	448	10
Zinc	0.069	0.25	0.116125	0.09	8

Notes: All constituents are dissolved concentrations, unless otherwise noted.

[1]Cadmium data obtained from FHWA 1990 for Denver, CO.

[2] Mean value for manganese includes one-half the detection limit for one non-detected sample.

Source: CDOT, 2004b.

4.8.2 Environmental Consequences

This section describes the methodology and the potential impacts from the No Action Alternative and the build alternatives to water quality in the study area. Mitigation, in the form of BMPs, for potential impacts are also identified and described.

4.8.2.1 Water Quality

This section discusses the impact analysis methodology used to assess potential impacts from the No Action Alternative and the build alternatives to water quality. Impacts to surface water and groundwater are both considered in this analysis.

Impact Analysis Methodology

Two major types of water quality impacts are identified—pollutant and physical.

Pollutant impacts are determined by comparing their loads (total amount of pollutant discharge into a waterbody) and by ascertaining whether a discharge of stormwater from the roadway will result in a waterbody not meeting its designated uses.

The FHWA-approved Driscoll Model was used to determine pollutant loading for comparing water quality impacts from each alternative (FHWA, 1990) and for calculating loads from each of the pollutants presented in **Table 4.8-1**. The results enabled an assessment of each alternative's potential water quality degradation (see **Table 4.8-2** through **Table 4.8-5**). A comparison of the loadings on each watershed for copper and zinc associated with the alternatives along the US 6/SH 93 alignment and the Indiana Street/McIntyre Street alignment is presented (see **Figure 4.8-6** through **Table 4.8-9**).

Determining if a designated use is being met is measured through a comparison of water quality standards. Comparing typical roadway runoff concentrations to acute biological standards is an effective method for determining potential impacts. Comparison to the acute biological criteria is appropriate because it represents a short-term exposure to runoff constituents, which is typical of discharges from roadways that occur at infrequent (or acute) intervals associated with storm events. Comparison to the chronic (or long-term) criteria is not effective because it does not appropriately represent the nature of stormwater discharge from a roadway.

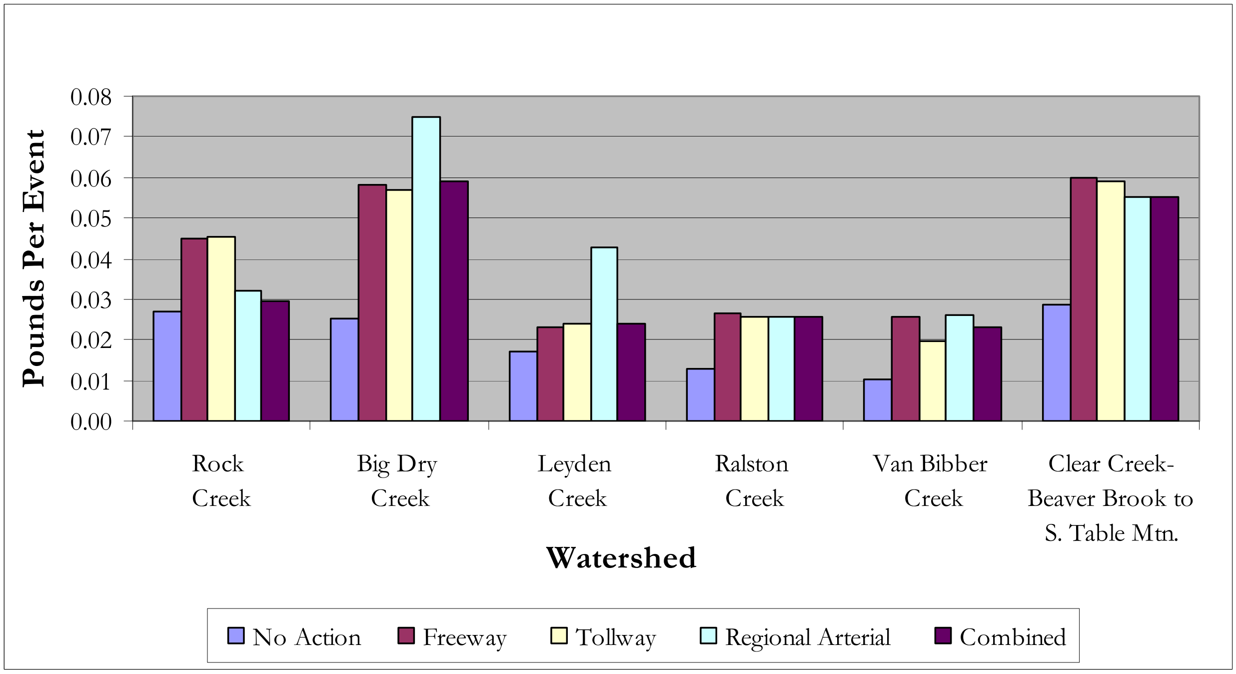
Table 4.8-2 Constituent Storm Event Load (pounds/event) Results from Driscoll Model for Roadway Improvements along Primary Alignment (US 6 and SH 93)

Alternative	Cadmium	Chloride	Copper	Manganese	Phosphorous	Sodium	Total Suspended Solids	Total Zinc[1]
Rock Creek Watershed								
No Action	0.051	36.3	0.027	0.087	1.7	16.3	1204	0.88
Freeway	0.085	60.5	0.045	0.15	2.8	27.1	2007	1.47
Tollway	0.086	61.3	0.045	0.15	2.9	27.5	2035	1.49
Regional Arterial	0.061	43.2	0.032	0.10	2.0	19.4	1434	1.05
Combined	0.056	39.6	0.029	0.095	1.9	17.8	1316	0.97
Big Dry Creek Watershed								
No Action	0.048	34.3	0.025	0.083	1.6	15.4	1138	0.85
Freeway	0.11	78.5	0.058	0.19	3.7	35.2	2604	1.91
Tollway	0.11	76.9	0.057	0.19	3.6	34.4	2551	1.87
Regional Arterial	0.14	101.3	0.075	0.24	4.7	45.4	3363	2.47
Combined	0.11	79.5	0.059	0.19	3.7	35.6	2637	1.94
Leyden Creek Watershed								
No Action	0.032	23.0	0.017	0.055	1.1	10.3	764	0.56
Freeway	0.044	31.3	0.023	0.075	1.5	14.0	1039	0.76
Tollway	0.045	32.3	0.024	0.078	1.5	14.5	1072	0.79
Regional Arterial	0.081	57.7	0.043	0.14	2.7	25.9	1915	1.41
Combined	0.045	32.3	0.024	0.078	1.5	14.5	1072	0.79
Ralston Creek Watershed								
No Action	0.024	17.3	0.013	0.042	0.81	7.8	575	0.42
Freeway	0.050	35.8	0.026	0.086	1.7	16.1	1189	0.87
Tollway	0.048	34.4	0.025	0.083	1.6	15.4	1141	0.84
Regional Arterial	0.048	34.4	0.025	0.083	1.6	15.4	1141	0.84
Combined	0.048	34.4	0.025	0.083	1.6	15.4	1141	0.84
Van Bibber Creek Watershed								
No Action	0.020	14.0	0.010	0.034	0.65	6.3	464	0.34
Freeway	0.049	34.9	0.026	0.084	1.6	15.6	1158	0.85
Tollway	0.038	26.8	0.020	0.065	1.3	12.0	891	0.65
Regional Arterial	0.049	35.0	0.026	0.084	1.6	15.7	1162	0.85
Combined	0.044	31.2	0.023	0.075	1.5	14.0	1036	0.76
Clear Creek-Beaver Brook to S. Table Mountain. Watershed								
No Action	0.055	39.0	0.029	0.094	1.8	17.5	1293	0.95
Freeway	0.11	80.6	0.060	0.19	3.8	36.1	2676	1.97
Tollway	0.11	79.7	0.059	0.19	3.7	35.7	2645	1.94
Regional Arterial	0.10	74.5	0.055	0.18	3.5	33.4	2474	1.82
Combined	0.11	74.8	0.055	0.18	3.5	33.5	2482	1.82

Notes: [1]Total zinc concentrations from FHWA 1990 were used to ensure that the BMP analysis discussed in **Section 4.8.2.5** through **Section 4.8.2.7** is applicable.

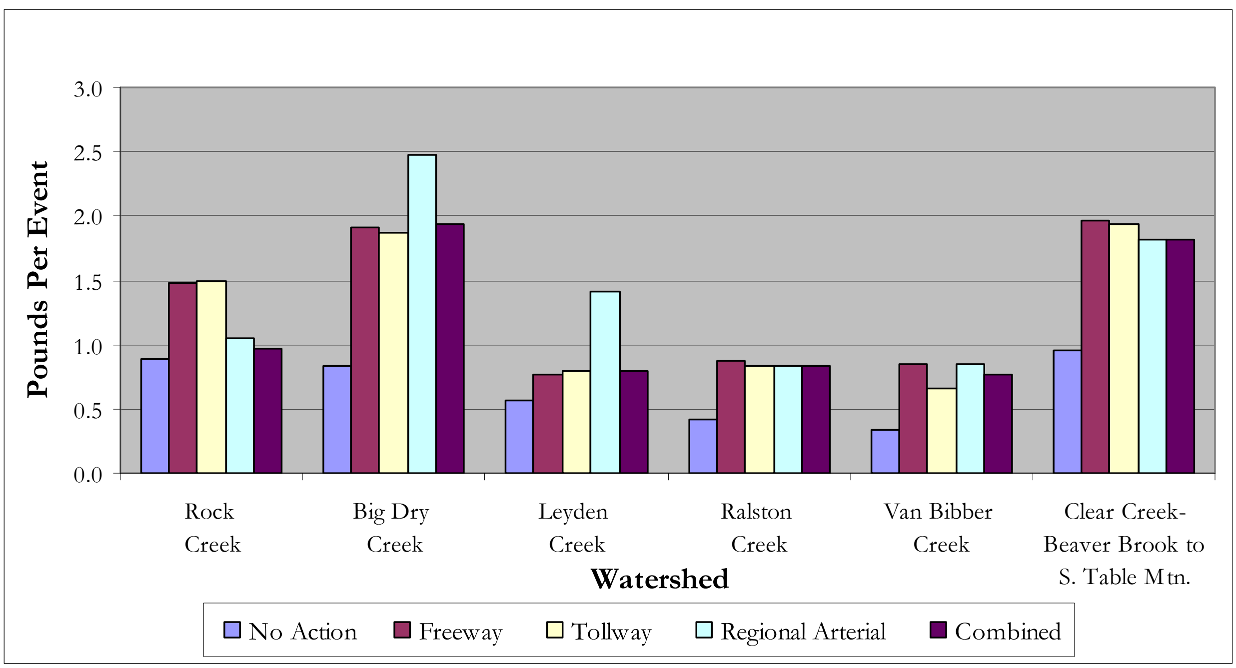
Source *Results from FHWA Pollutant Loadings and Impacts from Highway Stormwater Runoff. Volumes I, II, and II, 1990.*

Figure 4.8-6 Copper Loadings along Primary Alignment (US 6 and SH 93)



Source Results from FHWA Pollutant Loadings and Impacts from Highway Stormwater Runoff. Volumes I, II, and II, 1990.

Figure 4.8-7 Total Zinc Loadings along Primary Alignment (US 6 and SH 93)



Source Results from FHWA Pollutant Loadings and Impacts from Highway Stormwater Runoff. Volumes I, II, and II, 1990.

Table 4.8-3 Ranking of Alternative Loading from Greatest To Least and Percentage Greater than No Action Alternative for US 6/SH 93 Alignment

Rock Creek Watershed		Big Dry Creek Watershed		Leyden Creek Watershed		Ralston Creek Watershed		Van Bibber Creek Watershed		Clear Creek— Beaver Brook to South Table Mtn. Watershed	
Percent of Load Greater Than No Action		Percent of Load Greater Than No Action		Percent of Load Greater Than No Action		Percent of Load Greater Than No Action		Percent of Load Greater Than No Action		Percent of Load Greater Than No Action	
No Action	—	No Action	—	No Action	—	No Action	—	No Action	—	No Action	—
Tollway	41%	Regional Arterial	66%	Regional Arterial	60%	Freeway	52%	Regional Arterial	60%	Freeway	52%
Freeway	40%	Combined	57%	Tollway	29%	Regional Arterial	50%	Freeway	60%	Tollway	51%
Regional Arterial	16%	Freeway	56%	Combined	29%	Tollway	50%	Combined	55%	Combined	48%
Combined	8%	Tollway	55%	Freeway	26%	Combined	50%	Tollway	48%	Regional Arterial	48%

Source *Results from FHWA Pollutant Loadings and Impacts from Highway Stormwater Runoff. Volumes I, II, and II, 1990.*

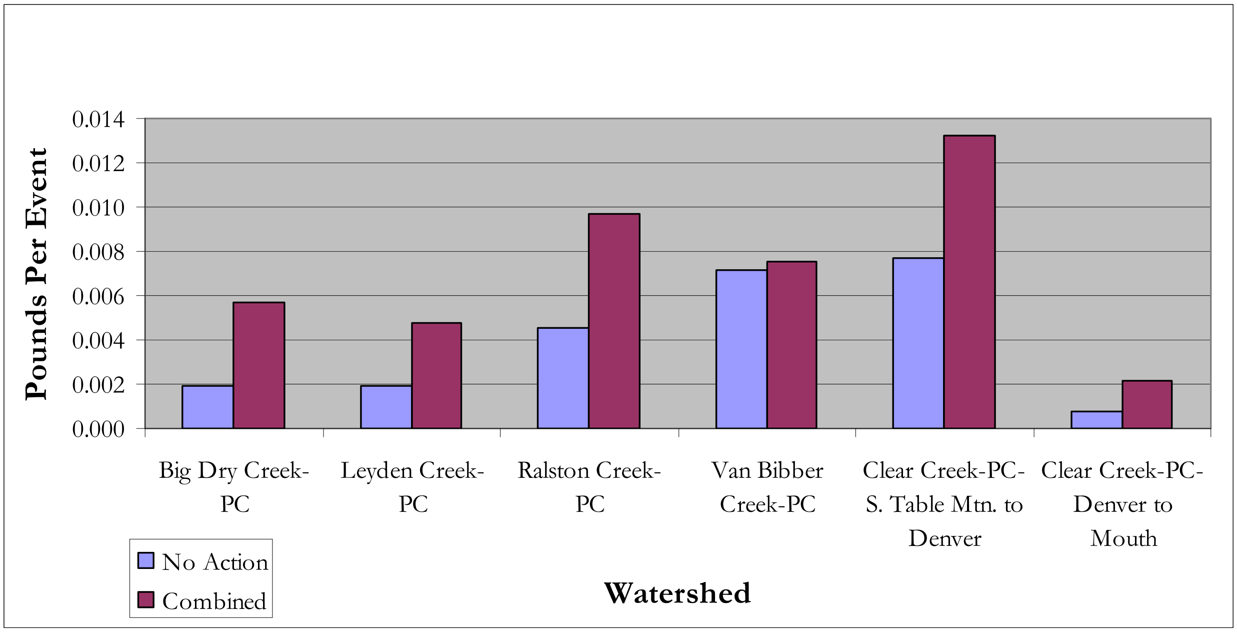
Table 4.8-4 Constituent Storm Event Load (pounds/event) Results from Driscoll Model for Roadway Improvement along Indiana Street and McIntyre Street

Alternative	Cadmium	Chloride	Copper	Manganese	Phosphorous	Sodium	Total Suspended Solids	Total Zinc[1]
Big Dry Creek Watershed								
No Action	0.0036	2.56	0.0019	0.006	0.121	1.16	85.8	0.063
Combined	0.0109	7.73	0.0057	0.019	0.361	3.47	257	0.19
Leyden Creek Watershed								
No Action	0.0037	2.61	0.0019	0.006	0.122	1.17	86.5	0.064
Combined	0.00908	6.45	0.0048	0.016	0.301	2.89	214	0.16
Ralston Creek Watershed								
No Action	0.00866	6.16	0.0046	0.015	0.287	2.76	204	0.15
Combined	0.0184	13.1	0.0097	0.032	0.611	5.87	435	0.32
Van Bibber Creek Watershed								
No Action	0.0135	9.62	0.0071	0.023	0.449	4.31	319	0.23
Combined	0.0143	10.2	0.0075	0.025	0.475	4.57	338	0.25
Clear Creek (South Table Mountain to Denver) Watershed								
No Action	0.0147	10.4	0.0077	0.025	0.486	4.67	346	0.25
Combined	0.0252	17.9	0.013	0.043	0.834	8.01	593	0.44
Clear Creek (Denver to Mouth) Watershed								
No Action	0.00152	1.08	0.00081	0.003	0.050	0.485	35.9	0.026
Combined	0.00412	2.93	0.0022	0.007	0.137	1.31	97.2	0.071

Notes: [1]Total zinc concentrations from FHWA 1990 were used to ensure that the BMP analysis discussed in **Section 4.8.2.5** through **Section 4.8.2.7** is applicable

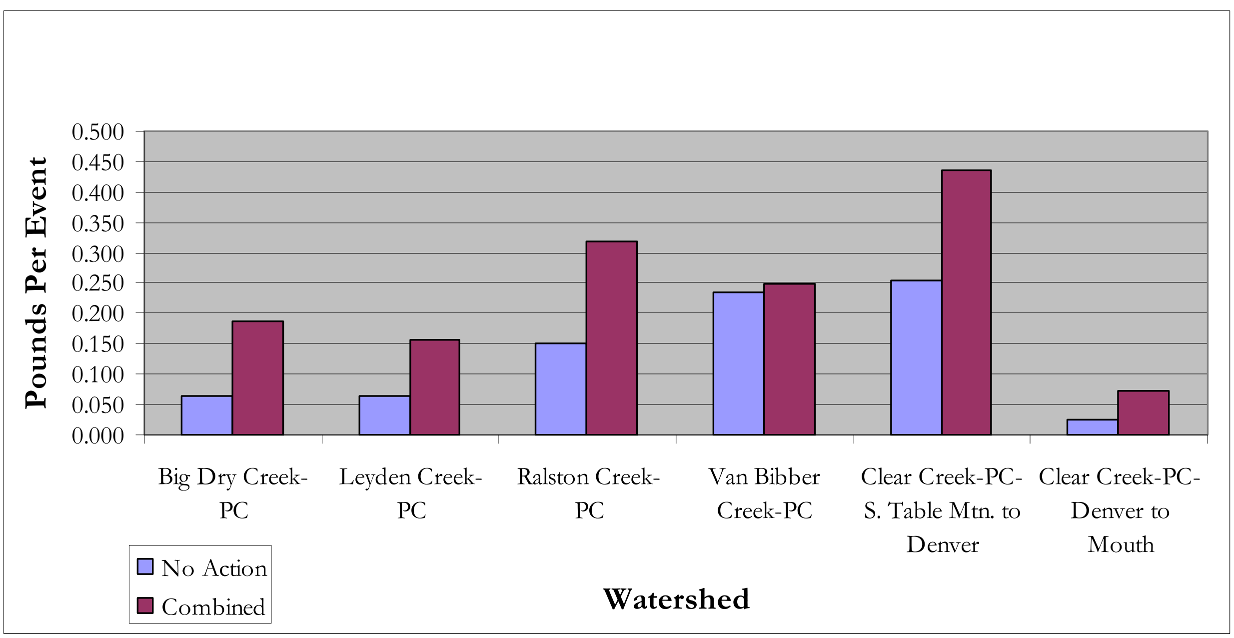
Source *Results from FHWA Pollutant Loadings and Impacts from Highway Stormwater Runoff. Volumes I, II, and II, 1990.*

Figure 4.8-8 Total Copper Loadings along Indiana Street/McIntyre Street Alignment



Source Results from FHWA Pollutant Loadings and Impacts from Highway Stormwater Runoff. Volumes I, II, and II, 1990.

Figure 4.8-9 Total Zinc Loadings along Indiana Street/McIntyre Street Alignment



Source Results from FHWA Pollutant Loadings and Impacts from Highway Stormwater Runoff. Volumes I, II, and II, 1990.

Table 4.8-5 Percentage Greater than No Action Alternative for Indiana Street/McIntyre Street Alignment

Big Dry Creek Watershed		**Leyden Creek Watershed**		**Ralston Creek Watershed**		**Van Bibber Creek Watershed**		**Clear Creek—** South Table Mtn. to Denver **Watershed**		**Clear Creek—** Denver to Mouth **Watershed**	
Percent of Load Greater Than No Action		Percent of Load Greater Than No Action		Percent of Load Greater Than No Action		Percent of Load Greater Than No Action		Percent of Load Greater Than No Action		Percent of Load Greater Than No Action	
No Action	N/A	No Action	N/A	No Action	N/A	No Action	N/A	No Action	N/A	No Action	N/A
Combined	67%	Combined	60%	Combined	53%	Combined	6%	Combined	42%	Combined	63%

Source Results from FHWA Pollutant Loadings and Impacts from Highway Stormwater Runoff. Volumes I, II, and II, 1990.

4.8.2.2 IMPACTS COMMON TO ALL BUILD ALTERNATIVES

This section discusses impacts to water quality that are common to all build alternatives.

DIRECT IMPACTS

Pollutants

Sediment in runoff is the primary pollutant associated with roadways and comes from multiple sources, such as tire wear, brake linings, road wear, traction sand, and aerial deposition. Sediment entering a receiving water can have severe impacts on streams. It can alter the structure of the stream by changing the physical dimensions of the streambed. For instance, if a stream bottom is typically composed of cobble and large amounts of sediment are allowed to enter the system and settle, the sediment can fill in the gaps between the cobbles and eventually engulf them. This changes the natural stream characteristics, such as flow rate. Additionally, this impacts fish habitat by removing areas for spawning and feeding. The addition of sediment into a stream system also can cloud the water, thereby decreasing the amount of light penetration which can affect the fish habitat and even stream chemistry.

In addition to sediments coming off the roadway and impacting receiving waters, certain sources of sediments can have concentration of chemicals associated with them. These chemicals can impact the stream by altering its chemistry and by potentially causing adverse effects to aquatic species, such as fish and aquatic invertebrates. While metals can occur in both the total and dissolved forms, using the dissolved concentration of these constituents to compare against aquatic life standards is appropriate because these standards are based on the dissolved form. The results show that for all constituents, except chloride and zinc, concentrations coming from the roadway do not exceed water quality standards (see **Table 4.8-6**). Water quality standards are presented for each of the major watersheds because many of the standards have to be calculated using stream specific information. A general standard was calculated for all streams and waterbodies in the entire watershed because of the high number of streams and waterbodies in the study area and a lack of data for every individual stream.

Table 4.8-6 Stormwater Runoff compared with Water Quality Standards Dissolved, unless otherwise noted (mg/l)

Constituents	Mean Concentration[1]	Clear Creek Watershed	Big Dry Creek Watershed	Rock Creek
		Quantitative Water Quality Standard[2]		
Cadmium	[3]	0.00354	0.0102	0.0148
Chloride (mg/l)	**14.4**	**0.25** [4]	**0.25** [4]	**0.25** [4]
Copper	0.0114	0.0129	0.0326	0.0449
Magnesium	4.28	N/A	N/A	N/A
Manganese	0.0667	2.94	4.08	4.58
Total Phosphorous	0.79	N/A	N/A	N/A
Sodium	6.13	N/A	N/A	N/A
Total Suspended Solids	549	N/A	N/A	N/A
Zinc	**0.116**	**0.113**	0.26	0.347

Notes: **Bold** values represent where runoff exceeds water quality standards;
N/A = not available
[1]Data from I-70 runoff collected from 2000 to 2003 (CDOT 2004b).
[2]Standards are from CDPHE, 2005a
[3]**Available cadmium** concentration is total, not dissolved and is not appropriate for comparison because water quality standards are based on dissolved fraction.
[4]Secondary drinking water standards

Source: CDOT I-70 PEIS. 2004b.

While it might appear that chloride is causing water quality problems, impacts from chloride to aquatic life are not anticipated because the water quality standard for this constituent is a secondary drinking water standard. Secondary standards are based on aesthetic concerns rather than on impacts to aquatic life and water treatment plants treat water for chloride prior to public use. Additionally, secondary water quality standards are based upon 30-day averages, while stormwater runoff is acute in nature. In other words, the runoff concentration measures a single rain event, while the standard includes an average of 30 days of continuous releases.

The fact that zinc is slightly exceeding the calculated standard in Clear Creek is not unexpected because, as previously stated, Clear Creek is currently impaired by zinc from upstream mining sources. The mean concentration of zinc used for the comparison might be upwardly skewed by one sample that was 40 percent higher than the next highest value. The median zinc concentration (0.09 mg/l) is less than the water quality standard. Additionally, this comparison is inherently conservative because the standard is based on an in-stream concentration. The roadway runoff when it reaches the stream will be diluted and thus, the stream concentration will be much less than the roadway runoff concentration. Therefore, roadway runoff is not expected to cause any exceedances of water quality standards.

During the public scoping process, concern regarding the aerial deposition of chemicals onto the roadway was discussed. Delineation and determination of chemicals on roadways from aerial sources is relatively unstudied. Studies conducted by the United States Geological Survey (USGS) have shown that the state of data is currently insufficient to adequately determine exactly which constituents on the roadway are from aerial sources and which are from roadway or vehicles (Colman et al., 2001). While the source of constituents is unavailable, it is anticipated that constituents that are deposited aerially are present, and are therefore accounted for in the characterization of roadway runoff. The runoff data used in this analysis is assumed to contain constituents from both methods of deposition.

Public concern regarding impacts to potential drinking water sources has been taken very seriously in preparation of this document. Care was taken to ensure that roadway drainage is not discharged into drinking water sources, most notably near Welton Reservoir and Golden's drinking water ponds. While roadway alignments are very close to Golden's drinking water ponds, roadway drainage in that area is collected and discharged to Clear Creek outside of the ponds. It should be noted that the collection intake for the ponds is approximately 0.5 miles upstream from US 6, therefore, roadway drainage does not enter Golden's drinking water supply.

Recent changes in CDOT winter maintenance activities include the use of magnesium chloride as a liquid deicer. The use of magnesium chloride was prompted by the known negative environmental impacts of using sodium chloride (road salt), such as severe alteration of water chemistry and impacts to roadside vegetation. The long-term environmental impacts associated with the use of magnesium chloride are anticipated to be much less than road salt, however, it is reasonable to assume that the addition of any chemical, including magnesium chloride, to a waterbody may result in some sort of impact on the receiving water. CDOT is currently conducting multiple research projects that consider the impacts of magnesium chloride usage in Colorado. The exact water impacts from its use are currently not known.

Potential impacts to both shallow and deep aquifers from the introduction of contaminants can occur by changing land uses, recharge zones or groundwater movement patterns, and water tables. Contaminants associated with construction, maintenance, and traffic can be introduced if these contaminants are allowed to be exposed to recharge areas. Increases in impermeable surfaces and cutting and filling across faults that direct fluids can cause changes in recharge and discharge areas for groundwater. This can affect water tables by allowing the introduction of contaminants. As previously discussed, changes in recharge zones can result in impacts to shallow, alluvial aquifers along natural drainages. The recharge zones for the deep aquifers occur along the edge of the foothills and plains in the study area. Because the recharge zones for the deep aquifers are so large, the alternatives are not anticipated to cause an impact from constituents or alter the effectiveness of recharge for these deep aquifers.

Physical Impacts

Generally, physical impacts to water resources associated with roadways occur as the result of the addition of impervious surfaces. Impervious surface areas, such as roadways, accelerate runoff that normally would be detained by vegetated soils. The associated increase in water velocity can cause erosion to occur by scouring the banks of receiving waters. Downcutting of exposed soil around discharge pipes would occur if water velocities were dramatically increased. Both of these conditions would add to the amount of sediment that comes from the roadway to the receiving water and exacerbate the impacts from sedimentation discussed above.

Increasing impervious surfaces cause increases in runoff and cause impacts to water quality. As previously mentioned, all of the stormwater runoff is being collected and distributed, which concentrates stormwater flows. This concentration of runoff combined with the increases in impervious surfaces would produce an increase in runoff volumes, which would worsen the impacts of the increased runoff velocity discussed above. The impervious surfaces of each alternative are presented (see **Table 4.8-7**).

Table 4.8-7 Acres of Impervious Surfaces by Alternative

Alternative	Total Impervious Surface (acres)	Impervious Surface Greater than Existing Conditions (acres)
No Action	240.8	N/A
Freeway	388.8	299.0
Tollway	362.5	289.9
Regional Arterial	479.0	348.0
Combined (Recommended)	425.7	325.6

Source: GIS, FHU, 2007.

The impacts associated with runoff velocities and volumes are expected to be the greatest in the northern and southern developed areas of the study area where a portion of the adjacent land cover is already impervious surfaces. Rainfall runoff from the impervious surfaces of the roadways would be added to the runoff generated from the developed areas. The undeveloped part of the study area, mainly in the central portion, is not anticipated to have major impacts associated with runoff velocities and volumes due to its large areas of pervious land where rainfall is absorbed by the soil.

Groundwater impacts associated with shallow, or alluvial, aquifers could include the alteration of recharge areas; disrupting, enhancing, or redirecting groundwater discharge; and changing hydraulic connectivity within or between aquifers.

Altering groundwater recharge areas by adding fill over shallow aquifers, cutting into shallow aquifers, removing aquifer material, increasing impervious surfaces, or redirecting runoff through detention ponds causes effects to shallow aquifers. These impacts can include exposing the surface area of the aquifer, changing the surface gradient across the aquifer, changing infiltration rates, and the quantity and distribution of groundwater flows. Each of these affects the ability of the aquifer to recharge according to historic conditions.

Impacts associated with groundwater discharge could be caused by cutting into, adding fill, or altering natural discharge paths, such as seeps or wetlands. These conditions affect the leakage within and between aquifers, affect surface seeps, alter evaporation and transpiration rates, and thus alter water tables. These impacts would be anticipated to occur in shallow aquifers.

Any future development that occurs adjacent to the roadway has potential to affect the drainage system, but generally will have very little impact upon any of the alternatives. Impacts to the drainage system are limited by CDOT's access permit process. Development plans directly adjacent or discharging to the CDOT right-of-way are reviewed by CDOT to ensure that release rates do not have any adverse impacts. The flow release rate of additional discharges must meet historical channel conditions.

CONSTRUCTION/TEMPORARY IMPACTS

Construction of any build alternative has the ability to impact water quality in the study area. Of primary concern is the exposure of large areas of open ground and soil to rainfall, which can result in severe erosion, and consequently sedimentation in receiving waters. The large areas of open ground occur from cuts for the roadway, stockpiling soil for fill, and grading activities.

The demolition and construction of bridges in and near stream channels would have the potential to add sediments and other debris directly into streams. Construction of caissons for bridge piers may require dewatering activities that may release contaminated water into a stream.

During construction, areas are needed for washing out concrete trucks. The runoff water from these activities is extremely caustic and will cause impacts if released to adjacent streams or waterbodies.

Groundwater impacts from construction activities would be similar to those of surface water. For instance, the construction of bridges, including caissons, could result in the dewatering of shallow groundwater. Dewatering activities near groundwater recharge zones could also potentially introduce contaminants into shallow groundwater. BMPs could be utilized to minimize impacts associated with construction activities (see **Section 4.8.3**).

During construction activities, the drainage system would need to be protected from erosion sediment. Both the ditches and outfalls would need to be protected to prevent erosion. Any connections made to existing storm sewer systems may require the upsizing of the downstream pipes to handle added capacity.

The existing storm sewer system in the Interlocken Technology Park would need to be further investigated to assess the potential impacts as a result of the build alternatives. This area has a storm sewer system and appears to use common detention. Both roadway detention and development detention are used as water features on development property or the Omni Interlocken Golf Course. The capacity of these facilities has not been analyzed, and the potential use of these ponds for additional runoff is unknown at this time.

INDIRECT EFFECTS

Indirect effects to water quality are likely with all build alternatives. Most of the indirect effects are associated with the detention ponds used as BMPs and discussed in the suggested mitigation section. While these ponds are designed to mitigate water quality impacts and prevent flooding, the area required to construct them impacts other resources. For instance, in some cases, previously undisturbed areas would be developed thereby impacting the natural vegetation and wildlife habitat.

The collections of stormwater required by the MS4 permit results in indirect effects. Hazardous waste or chemical spills occurring on the roadway may be intensified by concentrating and discharging directly into a BMP structure or receiving water. This is not anticipated to be a common occurrence because the current roads and roads associated with the build alternatives in the study area are not designated hazardous waste routes. Although roads associated with the build alternatives could become a designated hazardous waste route in the future, there are no current plans for such designation.

Many of the potential direct impacts associated with groundwater could also be considered indirect effects. For example, the alteration of discharge areas could impact the depth of the water table. Therefore, most of the impacts previously discussed, with the exception of the dewatering impacts during construction, would also be considered indirect effects.

4.8.2.3 NO ACTION ALTERNATIVE

DIRECT IMPACTS

As with all build alternatives, the No Action Alternative would have impacts if implemented. The degree of impacts associated with the No Action Alternative may vary from the build alternatives; however, mitigation measures (BMPs) included in the design of the build alternatives should be considered in an overall comparative evaluation. Currently, minimal BMPs are in place in the study area. The current situation allows overland flows or direct discharge into receiving waters, where the build alternatives would pass water through BMPs, typically detention basins, which remove contaminants including sediments. These BMPs also are designed for flood attenuation that prevents large storm events from eroding stream banks and causing severe scour.

Since there are not many permanent BMPs for stormwater treatment existing in the study area and, under the No Action Alternative, not many projects will be constructed that may require BMPs, the impacts from increased stormwater runoff velocity and volumes will continue.

Chemical constituents in roadway runoff would increase with the No Action Alternative as traffic volumes continue to increase. However, chemicals in roadway runoff are not anticipated to cause exceedances of acute biological criteria (see **Table 4.8-6**). As previously stated, BMPs associated with the build alternatives would remove much of the sediments, and hence much of the total recoverable metals that have been absorbed by the sediment particles. These metals would not be removed from runoff with the No Action Alternative and there would be an increase in sediment and total recoverable metal loads to waterbodies.

No dramatic impacts to groundwater would be associated with the No Action Alternative.

The impacts of the No Action Alternative to the drainage system would be mainly maintenance impacts. Many of the culverts are clogged and undersized, which leads to flooding. The roadside ditches conveying runoff are subject to erosion and lead to sedimentation of downstream culverts. Ditch erosion and outfall erosion also would occur. General debris limits capacity in both ditches and culverts. Maintenance would need to be performed to keep conveyance elements performing as designed. Any culverts that are undersized or damaged would need to be replaced as part of a maintenance project.

INDIRECT EFFECTS

Indirect effects associated with the No Action Alternative include further degradation of aquatic habitat caused by increasing sediment loads from the current roadways. As traffic volumes gradually increase, the sediment load from the roadway would increase and impact aquatic habitat by filling in spaces between the cobbles and other natural substrates of the stream bottoms. Eventually, the sedimentation could overcome the receiving water's natural ability to control the natural substrate and would change the natural character of the receiving water.

4.8.2.4 FREEWAY ALTERNATIVE

This section discusses the direct impacts specific to the Freeway Alternative. The indirect and cumulative impacts associated with the Freeway Alternative are discussed in **Section 4.8.2.2**.

Surface Water

The amount of impervious surface is a general measurement of potential water quality impacts associated with increases in water velocities and volumes. The total amount of impervious surface associated with the construction of the Freeway Alternative is approximately 389 acres, or 299 acres greater than the existing condition, which is less than the Regional Arterial Alternative and the Combined Alternative (Recommended Alternative).

The results of the Driscoll Model show that the increase in constituent loading for the Freeway Alternative over the No Action Alternative ranges from 26 percent to 60 percent. The Freeway Alternative has the greatest or second greatest increase in constituent loading for four of the six watersheds (Rock Creek, Ralston Creek, Van Bibber Creek, and Clear Creek [Beaver Brook to South Table Mountain]). In the Big Dry Creek and Leyden Creek Watersheds, the percentage increase of constituent loading is similar to the Tollway Alternative and the Combined Alternative (Recommended Alternative). It should be noted that in these two watersheds, the Freeway Alternative is located along undeveloped land where no roadway currently exists, thus creating a new source of loading.

BMPs (typically, extended detention ponds) have been incorporated into the design of the Freeway Alternative. The removal efficiencies, or the percentage of constituent removed by the BMP, are presented (see **Table 4.8-8**). Only values for total suspended solids, total phosphorus, and total zinc are presented because these values are widely accepted, while removal efficiencies for other constituents have not been widely agreed upon (CDOT, 2004a). Zinc is used as a general gauge for other metals because zinc has been identified as an "indicator" of stream health in Clear Creek, the major stream in the study area (USEPA/CDPHE, 1997). Zinc typically stays in solution rather than attaching to particles like other metals.

Therefore, using zinc is a conservative indicator for other metals. Other metals, such as cadmium have been found to be associated with the particulate form in stormwater runoff (Thiem et al. 1998).

As shown in the table, the expected probable range of pollutant removals by extended detention ponds extends to 60 and 75 percent removal of total zinc and TSS, respectively. This means that an extended detention pond will be able to bring the Freeway Alternative constituent loads down to the No Action Alternative levels. Based on the literature reported range (LRR) and expected probable range (EPR), total phosphorus can be reduced to No Action Alternative Levels with retention ponds in the Van Bibber Creek Watershed.

Table 4.8-8 BMP Removal Ranges (percentages) for Stormwater Runoff and Expected Probable Range for BMPs.

	Total Suspended Solids		Total Phosphorus		Total Zinc	
	LRR	EPR	LRR	EPR	LRR	EPR
Grass Buffer	10–50	10–20	0–30	0–10	0–10	0–10
Grass Swale	20–60	20–40	0–40	0–15	0–40	0–20
Modular Block Porous Pavement	80–95	70–90	65	40–55	98	40–80
Porous Pavement Detention	8–96	70–90	5–92	40–55	10–98	40–80
Porous Landscape Detention	8–96	70–90	5–92	40–55	10–98	50–80
Extended Detention Basin	50–70	55–75	10–20	45–55	30–60	30–60
Constructed Wetland Basin	40–94	50–60	4–90	40–80	29–82	30–60
Retention Pond	70–91	80–90	0–79	45–70	0–71	20–60
Sand Filter Extended Detention	8–96	80–90	5–92	45–55	10–98	50–80
Constructed Wetland Channel	20–60	30–50	0–40	20–40	0–40	20–40

Notes: LRR = Literature Reported Range
EPR = Expected Probable Range

Source: ***Table 4.7*** *in CDOT ,2004.*

Groundwater

New landslides can be initiated or old slides can be reactivated by changes in groundwater movement, including changes that increase load at the top of a slope or decrease strength within or at the toe of a slope. Water-lubricated landslides can occur on gentle slopes. An active but currently stabilized landslide lies just north of Clear Creek on the west side of SH 93 along the Freeway Alternative. The landslide area is on the Golden Fault, which probably provides a groundwater conduit that lubricates bedrock in the slide area and exacerbates the condition. Similar landslides could develop along SH 93 where the Golden Fault intersects the Freeway Alternative. These impacts are not direct impacts to groundwater, but are further discussed in the Geology and Soils discussion (see **Section 4.19**). Any potential impacts are expected to be minor impacts to very shallow aquifers and not to the major, deep aquifers.

Drainage System
The major impact of the Freeway Alternative would be to existing drainage systems. The increased runoff would require some of the existing systems to be enlarged.

4.8.2.5 Tollway Alternative

This section discusses the direct impacts specific to the Tollway Alternative. The indirect and cumulative impacts associated with the Tollway Alternative are discussed in **Section 4.8.2.2**.

Surface Water
The amount of impervious surface associated with the construction of the Tollway Alternative is approximately 363 acres, or 290 acres above existing conditions—the least amount of all of the build alternatives. The Tollway Alternative has the least impervious surface area because it has fewer interchanges or intersections to maintain limited access. However, because construction of the Tollway Alternative would require existing roads, such as SH 93, be maintained in their current non-tolled state, the Tollway Alternative would need to be a completely separate facility leaving the existing roads intact. Therefore, the total amount of impervious surface area associated with the Tollway Alternative and the existing roadway laneage is considerable.

The results of the Driscoll Model show that the increase in constituent loading for the Tollway Alternative over the No Action Alternative ranges from 29 percent to 55 percent. The Tollway Alternative has the greatest or second greatest increase in constituent loading for half of the six watersheds (Rock Creek, Leyden Creek, and Clear Creek [Beaver Brook to South Table Mountain]). It has the lowest percentage increase for the Big Dry Creek and Van Bibber Creek Watersheds. In the Big Dry Creek and Leyden Creek watersheds, the percentage increase of constituent loading is similar to the Freeway Alternative and the Combined Alternative (Recommended Alternative). It should be noted that in these two watersheds, the Tollway Alternative is located along currently undeveloped land where no roadway currently exists, thus creating a new source of constituent loading.

As shown in **Table 4.8-8**, the expected probable range of pollutant removals for extended detention ponds extends to 55, 60, and 75 percent removal of total phosphorus, total zinc, and total suspended solids, respectively. This means that an extended detention pond will be able to bring the Tollway Alternative loads down to the No Action Alternative levels.

Groundwater and Drainage System
The major impact of the Tollway Alternative would be to existing drainage systems. The increased runoff would require some of the existing systems to be enlarged.

4.8.2.6 Regional Arterial Alternative

This section discusses the direct impacts specific to the Regional Arterial Alternative. The indirect and cumulative impacts associated with the Regional Arterial Alternative are discussed in **Section 4.8.2.2**.

Surface Water
The amount of impervious surface associated with the construction of the Regional Arterial Alternative is approximately 479 acres, or 348 acres above existing conditions. This impervious surface area is considerably greater than the current conditions and the greatest of all of the build alternatives. The amount of impervious surface is a general measurement of potential water quality impacts because of their association with increases in water velocities and volumes. The Regional Arterial Alternative has more impervious surface area than the Freeway Alternative, Tollway Alternative, and Combined Alternative (Recommended Alternative) because, to stay on existing roadways, the alternative takes a more circuitous and, therefore, longer route (approximately 3 miles longer) specifically, along SH 128 and Indiana Street in the north and SH 72 and SH 93 in the central portion of the study area. Additionally, the Regional Arterial Alternative has a combination of interchanges and intersections at a higher frequency than the other alternatives. Turning lanes associated with these intersections result in additional impervious surface area.

The results of the Driscoll Model show that the increase in constituent loading for the Regional Arterial Alternative over the No Action Alternative ranges from 16 percent to 66 percent. The Regional Arterial Alternative has the greatest or second greatest increase in constituent loading for four of the six watersheds (Big Dry Creek, Leyden Creek, and Van Bibber Creek). It has the lowest percentage increase for the Clear Creek (Beaver Brook to South Table Mountain) Watershed.

As shown in **Table 4.8-8**, the expected probable range of pollutant removals for extended detention ponds extends to 55, 60, and 75 percent of total phosphorus, total zinc, and total suspended solids, respectively. This means that an extended detention pond will be able to bring the Regional Arterial Alternative constituent loads down to the No Action Alternative levels for total suspended solids in all watersheds; total phosphorus in Rock Creek, Ralston Creek, and Clear Creek (Beaver Brook to South Table Mountain) Watersheds and total zinc in all but Big Dry Creek.

Based on the LRR and the EPR, total phosphorus, and total zinc can be reduced to the No Action Alternative levels with retention ponds in the Big Dry Creek, Leyden Creek, and Van Bibber Watersheds.

Groundwater

Numerous faults and fracture zones exist across the study area. Faults are important because they can:

- Provide preferential conduits for groundwater movement.
- Compartmentalize flow by putting impermeable and permeable units into contact.
- Hydraulically connect shallow aquifers with deep bedrock aquifers.

These areas are of particular concern. The portion of the Regional Arterial Alternative between Walnut Creek and SH 128 crosses the Walnut Creek Fault, which offsets the contact between the Laramie Formation and overlying alluvium. The site is of concern because underlying material is at a depth of less than 10 feet and may have high shrink-swell potential and can be more susceptible to groundwater impacts. Any potential impacts are expected to be minor and only very shallow aquifers and not the major, deeper aquifers.

Drainage System

The major impact of the Regional Arterial Alternative would be to existing drainage systems. The increased runoff would require some of the existing systems to be enlarged.

4.8.2.7 COMBINED ALTERNATIVE (RECOMMENDED ALTERNATIVE)

This section discusses the direct impacts specific to the Combined Alternative (Recommended Alternative). The indirect and cumulative impacts associated with the Combined Alternative (Recommended Alternative) are discussed in **Section 4.8.2.2**.

Surface Water

The amount of impervious surface associated with the construction of the Combined Alternative (Recommended Alternative) is 426 acres, or about 326 acres greater than the current conditions. This equates to the second greatest amount of impervious surface of all build alternatives because of the additional roadway associated with the segment along Indiana Street/McIntyre Street. The amount of impervious surface is a general measurement of potential water quality impacts because of their association with increases in water velocities and volumes.

The results of the Driscoll Model show that the increase in constituent loading for the Combined Alternative (Recommended Alternative) over the No Action Alternative ranges from 8 percent to 57 percent along the US 6/SH 93 alignment and from 6 percent to 67 percent along the Indiana Street/McIntyre Street alignment.

US 6/SH 93 Alignment
The Combined Alternative (Recommended Alternative) has the second greatest increase in constituent loading the Big Dry Creek Watershed. It has the lowest percentage increase for the Rock Creek and Leyden Creek Watersheds. In the Big Dry Creek and Leyden Creek Watersheds, the percentage increase of constituent loading is similar to the Freeway Alternative and Tollway Alternative. It should be noted that in these two watersheds, the Combined Alternative (Recommended Alternative) is located along currently undeveloped land where no roadway currently exists, thus creating a new source of constituent loading.

As shown in **Table 4.8-8**, the expected probable range of pollutant removals for extended detention ponds extends to 55, 60, and 75 percent of total phosphorus, total zinc, and total suspended solids, respectively. This means that an extended detention pond will be able to bring the Combined Alternative (Recommended Alternative) constituent loads down to the No Action Alternative levels for total suspended solids and total zinc in all watersheds, and for total phosphorus in all except the Big Dry Creek Watershed.

Based on the LRR and the EPR, total phosphorus can be reduced to the No Action Alternative levels with retention ponds in the Big Dry Creek Watershed.

Indiana Street/McIntyre Street Alignment
As shown in **Table 4.8-8**, the expected probable range of pollutant removals for extended detention ponds extends to 55, 60, and 75 percent of total phosphorus, total zinc, and total suspended solids, respectively. This means that an extended detention pond will be able to bring the Combined Alternative (Recommended Alternative) constituent loads down to the No Action Alternative levels for total suspended solids in all watersheds; total zinc in all watersheds except for Big Dry Creek and Clear Creek (Denver to Mouth); and total phosphorus in the Van Bibber and Clear Creek (South Table Mountain to Denver) Watersheds.

Based on the LRR and the EPR, total zinc and total phosphorus can be reduced to the No Action Alternative levels with retention ponds in the Big Dry Creek, Leyden Creek, and Clear Creek (Denver to Mouth) Watersheds.

<u>Groundwater</u>
The direct impacts to groundwater from this alternative are expected to be the same as those listed for the Freeway Alternative.

<u>Drainage System</u>
The major impact of the Combined Alternative (Recommended Alternative) would be to existing drainage systems. The increased runoff would require some of the existing systems to be enlarged.

This alternative involves improvement along Indiana Street south of SH 72 and along McIntyre Street that are not included in the other build alternatives. Many water supply and agricultural irrigation ditches pass under or parallel to this alignment. Extension or replacement of 13 irrigation canal crossings would need to occur. In addition, a 700-foot section of Croke Canal that runs parallel to Indiana Street would need to be enclosed or realigned. Irrigation disturbances associated with construction would be a major impact of this alternative. The water supply canals, unlike agricultural irrigation, continue to operate year-round. The water supply ditches are out of service at various times during the year and construction would have to accommodate ditch operation schedules. Special erosion control and sediment control measures would need to be implemented during construction to avoid affecting those canals under operation.

Adverse impacts would transpire at the regional detention pond located on Moon Gulch. The pond is located north of 72nd Street on the west side of Indiana Street. The pond has a total detention volume of 102 acre-feet with 4.33 acre-feet of water quality detention. The pond volume would decrease as a result of roadway improvements and the shifting of the Croke Canal to the west.

Minor changes to historical drainage patterns would happen because of this alternative. Currently, runoff from the roadway surface discharges into the water supply canal. The owners of the canals would no longer permit this occurrence. Runoff would be directed to the nearest natural drainageway or existing storm sewer system.

4.8.3 Suggested Mitigation

4.8.3.1 Mitigation Analysis

All build alternatives would have stormwater runoff impacts because of increases in impervious surface area. The impacts to receiving waters would include increased stormwater flow; increased sediment loading; and an increase in metal, oil, grease, and general debris. To mitigate these impacts into conformance with the Clean Water Act and State of Colorado Regulations, BMPs could be developed to protect the designated uses of the receiving waters.

As previously discussed, the study team is applying the conditions of CDOT's MS4 Permit (COS-000005) to the entire study area. In accordance with the permit, BMPs will be designed, constructed, and maintained. BMPs are methods to improve and/or maintain existing water quality by treating stormwater to the maximum extent practical. There are three main types of BMPs: structural, nonstructural, and construction.

- Structural BMPs remain in place and require routine maintenance to ensure their functionality. Examples are grass buffers, water quality/sedimentation ponds, riprap outlet protection, and wetland channels.
- Nonstructural BMPs reduce or eliminate the pollutants that impact stormwater runoff (UDFCD, 2001). Examples are street sweeping and spill containment.
- Construction BMPs reduce erosion of disturbed soil and often remain in place until vegetation is established. Examples are silt fences, straw bale barriers, and temporary check dams.

Structural BMPs

CDOT's MS4 permit requires that structural BMPs be included for the on-site drainage area. The goal of this requirement is to improve and protect water quality conditions in the receiving waterbody. Currently very few BMPs, such as riprap outlet protection, for roadway runoff are present within the study area. With the construction of a build alternative, the quality of stormwater runoff discharging into the receiving waters in some locations could be improved over existing conditions. The New Development and Redevelopment Program states that 100 percent of water quality capture volume (WQCV) must be provided for the study area or there must be 80 percent removal of total suspended solids (CDOT, 2004). Many different structural BMPs that met approval for use in CDOT projects can meet these requirements.

The Northwest Corridor is considered to be a Tier 1 BMP project because of the sensitivity of the water resources in the study area. This is the highest, most protective level of BMP application. There were three analyses undertaken for the BMP evaluation process for this study: (1) sensitive waters evaluation, (2) physical design constraints, and (3) maintenance considerations.

Sensitive Water Evaluation

The evaluation of sensitive waters in the study area was completed and sensitive waters identified (see **Northwest Corridor Supporting Technical Document-Water Resources**). A sensitive water is defined as a water body that is on the State of Colorado's Impaired Stream list, is used as a domestic drinking water source, has the presence of threatened or endangered species, is a high quality recreational water, or is a high quality cold water stream. The result of this analysis was that a majority of the streams in the study area would be considered sensitive because they deliver water for storage and are eventually used as drinking water.

Physical Design Constraints

Design constraints for BMPs, such as drainage area size, are required for the BMP, and releases to water bodies were considered during the BMP evaluation process. There are many BMPs that could be used, such as constructed wetlands, extended detention ponds, grass swales, and proprietary BMPs. Extended detention/retention ponds were determined to be the water quality BMP of choice for this project because of the adequate space, climatic considerations, and requests of CDOT Maintenance personnel (see discussion below). Extended detention/retention ponds have been incorporated into the designs for the build alternatives where feasible, considering physical design constraints (see **Figure 4.8-1** through **Figure 4.8-3**). During the preliminary drainage design, adjacent property usages and right-of-way requirements were considered and included in the overall alternative designs. It is anticipated that changes to types or sizes of BMPs could be modified to further minimize or avoid other environmental resources, such as Section 4(f) resources.

The preliminary drainage design for the build alternatives is based on the CDOT *Drainage Design Manual* (CDOT, 2004c) and Volume 3 of the Urban Drainage and Flood Control District (UDFCD) *Urban Storm Drainage Criteria Manual* (2001). The UDFCD manual would be used for the design of hydraulic features. The criteria in these two manuals should help minimize impacts associated with highway and urban development.

Maintenance Considerations

The maintenance and longevity of a BMP needs to be considered. The available maintenance equipment and the access required would influence the design. The designs should also consider the man hours required to ensure that the BMP works as designed. Meetings with CDOT Maintenance were conducted as part of this study. During these meetings, maintenance personnel requested that subsurface structures be avoided if at all possible. These structures are difficult to inspect and may require specialized equipment for maintenance. Also, maintenance personnel would need to be trained to comply with the OSHA confined space entry requirements. During the conceptual design for the build alternatives, extended detention/retention ponds were incorporated so that the 100 percent WQCV requirement is anticipated. Therefore, subsurface structures would not be necessary to meet the Tier 1 BMP requirements.

NONSTRUCTURAL BMPS

Nonstructural BMPs include general maintenance practices such as street sweeping and snow storage and removal practices. The use of magnesium chloride and other deicers instead of salt and sand is another example of a nonstructural BMP.

CONSTRUCTION BMPS

There is also potential for several temporary impacts to a river due to the demolition and construction activities of a bridge. CDOT's specifications for managing stormwater at a construction site (currently specifications 107.25 and 208) should be followed. When put into practice, the actions identified below could help avoid such impacts:

- If lead paint is present, this material must not be allowed to flake off and enter receiving waters. (Section 402, Clean Water Act, CDPHE Regulation 61).
- If cranes and other equipment are used for bridge demolition within a river or streambank area, the equipment would be kept out of the river to the greatest extent possible, and all work shall minimize temporary impacts to the river (State Regulation, Senate Bill 40). The creation of a crane pad is necessary if cranes or other equipment cannot be kept out of the river.
- Sediment may enter the river from land disruption and subsequent erosion. Construction BMPs would be implemented and maintained in compliance with the CDPHE general construction permit. Construction plans must develop and adhere to a stormwater management plan (Section 402, Clean Water Act, CDPHE Regulation 61).

- An energy dissipation device or material, such as riprap, will control post-construction erosion near the bridge. If riprap is used above the ordinary high water level of the river, it must be covered with topsoil and vegetated. Vegetation or other erosion control techniques (as indicated by CDOT erosion control practices) must be established to prevent sediment loading in compliance with the general stormwater construction permit.
- Caissons used to create bridge piers may require groundwater dewatering. A discharge permit and a possible treatment strategy would be needed before dewatering activities can occur.

PERMITS
All applicable permits associated with water quality should be obtained prior to construction of this project. These include, but are not limited to, National Pollutant Elimination Discharge Elimination System (NPDES) and Colorado Discharge Permit System (CDPS) dewatering permits.

4.8.3.2 PROJECT SPECIFIC MITIGATION

NO ACTION ALTERNATIVE
The No Action Alternative would not contain any mitigation measures. Mitigation measures would have to occur as part of maintenance projects or other development within the basin.

MITIGATION COMMON TO ALL BUILD ALTERNATIVES
All build alternatives should follow the design standards as listed above. These standards are accepted practices designed to limit impacts associated with highway construction. Outfall protection should be provided and energy dissipaters should be implemented where needed. Special attention to detention would be required in Interlocken to account for highway improvements and future development. There is potential for coordinated use of detention ponds that needs to be investigated.

Any runoff during construction and after completion located adjacent to Rock Flats National Wildlife Refuge must follow the existing drainage patterns. Great Western Reservoir and the containment reservoir should ultimately receive the runoff to prevent any possible contamination associated with contaminated soils.

Any construction near or within delineated floodplains should comply with federal requirements set forth by Executive Order 11988, Floodplain Management, and applicable FHWA and FEMA requirements.

The study area complies with CDOT's MS4 permit. If a build alternative is selected, final design would require coordination with adjacent municipalities to meet the MS4 permit requirements of those communities.

FREEWAY ALTERNATIVE
Accommodations for water quality are integrated into the design of the Freeway Alternative. A combination of extended detention ponds and/or retention ponds have been provided for all areas, with the exception of direct discharge from snow plow blast from bridge decks and the Interlocken area. Extended detention/retention ponds would be located within interchange infields where possible. Areas of additional right-of-way needed for detention has been incorporated into the current plans. The exact pond sizes are approximate, and outfalls have not been designed. Special care was taken to match historical drainage patterns.

The alignment for the Freeway Alternative would be within 1,000 feet of the water surface at the western end of Welton Reservoir. Water quality ponds have been incorporated to treat highway runoff. The proposed roadway adjacent to the reservoir is below the existing ground since any material that spills would be directed to the water quality ponds. Because of the proximity to a water supply sources, these ponds would be designed as retention/infiltration ponds, and there would be no discharge to the reservoir.

TOLLWAY ALTERNATIVE

The mitigation measures for this alternative are the same as those for the Freeway Alternative.

There would be additional considerations for the area discharging to Clear Creek. Special BMPs may need to be considered for discharges into the creek. Clear Creek is on the impaired stream list for cadmium and zinc. Cadmium and zinc are pollutants associated with highway runoff and BMPs to treat these specific pollutants may be required. Further investigation into this mitigation measure would be conducted if this is the chosen build alternative.

REGIONAL ARTERIAL ALTERNATIVE

The proposed improvements for the Regional Arterial Alternative occur on the south side of Welton Reservoir along the SH 72 alignment. As with the previous alternatives, special water quality mitigation would need to be considered. To prevent any direct discharge or material spills from the roadway, a combination of infiltration ditches, retention ponds, and walls would be used. Infiltration swales, detention ponds, and retention ponds could be used along the SH 72 alignment just east of the reservoir. Directly adjacent to the reservoir, the roadway section along the SH 72 alignment would consist of walls and a storm sewer system to convey any potential pollutants downstream of the reservoir.

COMBINED ALTERNATIVE (RECOMMENDED ALTERNATIVE)

The Combined Alternative (Recommended Alternative) has the same alignment near Welton Reservoir as the Freeway Alternative and Tollway Alternative. The same mitigation measures would be implemented.

As previously mentioned, historic drainage patterns would occur as a result of water supply canal mitigation. Extended detention/retention ponds should be used to ensure that rerouted flows do not impact historic flow rates. Clean water diversions and other erosion and sediment control BMPs should be implemented during the construction phase to ensure the uninterrupted operation of the water supply canals.

The regional detention pond located north of 72nd Street on the west side of Indiana Street would need to be regraded and a new outfall designed. Under the current design, the pond is overtopped in the 100-year event and the overflow conveyed in Croke Canal. Further investigation would be required to determine if historical routing could continue. The existing pond has a total detention volume of 102 acre-feet with 4.33 acre-feet of water quality detention. Under current definitions, this pond may be defined as a jurisdictional dam. Any retrofitting or improvements pond may require the approval of the State Engineers Office.

4.8.4 SUMMARY

Because of the application of water quality BMPs (extended detention and retention ponds), constituent loading from all alternatives can be reduced to the No Action Alternative levels. Therefore, all alternatives are essentially equal in terms of constituent loading. However, the Regional Arterial Alternative has the greatest amount of increased impervious surface over the No Action Alternative, followed by the Combined Alternative (Recommended Alternative), the Freeway Alternative, and the Tollway Alternative.

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