Section 6
Water Quality

6.1 Introduction

The Deadmans Run watershed is considered fully urbanized. As such, the land is covered with impervious surfaces such as roads, parking lots, roofs, driveways, and sidewalks that prevent rainfall from infiltrating into the ground. Even the remaining green space, (pervious surfaces) such as parkland, cannot infiltrate rainfall into the ground as rapidly as it did before development because during construction the topsoil is removed, compacted, and/or mixed with the underlying less permeable soil. The combined result is that infiltration is greatly reduced or halted by urbanization, and 40 to 90 percent of the rainfall (depending upon land use) is directly converted to stormwater runoff. This causes an increase in stormwater runoff flow rate, volume, and velocity. If the proper stormwater controls are not installed as urbanization occurs, these hydrologic changes will cause erosion and sediment deposition within the natural stream network.

Over the years, the majority of open channels within the Deadmans Run watershed have been channelized with hard armoring materials. The armoring has mitigated the erosion problems caused by urbanization but at the same time minimized aquatic habitat, limited natural filtration for water quality, and may be contributing to increased velocities that cause erosion in unlined portions of the main channel. Several natural stream segments still remain, including the segment extending from Cornhusker Highway to the confluence with Salt Creek, which is experiencing bed and bank failures. Section 7 of this report discusses fluvial geomorphology, or the science of how moving water shapes the land, and the geomorphic processes that are causing the stream instability problems that are affecting the natural stream segments.

In addition to the adverse impacts caused by increased erosion and sediment deposition, aquatic habitat is also affected by pollutants transported by stormwater runoff. During dry weather, impervious surfaces collect pollutants such as oil and grease that leak from automobiles and sand and salt deposits along roadways. Other pollutants include nutrients and bacteria from pesticides and fertilizer usage, leaves, grass clippings, and animal wastes. The pollutants have the potential to directly impact water quality in the Deadmans Run main channel as well as adversely impact water quality in downstream water bodies.

6.2 Regulatory Compliance

The Deadmans Run drainage system is subject to regulatory requirements that are designed to improve the stormwater runoff quality with the goal of maintaining an acceptable surface water quality within the channel system. A brief overview of these regulations is provided below.

6.2.1 Stormwater Regulations

Stormwater runoff quality is regulated under the National Pollutant Discharge Elimination System (NPDES) Program. Specifically, the 1987 amendment to the Clean Water Act (CWA) introduced regulations pertaining to stormwater, which are enforced by EPA and individual

states and tribes. Because the State of Nebraska is a delegated state, the stormwater program is implemented by the Nebraska Department of Environmental Quality (NDEQ). To comply with the NPDES program, the City is required to develop, implement, and enforce a program to address the quality of stormwater runoff. The program must involve the implementation of BMPs, which are actions and practices designed to preserve the quality and integrity of streams and lakes. In general, BMPs can be classified as nonstructural and structural.

Nonstructural BMPs consist of pollution prevention techniques designed to prevent the pollutants from entering the drainage system rather than trying to control pollutants with constructed facilities (structural BMPs). Structural BMPs are constructed facilities such as designed to remove pollutants and slow down the runoff before the stormwater enters the receiving stream. Structural BMPs are designed to address the smaller more frequent rainstorms that carry the majority of pollutants. In designing structural BMPs, the smaller rainstorms are defined by the water quality control volume (WQCV), which is the initial amount of stormwater runoff from a development site. The use of specific structural BMPs depends on the site conditions and objectives such as pollutant removal, stream stability, and flood control.

6.2.2 Surface Water Regulations

The CWA also requires that each state establish water quality standards to protect public health or welfare and enhance the quality of surface waters. The water quality standards applied to surface waters consist of two primary parts: (1) designated or beneficial uses, and (2) the water quality criteria necessary to protect those uses. These two elements, which are applicable to any surface water, provide the basis for evaluating water quality data and identifying water quality concerns.

NDEQ is the regulatory agency responsible for establishing and implementing water quality standards in the State of Nebraska. NDEQ has established the following beneficial uses for Deadmans Run (Nebraska Administrative Code, Title 117, Chapter 5, Section 004):

- Primary Contact Recreation - waters where there is a high potential for prolonged or intimate contact with the water, including swimming
- Aquatic Life Warmwater Class B - waters where the resident biota is presently limited by water volume or flow, water quality (natural or irretrievable human-induced conditions), substrate composition, or other habitat conditions
- Agricultural Water Supply Class A - waters used for general agricultural purposes (e.g., livestock watering and irrigation) without treatment
- Aesthetics - waters that are aesthetically acceptable and free from human-induced pollution such as noxious odors, floatable materials, refuse, and algal blooms

As required by CWA regulations, NDEQ periodically assesses available water quality data to identify water quality concerns. If the concern is sufficiently high, a surface water may be classified as impaired, i.e., water quality data indicate that one or more beneficial uses are not protected. Waters classified as impaired are placed on the 303(d) list and require the development of a total maximum daily load (TMDL). A TMDL establishes the

pollutant control requirements deemed necessary to resolve the impairment and bring the water body into compliance with water quality standards.

The most recent assessment published by NDEQ (2006 Nebraska Surface Water Quality Integrated Report) indicated the following water quality conditions in Deadmans Run:

- Primary Contact Recreation - beneficial use is not supported; water body is impaired based on a finding of elevated concentrations of *Escherichia coli* (*E. coli*) bacteria
- Aquatic Life Warmwater Class B - beneficial use is supported; no water quality concerns identified that impair aquatic life
- Agricultural Water Supply Class A - beneficial use is supported; no water quality concerns identified that impair agricultural water supply
- Aesthetics - insufficient data available in 2006 assessment to evaluate this beneficial use

Based on the above assessment findings, NDEQ identified only one water quality pollutant at a level that resulted in pollutant control requirements in Deadmans Run: elevated bacteria that impair the primary contact recreation beneficial use. Accordingly, in June 2007 NDEQ published a TMDL for *E. coli*. The TMDL establishes allowable pollutant loadings for the Deadmans Run main channel. Per the TMDL, a 92 percent reduction in bacteria loading is required to achieve the bacteria water quality standard.

Implementation of the TMDL in Deadmans Run is targeted at control of nonpoint sources, including urban runoff. NDEQ plans to rely on the implementation of BMPs under stormwater discharge permits to improve water quality. If water quality improvements are not achieved, then, as noted in the TMDL, NDEQ may apply wasteload allocations to individual stormwater outfalls. If this occurs, additional treatment controls may be necessary at these outfalls.

6.3 Evaluation Approach

For this study, a water quality evaluation was conducted to evaluate various nonstructural and structural BMPs to address pollutants at their source and to provide treatment at regional locations. The water quality evaluation included three major components:

- Review of previous Deadmans Runs water quality studies, with the goal of building on past efforts.
- A limited wet weather sampling program to characterize the quality of the receiving waters
- Recommendation of watershed management practices to improve water quality, while addressing the regulatory issues

The following sections summarize the methodology, results, conclusions, and recommendations.

6.4 Previous Water Quality Studies

The University of Nebraska has published two studies addressing water quality issues in the Deadmans Run watershed. These studies are discussed below.

6.4.1 Stormwater Quality Evaluation of Livestock Runoff

A Masters of Science thesis, *The Storm Water Quality Evaluation of Livestock Runoff From East Campus Site* (written by Rabab Shamayleh under the supervision of Dr. Bruce Dvorak, December 2004), examined runoff from a transient livestock facility at the University's east campus, which was suspected to contribute surface water pollution in the Deadmans Run main channel. The thesis focused on one specific area in the watershed - immediately upstream of 38th Street adjacent to the main channel. During seven rainfall events, the quantity and quality of water discharged from upstream of the livestock facility and along the main channel of Deadmans Run were investigated. The test results showed a median fecal coliform count of 2,500 colony forming units (CFU)/100 milliliters (ml) at the upstream site and 21,000 CFU/100 ml along the main channel. The thesis concluded that the livestock facility is a source of bacterial loads to the Deadmans Run main channel. The thesis provided recommendations including additional sampling and implementation of BMPs to reduce the amount of bacterial contamination delivered to Deadmans Run main channel. The University is currently regulated through the NPDES program and is investigating options to address the bacteria issues.

6.4.2 Dry Weather Stormwater Monitoring

The University of Nebraska submitted the study Dry Weather Stormwater Monitoring to the City of Lincoln Public Works and Utilities Department, Engineering Services, in September 2005. The purpose of the study was to conduct dry weather sampling to characterize instream water quality and to identify areas contributing pollutants to the main channel during dry weather conditions. The University's report did not identify any linkage between water quality conditions and land use activities occurring at sample sites but did provide data within the watershed for temperature, pH, chloride, total chlorine, copper, fluoride, nitrate, sulfate, anionic surfactants, and phenols. The study recommended further investigation of six sites based on high concentrations of total chlorine, fluoride, surfactants, sulfates, or nitrates.

6.5 Wet Weather Water Quality Assessment

The objective of wet weather sampling is to characterize the quality of stormwater runoff and evaluate potential impacts to receiving waters. For this study, wet weather stormwater runoff data were collected and evaluated to assess stormwater quality in the main channel of Deadmans Run.

6.5.1 Water Quality Sampling Program

Samples were collected from two locations, the 33rd Street crossing at Baldwin Street and the 70th Street crossing of Deadmans Run (Figure 6-1). The sites were chosen based on

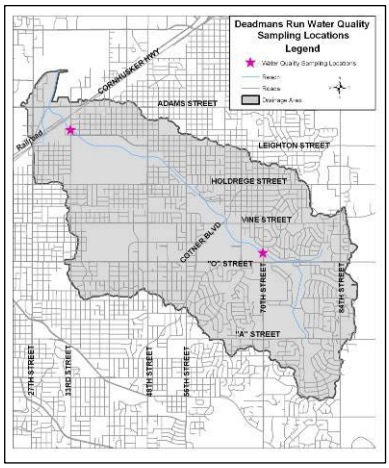


Figure 6-1
Water Quality Sampling Locations

the location in the watershed as well as accessibility to the stream. The 70th Street sampling site includes flow from the headwater tributaries, multiple parks, and Wedgewood Lake. The 33rd Street site was the best location to collect samples from the majority of the watershed while limiting safety concerns. Wet weather sampling was conducted during two separate storm events, the first on July 13, 2006, and the second on September 21, 2006. To capture the first flush, the team tracked weather conditions and prepared for a sampling event if the forecast called for a greater than 70 percent chance of rain. Grab samples were analyzed by Midwest Laboratories Inc. in Omaha, Nebraska. Constituents measured included biochemical oxygen demand, copper (total), cyanide, fecal coliform, fecal streptococcus, hexane extractable materials, kjeldahl nitrogen, lead (total), phenols, phosphorus (total), residual chlorine, total dissolved solids, total suspended solids, and zinc (total). The constituent analysis data sheets and comparison graphs are included in Appendix D.

6.5.2 Water Quality Sampling Results

Similar to previous NDEQ assessments, the water quality samples demonstrated compliance with the minimum requirements established for aquatic life protection but failed to comply with the primary contact recreation requirements for bacteria. In 2002, NDEQ opted to convert from fecal coliform to *E. coli* bacteria as the indicator for primary contact recreation assessment. The study sampling included fecal coliform rather than *E. coli* but still provides relevant results for analyzing bacteria concentrations. Comparing the results from the two sampling sites on July 13, 2006, the fecal coliform counts were higher at the 70th Street site (60,000 CFU/100 ml) than at the 33rd Street sampling site (55,000 CFU/100 ml). In contrast, the fecal coliform counts for the September 21, 2006 event were lower at the 70th Street site (6,000 CFU/100 ml) than at the 33rd Street site (60,000 CFU/100 ml). Such variability in bacteria results is common in stormwater runoff.

Although it is difficult to draw any location-specific conclusions from these data, the sample results support previous NDEQ findings regarding impairment. In addition, the wet weather results coupled with the dry weather data suggest that bacteria sources are widespread in the watershed. Identifying specific sources of bacteria can be difficult. Fecal coliform bacteria are microscopic organisms that live in the intestines of warm-blooded animals. Accordingly, potential sources range from livestock and wild animals to illicit sanitary sewer connections and pet waste.

6.6 Water Quality Recommendations

A series of watershed management recommendations are provided below that are designed to improve the water quality of Deadmans Run, with the primary goal of addressing the regulatory requirements. In addition to regulatory requirements, the recommendations address a wide variety of urban pollutants with the overall goal of water quality enhancement. The recommendations include enforcing existing nonstructural BMP programs, integrating structural BMPs using both retrofit techniques and installing new facilities, private sector BMP demonstration projects, and additional studies to better understand the pollutant sources.

6.6.1 Nonstructural BMPs

Nonstructural BMPs, if correctly implemented, can be the most efficient method of reducing stormwater pollution and improving water quality. The more nonstructural BMPs that are implemented in a watershed, the fewer burdens are placed on structural BMPs to remove pollutants from the stormwater runoff. For the Deadmans Run watershed the recommendation includes enforcing existing City programs that are designed to provide education, reducing pollutant sources, and using natural systems for stormwater management. These programs include:

- Outlot education program
- Low nonphosphorus fertilizer program
- Contractor/developer/realtor education
- Household hazardous waste collection program
- Earth Wellness Festival
- Waterfest
- Pet waste management education
- Rain to Recreation Program

6.6.2 Structural BMPs

The Deadmans Run watershed is fully urbanized and contains limited open space that is suitable for new structural BMPs. Because of this limitation, the recommended management strategy includes a combination of new structural BMPs located on public property and the retrofit of existing ponds to integrate water quality features. Once retrofitted, the existing ponds will perform like "extended wet detention basins," or "extended dry detention basins," which are types of structural BMPs designed to remove a variety of different pollutants. Table 6-1 lists the structural BMP CIP projects for the Deadmans Run watershed.

Table 6-1
Structural BMP CIP Projects

CIP No.	Project Name	Structural BMP Type
8	Wyuka Cemetery	Wet pond retrofit
9	Bethany Park	New extended dry detention basin
10	Russwood	Dry pond retrofit
11	Trendwood Park	New extended wet detention basin
12	Cotner Boulevard	New hydrodynamic separator

Section 8.3.4 of this report provides additional details for each of the projects listed above. In addition, the following paragraphs provide a general description of the structural BMPs being recommended for the Deadmans Run watershed.

Extended Dry Detention Basins

Targeted Constituents

Sediment	◗
Nutrients	○
Trash	●
Metals	◗
Bacteria	◗
Oil and Grease	◗
Organics	◗

Legend *(Removal Effectiveness)*
○ Low ◗ Medium ● High

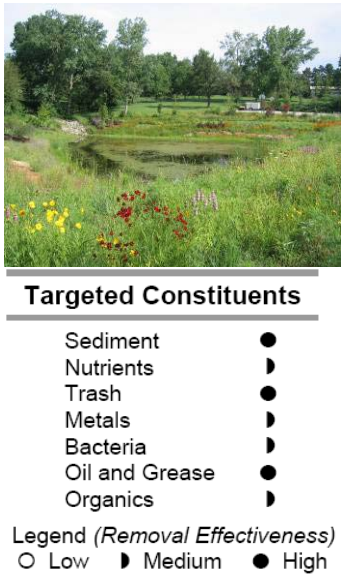
Extended dry detention basins are well suited for removing a variety of constituents including bacteria, which has been identified by NDEQ as a pollutant of concern for this watershed (Section 6.2.1). Therefore, this type of BMP is a good application for this watershed. In addition, these types of BMPs can be easily configured to become an integral part of the urban landscape by supplementing landscape features, park amenities, and passive and active recreation facilities. These types of detention facilities can be situated in a variety

of locations including residential developments, commercial property, open space lots, and adjacent to stream corridors.

The vegetation within the basin provides erosion control and sediment entrapment. The basin can be planted with native grasses or with turf grasses depending on the design intent and its other intended uses, such as recreation. Sediment deposition, along with frequent and prolonged periods of inundation, makes it difficult to maintain healthy grass cover on the bottom of the basin. Other alternatives are available, including marshy wetland bottoms, riparian shrub, or other types of vegetation that can survive conditions found at the bottom of the basin.

Extended Wet Detention Basins

Extended wet detention basins are similar to extended dry detention basins, except they are designed to have a permanent pool of water that is surrounded by emergent wetland vegetation. The permanent pool provides a mechanism for the settling of solids between storms and the removal of nutrients and dissolved pollutants. The wetland vegetation bench is called the littoral zone and provides aquatic habitat and enhances pollutant removal. Wet basins are superior to extended dry detention basins in their ability to remove a variety of pollutants including sediment, nutrients, and dissolved pollutants. Like Extended Dry Detention Ponds, Extended Wet Detention Basins remove bacteria, which is a pollutant of concern identified by the NDEQ (Section 6.2.1). The City's *Drainage Criteria Manual* refers to this type of BMP as retention (wet) ponds.



Extended wet detention basins offer a number of aesthetic advantages. Typically, wet basins are more attractive than dry detention basins and are considered property value amenities in many areas. This is primarily because the sediment and debris accumulate within the permanent pool, hiding it from public view.

Hydrodynamic Separator

Hydrodynamic separators are an effective means of removing heavy particulates that can be settled out or floatables that can be captured. The units come in a wide variety of sizes, some small enough to fit in manholes. This makes hydrodynamic separators ideal for urban watersheds or areas where available open space is limited. There are many separation systems available. One example is the Continuous Deflective Separation system, which uses the natural

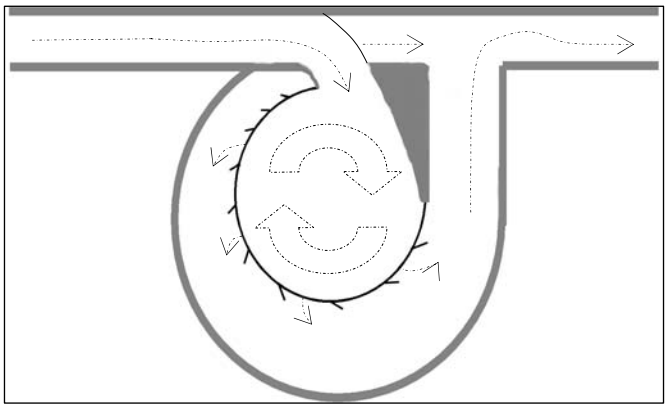


Figure 6-2
Continuous Deflection Plan View

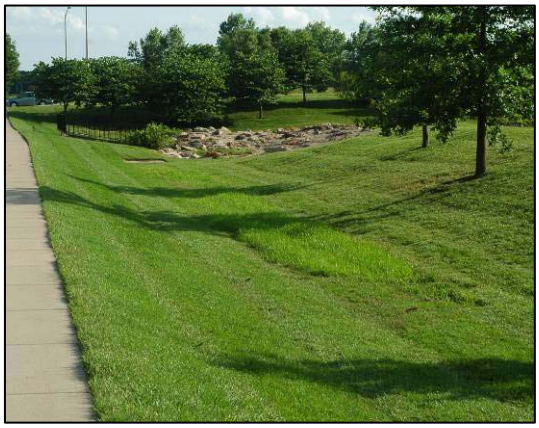
motion of water to separate and trap sediments by indirect filtration, as depicted on Figure 6-2. As the stormwater flows through the system, a very fine screen deflects the pollutants, which are captured in a litter sump in the center of the system. Floatables are retained separately. Maintenance of the hydrodynamic separator unit is site specific but typically requires inspection at least once every 30 days during the wet season. During these inspections, the floatables should be removed and the sump cleaned out (if it is more than 85 percent full). It is also recommended that the unit be pumped out and the screen inspected for damage at least once per year.

6.6.3 Private Development Demonstration Projects

One of the major sources of pollutants in urbanized watersheds is the large parking lots located within commercial and industrial areas. As discussed previously, these impervious surfaces collect pollutants such as oil, grease, sand, and salt, which are then transported by stormwater runoff into streams. To address this issue, the recommended management strategy is to partner with the private development community to implement parking lot structural BMPs to promote the benefits of these facilities.

The types of structural BMPs could include landscaped bioretention islands or grass swales located along the perimeter of parking lots. Examples of these techniques are provided below.

Example of bioretention cell



Example of a grass swale along a parking lot

6.6.4 Additional Studies

As discussed in Section 6.5.2, it is difficult to pinpoint site-specific sources of bacteria in the watershed, with the potential sources ranging from livestock, wild animals, pet waste, illicit sanitary sewer connections, and leaky sanitary sewer collection systems. In an effort to better understand potential human sources of bacteria, the following additional studies are recommended, which are beyond the scope of this Master Plan study:

- Conduct a comprehensive dry weather illicit sanitary sewer connection field investigation to identify potential bacteria sources.

- Conduct an inflow and infiltration study of the sanitary sewer system to identify areas where the collection system (manholes and pipelines) may contain maintenance issues, such as breaks and cracks, that may be contributing to the bacteria issues.

- Implement a comprehensive monitoring program. Monitoring is essential to all TMDLs to assess the future beneficial use status and to determine if the water quality is improving based on the implementation of the recommended BMPs. The monitoring program should include *E. coli* sampling along the main channel of Deadmans Run as well as localized sampling at the structural BMP sites. Sampling along the main channel is necessary to determine the overall effectiveness of implemented BMPs, whereas localized sampling provides necessary information to evaluate the effectiveness of specific BMPs.