CHAPTER 6
STRATEGIES FOR WATERSHED PROTECTION PLAN IMPLEMENTATION

INTRODUCTION

Chapters 4 and 5 illustrate the diverse sources of bacteria and nutrient loading to Kickapoo Creek in Henderson County. No single source of *E.coli* in the watershed is the primary cause of current levels in the watershed. According to SELECT modeling, cattle, pets, feral hogs, and OSSFs have the highest potential to contribute *E. coli* to the water body and its tributaries; however, all potential sources in the watershed contribute at some level. Due to the diverse potential sources, a range of management strategies are recommended to address all potential sources of *E.coli* in the watershed. Recommended management strategies were developed based on stakeholder feedback and management recommendation effectiveness in reducing bacteria loading.

Estimated potential load reductions from each management measure are presented with each recommended action discussed in this chapter. Each loading estimate presented is based on a predicted worst-case scenario loading. As a result, these estimates do not accurately predict real loadings that are occurring or expected load reductions that may be realized in-stream. Actual reductions are dependent on several factors that may trigger the need for adaptive implementation (AI). Potential annual load reductions from management measures are discussed in this chapter and indicate that reducing bacteria loads entering the Kickapoo Creek to levels that support primary contact recreation use is feasible.

Priority implementation areas for each recommended management strategy were identified based on spatial analysis and stakeholder feedback. While management measures can be implemented throughout the watershed, priority locations were selected based on areas where management strategies could be most effective in removing or reducing potential loading. To note, while the Kickapoo Creek in Henderson County watershed is primarily rural, urban areas do comprise of a small amount of the watershed. Opportunities to improve watershed health through improved stormwater management and water conservation do exist but are not included in this plan.

Table 6.1. Available pasture and rangeland practices to improve water quality.

Practice	NRCS Code	Focus Area or Benefit
Brush Management	314	Livestock, water quality, water quantity, wildlife
Fencing	382	Livestock, water quality
Filter Strips	393	Livestock, water quality, wildlife
Grade Stabilization Structures	410	Water quality
Grazing Land Mechanical Treatment	548	Livestock, water quality, wildlife
Heavy Use Area Protection	562	Livestock, water quantity, water quality
Pond	378	Livestock, water quantity, water quality, wildlife
Prescribed Burning	338	Livestock, water quality, wildlife
Prescribed Grazing	528	Livestock, water quality, wildlife

Range/Pasture Planting	550/512	Livestock, water quality, wildlife
Shade Structure	N/A	Livestock, water quality, wildlife
Stream Crossing	578	Livestock, water quality
Supplemental Feed Location	N/A	Livestock, water quality
Water Well	642	Livestock, water quantity, wildlife
Watering Facility	614	Livestock, water quantity

Natural Resource Conservation Service, NRCS

Stakeholder input was crucial throughout the decision-making process for these suggested management strategies. Management measures suggested in this chapter are voluntary and will rely on stakeholder adoption for successful implementation. Therefore, receiving stakeholder input on willingness to adopt these practices is important throughout this process. All management measures were discussed with and approved by stakeholders to ensure community support and successful implementation.

Management Measure 1 – Developing and Implementing Water Quality Management Plans or Conservation Plans

Potential bacteria loadings in the Kickapoo Creek watershed from cattle and other livestock are relatively high to other evaluated sources. Livestock waste is mostly deposited in upland areas and transported to water bodies during runoff events. Therefore, much of the *E. coli* bacteria in livestock waste die before reaching a water body. However, livestock may spend significant amounts of time in and around water bodies, thus, resulting in more direct impacts on water quality.

Livestock distribution is highly dependent upon the availability and distribution of water, food, and shelter. This allows livestock to be managed easily compared to non-domesticated species. The time livestock spends in and around riparian areas can be reduced by providing supplemental water, feed, shade, and forage around a property. As a result, it can effectively reduce the potential of *E. coli* concentrations from runoff entering nearby water bodies.

A variety of BMPs are available to achieve goals of improving forage quality, diversifying water resource locations, and better-distributing livestock across a property. Practices commonly implemented to effectively improve forage and water quality are listed in Table 6.1. However, the actual appropriate practices will vary by operation and should be determined through technical assistance from NRCS, TSSWCB, and local soil and water conservation districts (SWCDs) as appropriate. Currently, there are NUMBER conservation plans in the watershed. Through the implementation of this watershed plan, we hope to increase the adoption of Conservation Plans (CPs) and Water Quality Management Plans (WQMPs) to 50 total plans over the next 10 years. Load reductions achieved from this measure will vary depending on location and what conservation measures are implemented in various plans. Establishing additional acreage under management practices and additional conservation plans in this watershed is the primary goal of this management measure.

The implementation of CPs and WQMPs is beneficial, regardless of location in the watershed. Although those management measures mainly address and calculate bacteria sources from cattle, the use of CPs and WQMPs can reduce fecal loading from all types of livestock. Research has proven that recommended management measures also reduce nutrient and sediment loading from properties where they are implemented. The overall effectiveness of CPs and WQMPs can be greater on properties with riparian habitats. Therefore, all properties with riparian areas are considered a priority. Meanwhile, properties without riparian habitats are also encouraged to participate in implementation activities.

Priority areas will include Subwatershed 1, 6, 21, and 22. Table 6.2. summarizes management recommendations for cattle and other livestock in the watershed.

Management Measure 2 – Promote Technical and Direct Operational Assistance to Landowners for Feral Hog Control

Potential *E. coli* loading from feral hogs across the watershed represents a considerable potential influence on instream water quality. While other sources of *E. coli* are potentially larger in volume, due to feral hogs' preference for dense habitats, food resources, and water typically provided in riparian areas enhances the potential effects that they can have on instream water quality. Common feral hog behavior, such as rooting and wallowing also affects water quality by degrading ground cover, increasing soil/sediment disturbances, and decreasing bank stability. Through a combination of agency technical assistance, education, and landowner implementation of feral hog management techniques, the goal of this management measure is to reduce and maintain feral hog populations 15% below current populations (Table 6.3).

Physically removing hogs is the best strategy for reducing their impact on water quality. While complete eradication of feral hogs in the watershed is not feasible, a variety of methods are available to manage or reduce populations. Trapping animals is the most effective method available to landowners in the watershed. With proper planning and diligence, trapping can successfully remove large numbers of hogs at once. Furthermore, the costs of purchasing or building live traps can also be split amongst landowners. Shooting removes comparatively fewer hogs before they begin to move to other parts of the watershed.

Excluding feral hogs from the supplemental feed is also an effective management tool. Given the opportunistic feeding nature of feral hogs, minimizing available food from deer feeders is important. The construction of exclusion fences around a feeder can help reduce the ability of feral hogs to access food sources (Rattan et al. 2010). Additionally, locating feeders away from riparian areas is another important strategy for minimizing feral hog impacts on water quality.

Education programs and workshops will be used to improve feral hog removal effectiveness. Currently, AgriLife Extension provides a variety of educational resources for landowners: http://feralhogs.tamu.edu. Delivering up-to-date information and resources to landowners through workshops and demonstrations is critical to maximizing landowner success in removing feral hogs. Meanwhile, developing wildlife management plans designed by landowners to establish the goals of landowners and describe the activities and practices will benefit wildlife, habitat, and water quality as well.

Based on spatial analysis, the highest potentials for loadings from feral hogs are in Subwatershed 1 and 21. However, given feral hogs' propensity to travel great distances along riparian corridors in search of suitable food and habitat, priority areas will include all subwatersheds with high importance placed on properties with riparian habitat.

Management Measure 3 – Identify and Repair or Replace Failing On-Site Sewage Systems

OSSFs are used to treat wastewater in areas of the watershed where centralized wastewater treatment facilities are not available. Conventional systems use a septic tank and a gravity-fed drain field that separates solids from wastewater prior to the distribution of the water into soil where actual treatment

takes place. In the Kickapoo Creek watershed, approximately 52.2% of the watershed's soils are considered very limited and 40.4% are considered somewhat limited.

In these areas, advanced treatment systems, most commonly aerobic treatment units, are suitable alternative options for wastewater treatment. While advanced treatment systems are highly effective, the operation and maintenance needs for these systems are rigorous compared to conventional septic systems. Limited awareness and lack of maintenance can lead to system failures.

Failing or non-existent OSSFs can provide significant bacteria and nutrient loading into the watershed. The exact number of failing systems is unknown. A number of reasons contribute to OSSF failure, including improper system design or selection, improper maintenance, and lack of education and financial resources.

To address these needs, efforts are required to focus on expanding and providing education and workshops to homeowners (Table 6.4). Additionally, maintenance providers, installers, and inspectors should be secured to assist homeowners to repair or replace OSSF systems should an issue arise. While OSSFs should be replaced as needed across the entire watershed, priority will be placed on Subwatersheds 1, 16, and 21. Additionally, priority will be placed on OSSFs within 150 yards of perennial water bodies.

Management Measure 4 – Manage SSOs and Unauthorized Discharges

Although infrequent, SSOs and unauthorized WWTF discharges can contribute to bacteria loads, particularly during high runoff events. Inflow is surface runoff that enters the sewer collection system through manhole covers, sewer cleanouts, damaged pipes, and faulty connections. Infiltration is groundwater that enters the collection system through comprised infrastructure.

The TCEQ SSO Initiative is a voluntary program that initiates an effort to address an increase in SSOs due to aging collection systems throughout the state while encouraging corrective action be taken before there is harm to human health and safety or damage to the environment. Sanitary Sewer Overflow Initiatives can be implemented in the Kickapoo Creek WPP.

Fats, oils, grease, non-flushables, and other substances, when disposed of down drains and toilets, can cause damage to collection systems. Several educational programs on the proper disposal of fats, oils, and grease are available through AgriLife Extension. Distribution of educational materials and providing online videos on the Kickapoo Creek WPP website will help homeowners dispose of fats, oils, and grease appropriately. Management measure recommendations for SSOs and unauthorized discharges is listed in Table 6.5.

Management Measure 5 – Reduce Illicit Dumping

Stakeholders have indicated that illicit dumping, particularly of animal carcasses, is a problem throughout the watershed. Dumping activities typically occur at or near bridge crossings where individuals may dispose of deer, hogs, or small livestock carcasses in addition to other trash. The scope of the problem is not entirely known or quantified but is anticipated to be a relatively minor contributor to bacteria loadings in the watershed compared to other sources. However, the development and delivery of educational and outreach materials to local residents on proper disposal of carcasses and their trash could help reduce illicit dumping and associated potential bacteria loadings (Table X).

Hazardous waste collection events happen around the watershed annually. Advertising the events and increasing the events to bi-annually can help increase participation in the collection events and reduce the amount of dumping at crossings and down drains.

Management Measure 6 – Increase Proper Pet Waste Management

Potential pollutant loading from pet waste was identified as one of the largest potential sources of bacteria in the watershed. If not managed properly, pet waste and the *E.coli* it contains are readily transported to local water bodies during runoff events. Properly disposing of pet waste in a trash can is a simple, yet effective, way of reducing *E. coli* loads in the watershed.

Management strategies emphasize reducing the amount of pet waste that can be transferred to streams via overland transport (Table 6.7). Examples of potential strategies include providing waste bag dispensers and collection stations in areas of higher pet density (parks, neighborhoods). These strategies encourage pet owners to pick up waste before it can be transported to streams. As there are no parks in the watershed, apartment complexes and homeowners' associations were identified as potential areas to install pet waste stations.

Low-cost spay and neuter programs can also help decrease populations of feral cats and dogs and therefore help reduce potential bacteria loading in the creek. Several animal rescues around the watershed offer these programs for pet owners and strays. Work to strengthen these programs and advertise their availability around the watershed is key to reducing populations of stray cats and dogs.

Finally, providing education and outreach materials to pet owners about bacteria and nutrient pollution and pet waste can increase the number of residents who pick up and dispose of pet waste. Recognizing that domestic pets in rural portions of the watershed likely have large areas to roam and that picking up pet waste is likely not feasible for all owners; management measures should target areas of the watershed with high housing and pet densities. The priority areas for this management measure are urbanized and public areas located in subwatersheds 1 and 16.

Table 6.2. Management Measure 1 – Cattle and Other Livestock

Source: Cattle and Other Livestock
Problem: Direct and indirect fecal bacteria loading due to livestock in streams; riparian degradation and overgrazing
Objectives: • Work with landowners to develop property-specific CPs and WQMPs that improve grazing and water quality. • Provide technical and financial support to producers. • Reduce fecal loadings attributed to livestock.
Location: Priority subwatersheds identified below.
Critical Areas: All properties with riparian habitat throughout the watershed and all properties in Subwatersheds 1,6,21 and 22
Goal: Develop and implement CPs and WQMPs that minimize time spent by livestock in riparian areas and better utilize available grazing resource across the property
Description: CPs and WQMPs will be developed with producers to implement BMPs that reduce water quality impacts from overgrazing, time spent by livestock in and near streams and runoff from grazed lands. Practices will be identified and developed in consultation with NRCS, TSSWCB, and local

SWCDs as appropriate. Education programs and workshops will support and promote the adoption of these practices.			
Implementation Strategy			
Participation	**Recommendations**	**Period**	**Capital Costs**
TSSWCB, SWCDs	Develop funding to hire WQMP technician	2023-2033	Estimated $60,000 per year
Producers, NRCS, TSSWCB, SWCDs	Develop implementation and provide financial assistance for 50 livestock CPs and WQMPs over 10 years	2023-2033	$1,500,000 (est. $30,000 per plan)
AgriLife Extension, ANRA, SWCDs	Deliver education and outreach programs and workshops to landowners		
Estimated Load Reduction			
Prescribed management will reduce loadings associated with livestock by reducing runoff from pastures and rangeland as well as reducing direct deposition by livestock. Implementation of 50 WQMPs and CPs is estimated to reduce annual loads from livestock by 1.51 x10^{14} cfu *E.coli* per year in the Kickapoo Creek watershed.			
Effectiveness	High: Decreasing the time that livestock spend in riparian areas and reducing runoff through effectively managing vegetative cover will directly reduce NPS contributions of bacteria and other pollutants to creeks.		
Certainty	Moderate: Landowners acknowledge the importance of good land stewardship practices and management plan objectives; however, financial incentives are often needed to promote the WQMP and CP implementation.		
Commitment:	Moderate: Landowners are willing to implement stewardship practices shown to improve productivity; however, costs are often prohibitive and financial incentives are needed to increase implementation rates.		
Needs	High: Financial costs are a major barrier to promote implementation. Education and outreach are needed to demonstrate benefits of plan development and implementation to producers.		

Table 6.3. Management measure 2: Feral Hogs

Source: Feral Hogs
Problem: Direct and indirect fecal pollutant loading and riparian habitat destruction from feral hogs
Objectives: • Reduce fecal contamination from feral hogs. • Work with landowners to reduce feral hog populations. • Reduce food availability for feral hogs. • Provide education and outreach to stakeholders.
Critical Areas: All subwatersheds with high importance placed on riparian properties.
Goal: Manage the feral hog population through all available means in efforts to reduce the feral hog population by 15% (492 hogs) in the watershed and maintain them at this level.
Description: Voluntary implementation of feral hog population management practices including trapping, reducing food supplies, and educating landowners.
Implementation Strategy

Participation	Recommendations	Period	Capital Costs
Landowners, managers, lessees	Voluntary construct fencing around deer feeders to prevent feral hog utilization		
	Voluntary trap/remove/shoot feral hogs to reduce numbers		
Landowners, producers, TPWD	Develop and implement wildlife management plans and wildlife management practices		
AgriLife Extension, Texas Wildlife Services, TPWD	Deliver Feral Hog Education Workshop		

Estimated Load Reduction	
Removing and maintaining feral hog populations directly reduces fecal loading potential to water bodies, as well as nutrient and sediment loading in the watershed. Reducing the population by 15% in the Kickapoo Creek watershed is estimated to reduce potential annual loads by $2.47x10^{13}$ cfu *E.coli* annually.	
Effectiveness	Moderate: Reduction in feral hog population will result in a direct decrease in bacteria and nutrient loading to the streams. However, removing enough feral hogs to decrease the population is difficult.
Certainty	Low: Feral hogs are transient, intelligent, and adapt to changes in environmental conditions. Population reductions require diligence on the part of landowners. Combined, this causes considerable uncertainty in the ability to remove 15% of the population annually.
Commitment:	Moderate: Many landowners are actively battling feral hog populations and will continue to do so as long as resources remain available. Hogs adversely affect their livelihood.
Needs	Moderate: Landowners benefit from technical and educational resources to inform them about feral hog management options. Funds are needed to deliver these workshops.

Task 6.4. Management Measure 3: OSSF management

Source: Identify and Report or Replace Failing or Non-Existent On-Site Sewage Facilities (OSSFs)
Problem: Pollutant loading reaching streams from untreated or insufficiently treated household sewage
Objectives: • Inspect failing OSSFs in the watershed and secure funding to promote OSSF repairs. • Repair or replace OSSFs by working with counites and communities. • Educate homeowners on system operations and maintenance.
Location: Entire watershed
Critical Areas: Primarily Subwatershed 1,16 and 21 and system within 150 yards of the perennial water body
Goal: Identify, inspect, and report or replace 50 failing OSSFs in the watershed, especially within critical areas

Description: Expanded education programs and workshops will be delivered to homeowners on the proper maintenance and operation of OSSFs. Failing or non-existent systems will be repaired or replaced as appropriate and as funding allows.			
Implementation Strategy			
Participation	**Recommendations**	**Period**	**Capital Costs**
Counties, contractors			
	Identify, inspect, and repair or replace OSSFs as funding allows		
Counties, Municipalities Districts, Homeowners, ANRA	Inspect and identify the possibility in connecting to existing infrastructure		
ANRA, AgriLife Extension, TIAER	Operate an OSSF education, outreach, and training program for installer, service providers and homeowners		
AgriLife Extension, TIAER	Develop and deliver materials (postcards, websites, handouts, etc.) to educate homeowners		
Estimated Load Reduction			
As planned, 50 OSSFs will be repaired or replaced throughout the watershed. It will result in a potential load reduction of $3.2x10^{15}$ cfu *E.coli* per year. Nutrients and BOD5 will be reduced as well. Due to the differences of onsite conditions and type of system installed, the reduction rates are not consistent. However, they generally range from 10-40% for nitrogen, 85-95% for phosphorus, and 90-98% for BOD5(EPA 2003).			
Effectiveness	High: Replacement or repair of failing OSSFs yield direct *E.coli* reductions.		
Certainty	Low: The level of funding available to identify, inspect and repair or replace OSSFs is uncertain; however, funding sources are available for assistance		
Commitment:	Moderate: Watershed stakeholders acknowledge failing OSSFs as a considerable source of bacteria loading Addressing this source will have the greatest effect on protecting human health and is a top priority.		
Needs	High: Financial resources are needed to identify, repair and replace systems as many homeowners do not have the resources to fund replacement themselves. Education is also critical because many homeowners with failing systems may not even realize their system is failing.		

Table 6.5. Management measure 4: Manage sanitary sewer overflows (SSOs) and unauthorized discharges.

Source: Manage Sanitary Sewer Overflow (SSO) or Unauthorized Discharges
Problem: Fecal bacteria loading from unauthorized discharges when excessive water enters the sanitary sewer system through **I&I**
Objectives: • Reduce unauthorized discharges and SSOs. • Replace and repair sewage infrastructure where I&I problems have been identified.

• Educate residents and homeowners about the impacts of I&I, the need for infrastructure maintenance and what types of waste can be put in the sewer system.			
Critical Areas: Urbanized areas in subwatersheds 16, 19, 20			
Goal: Work with entities operating WWTFs to continue and expand inspection efforts and identify problematic areas and repair or replace problematic infrastructure to reduce inflow and infiltration issues and minimize WWTF overload occupancies.			
Description: Identify potential locations within municipal sewer systems where inflow and infiltration occur using available strategies (e.g. smoke tests, camera inspections, etc.). Prioritize system repairs or replacements based on system impacts (largest impact areas addressed first). Complete repairs or replacements to reduce future inflow and infiltration issues and WWTF overloading.			
Implementation Strategy			
Participation	**Recommendations**	**Period**	**Capital Costs**
TIAER, AgriLife Extension, Cities	Identify potential resources and develop programs to assist homeowners with sewage pipe replacement		
Cities, AgriLife Extension, TIAER	Develop and deliver educational material to residents and property owners		
Estimated Load Reduction			
Reduction of SSOs and discharges associated with I&I will result in direct reductions in bacteria loads. However, because the response to education efforts and the development of resources to compel pipe repairs is uncertain, load reductions were not calculated.			
Effectiveness	Moderate to High: Although the infrequent, reduction in SSOs and unauthorized discharges will result in direct reductions to bacteria loading during the highest flow events.		
Certainty	Moderate to Low: Costs associated with sewer pipe replacement can be expensive to homeowners; homeowners often perceive the issue as a problem for the municipality to resolve.		
Commitment:	Moderate: Municipal public works have incentives to resolve I&I issues to meet discharge requirements. However, lack of funding precludes the replacement of sewage pipes.		
Needs	High: Financial needs are likely significant.		

Inflow and Infiltration, I&I; wastewater treatment facility, WWTF

Table 6.6. Management measure 5: Reduce Illicit Dumping.

Source: Illicit and Illegal Dumping
Problem: Illicit and illegal dumping of trash and animal carcasses in and along waterways
Objectives: • Promote and expand education and outreach efforts in the watershed
Critical Areas: Entire watershed with a focus on bridge crossing and public access areas.
Goal: Increase awareness of proper disposal techniques and reduce illicit dumping of waste and animal carcasses in water bodies throughout the watershed.
Description: Education and outreach materials will be developed and delivered to residents throughout the watershed on the proper disposal of carcasses and waste materials.
Implementation Strategy

Participation	Recommendations	Period	Capital Costs
Counties	Develop and deliver educational and outreach materials to residents		
Estimated Load Reduction			
Load reductions are likely minimal from this management measure and were not quantified.			
Effectiveness	Moderate: Preventing illicit dumping, especially animal carcasses, is likely to reduce bacteria loads by some amount, although this loading is likely limited to areas with public access.		
Certainty	Low: Anticipating changes in resident behavior due to education and outreach is difficult in rural areas. The issue is not a high priority and commitment to limited resources will likely remain low.		
Commitment:	Moderate: Many stakeholders indicate illicit dumping occurs; however, enforcement is difficult in rural areas. The issue is not a high priority and commitment to limited resources will likely remain low.		
Needs	Moderate: Some financial resources will be required to develop educational materials. Information could be incorporated into ongoing watershed-related educational outreach efforts.		

Table 6.7. Management measure 6: Increase Proper Pet Waste.

Source: Pet Waste			
Problem: Direct and indirect fecal bacteria loading from household pets			
Objectives: • Expend education and outreach messaging on the disposal of pet waste. • Install and maintain pet waste stations in public areas.			
Location: Entire Watershed			
Critical Areas: High pet concentration areas, subwatersheds **1 and 16.**			
Goal: Reduce the amount of pet waste that may wash into water bodies during rainfall and irrigation runoff by providing educational and physical resources to increase stakeholder awareness of water quality and health issues caused by excessive pet waste. Effectively manage *E.coli* loading from 12% of the estimated dog population, or 8,029 pets			
Description: Expand education and outreach regarding the need to properly dispose of pet waste in the watershed. Specifically target homeowners and the general public. Install and maintain pet waste stations and signage in public areas to facilitate increased collection and proper disposal of pet waste.			
Implementation Strategy			
Participation	**Recommendations**	**Period**	**Capital Costs**
City, local veterinary clinics, pet owners	Allow dog and cat owners to have pets spayed or neutered at little to no cost		
City officials/police, pet owners, Animal Control Department	Requires pet owners to remove any deposits from public areas. May restrict number of dogs and/or cats in a household.		

Cities, Counties, AgriLife Extension, TWRI, HOAs	Develop and provide educational resources to residents		

Estimated Load Reduction	
Load reductions resulting from this targeted management measure are reliant on changes in people's behavior and are therefore uncertain. Assuming 12% of targeted individuals respond by properly disposing of pet waste an annual load reduction of 6.6×10^{14} cfu *E. coli per year.*	
Effectiveness	High: Collecting and properly disposing of dog waste is a direct method of preventing *E. coli* from entering water bodies, directly reducing potential loading in water bodies.
Certainty	Low: Some pet owners in the watershed likely already collect and properly dispose of pet waste. Those that do not properly dispose of pet waste are likely difficult to reach of convince. The number of additional people that will properly dispose of waste is difficult to anticipate.
Commitment:	Moderate: Most parks currently have pet waste stations installed; however, maintenance is sometimes less frequent than it needs to be. Meanwhile, little to no enforcement occurs to require owners to pick up after their pets.
Needs	Low: Increasing maintenance on existing pet waste stations is something that could easily occur. Landscapers can easily add this to their list of items when mowing parks if the resources are provided.

References Chapter 6

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