Kohlman Creek Subwatershed Infiltration Study

Prepared for
Ramsey-Washington Metro Watershed District

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BARR

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Executive Summary

The purpose of the Kohlman Creek Subwatershed Infiltration Study was threefold:

- To identify an annual volume reduction goal for watershed areas tributary to Kohlman Lake.
- To identify specific infiltration BMP opportunities throughout the Kohlman Creek Subwatershed that would achieve phosphorus reduction in retrofit projects.
- To suggest potential infiltration opportunities in areas slated for redevelopment in the near future.

As a result of this study, an annual volume reduction goal of 3.2 acre-ft/year (138,797 cubic feet/year) is recommended. In order to meet the District's short-term and long-term water quality goals for Kohlman Lake, assuming other recommended CIP projects are implemented, a minimum of 3.2 acre-feet (138,797 cubic feet) of water quality volume should be implemented each year in the areas tributary to Kohlman Lake (Willow Creek, Kohlman Creek and Kohlman Lake Subwatersheds).

Water quality volumes achieved through the implementation of the volume reduction rule in redeveloping areas and through the District's BMP Cost Share Program should be tracked on an annual basis. Where implementation of the volume reduction rule alone does not allow the District to meet the volume reduction goal, additional projects (such as the ones presented in this report) should be implemented.

Results of this study show that there are some good opportunities for implementation of additional infiltration and other volume reduction BMPs in the Kohlman Lake Subwatershed. In particular, it is recommended that the District pursue projects that have been grouped into specific neighborhood areas where focused education and volume reduction initiatives can be launched on an as-needed basis.

The types of infiltration and volume reduction BMPs presented in this study are:

- Impervious surface reduction
- Infiltration basins
- Biofiltration basins
- Boulevard bump-outs with infiltration and biofiltration basins
- Permeable pavement
- Tree planting

1.0 Introduction

1.1 Purpose

The purpose of the Kohlman Creek Subwatershed Infiltration Study was threefold:

1. To identify an annual volume reduction goal, in terms of cubic feet of water quality volume, in the Kohlman Creek Subwatershed that, if achieved, can be expected to improve the water quality in Kohlman Lake to meet a 70 µg/L growing season average (June through September) within 10 years and a 60 µg/L growing season average (June through September) phosphorous concentration within 20 years.
2. To identify specific infiltration opportunities throughout the Kohlman Creek Subwatershed that would achieve phosphorus reduction in retrofit projects. These projects would offer additional infiltration when implementation of the volume reduction rule (Rule C, Number 3(c), RWMWD Rules, 2006) is not enough to meet the annual volume reduction goal. Projects that are not associated with redevelopment will be limited, as implementation will be limited by existing structures, etc. It is the intent of this report to recommend the types of retrofit infiltration projects that will likely be most effective in these areas. It is important to note that not all of the projects mentioned here would have to be implemented to meet the goals for the lake (even the 60 µg/L goal). Rather, this report contains a number of options from which the Ramsey Washington Metro Watershed District (District) or others can choose as needed when implementation of the volume reduction rule is not enough to meet the annual volume reduction goal.
3. To suggest potential infiltration opportunities in areas slated for redevelopment in the near future (road reconstruction projects are currently the only areas with scheduled plans for reconstruction). It is important to note that in future redeveloping areas that are subject to the District's volume reduction rule slated for redevelopment, there may be other types of infiltration projects that would be better suited to the site, depending on what type of redevelopment is planned. In these areas, developers will likely have a number of infiltration/filtration options available to them. However, this report does provide ideas for the types of infiltration projects that may be well-suited to these sites, given existing soil and land use conditions.

1.2 Background

This study was preceded by the *Phalen Chain of Lakes Strategic Lake Management Plan: Improvement Options and Recommendations* (SLMP) (draft, Barr, October 2004), the *Kohlman and Keller Lakes Total Maximum Daily Load Report* (TMDL) (draft, Barr, July 2005a), the *Internal Phosphorous Load Study: Kohlman and Keller Lakes* (Barr, October 2005b) and the *Kohlman Basin Area Water Quality Enhancements Study* (Barr, April 2007) which estimated through modeling the phosphorus reduction necessary to reduce Kohlman Lake's Total Phosphorus (TP) concentration to meet a range of different goals for the lake:

- Ramsey-Washington Metro Watershed District's (District's) short term (5 years – by the year 2012) phosphorus goal of 90 μg/L.
- The District's long term (10 years – by the year 2017) phosphorus goal of 70 μg/L.
- Minnesota Pollution Control Agency's (MPCA's) proposed shallow lake nutrient criteria of 60 μg/L. The target time frame for this goal is assumed to be 20 years, (by the year 2027).

Throughout the course of several studies (named above), the projects that will achieve these various goals have been identified and recommended for implementation. Figures 1a and 1b show the estimated effect of these projects in terms of the resulting phosphorous concentration of Kohlman Lake. The estimated impact of the implementation of the volume reduction rule (after 10 years and 20 years)[1] throughout the Kohlman Lake Subwatershed is also included in these figures.

Figure 1a shows the modeling results for each of three precipitation conditions ("average", or 2000-2001 precipitation, "wet", or 2001-2002 precipitation and "dry", or 1988-1989 precipitation) as well as a fourth, "Average of All Modeled Conditions" condition which was calculated by averaging the predicted water quality from each of the three modeled years. Figure 1b consolidates the information presented on Figure 1a, by presenting only the "Average of All Modeled Conditions" values. On the new chart, error bars indicate the range of phosphorus concentrations that were predicted among the three modeled precipitation conditions.

Figure 1a and 1b are intended to demonstrate that if the Board is managing for an "Average of All Modeled Conditions" scenario (as opposed to a worst-case scenario):

- The short term TP goal for the lake (90 μg/L) is essentially already met, especially considering that the Enhanced Sand Filter and the Permeable Limestone Barrier will soon be constructed. These two capital improvement projects were identified in the *Kohlman Basin Area Water Quality Enhancements Study* (Barr, April 2007). This study concluded that if the Kohlman Basin permeable limestone barrier and the enhanced sand filter in the Beam Avenue development site were pursued, a 6 percent reduction in Kohlman Basin's total phosphorus outflows (particulate and dissolved) could be achieved. The construction of the Kohlman Basin permeable limestone barrier and the Enhanced Sand Filter projects will be completed

[1] The method for calculating the impact of 10 and 20 years of volume reduction rule implementation and the assumptions that went into this analysis is included in the *Kohlman Basin Area Water Quality Enhancements Study* (Barr, April 2007).

this fall. The enhanced sand filter will be kept off-line until plantings are established in 2008.

Macrophyte management in Kohlman Lake is also recommended in the near future to better control the lake's macrophyte community for aesthetic and recreational reasons as well as to prepare for an internal load reduction project in the lake's future.

- The long term goal for the lake (70 µg/L) can be met with an additional 70 to 90 percent reduction in the lake's internal load.
- In order to meet the MPCA's proposed shallow lake criteria (60 µg/L), more phosphorus reduction is needed. Specifically, it was estimated that an overall 25 percent reduction in Kohlman Basin phosphorus outflows in addition to a 90 percent reduction in the lake's internal phosphorus load could achieve the 60 µg/L goal within 20 years It is estimated that this 25 percent reduction in Kohlman Basin phosphorus outflows could be accomplished through construction of the enhanced sand filter and the permeable limestone barrier along with successful implementation of the District's volume reduction rule (Rule C, Number 3(c), RWMWD Rules, 2006) for all projects requiring a District permit or through the implementation of retrofit projects throughout the Kohlman Lake, Kohlman Creek and Willow Creek Subwatersheds (all Subwatersheds that ultimately drain to Kohlman Lake).

It is important to note that the effect of 10 and 20 years of implementing the volume reduction rule shown on Figures 1a and 1b assumes that developers will be able to fully implement the volume reduction rule on their sites. Since it is likely that undesirable soil conditions will limit the amount of infiltration possible in some project locations, the impact of the volume reduction rule on Kohlman Lake's water quality over the next 10 and 20 years (as shown on Figures 1a and 1b) is considered overly optimistic. For this reason, other retrofit infiltration projects are identified in this report to help the District meet Kohlman Lake's long-term water quality goals and, ultimately, to remove the lake from the Impaired Waters List.

It was assumed that, at least for the foreseeable future, annual volume reductions for areas tributary to Kohlman Lake achieved during the permit process could be supplemented with retrofit infiltration projects (on an as-needed basis) in the Kohlman Creek Subwatershed. Figure 2 shows the boundary of the Kohlman Creek Subwatershed.

1.3 Infiltration BMPs—a Responsible Reaction to Climate Change

Climate change is an impending force that will affect Kohlman Lake and its watershed. Predictions for the Midwest states indicate that we will experience more days over 90 degrees Fahrenheit, increased wind, more intense but less frequent storm events, and less snow cover with higher average winter temperatures, among other affects (Seeley, 2007). This means changes for the watershed—

increased drying of soils and lower water levels in lakes, wetlands and streams, stressed vegetation, frequent drought, intense but infrequent storm events, and many other effects. The challenges presented by climate change will likely become more evident in the coming years.

Preparation for these changes should begin now. It is important to capture stormwater where it falls and store it in the ground for use by trees and to recharge groundwater, rather than treating it as a waste product to be discharged downstream. Runoff that still travels downstream after infiltration limits are reached will arrive at the receiving water body with lower concentrations of sediment and phosphorous, and at a slower rate of flow and cooler temperatures.

By pursuing infiltration BMPs in the areas tributary to Kohlman Lake, the District is working to counter the effects of climate change by both improving the water quality of Kohlman Lake as well as recharging groundwater levels and putting water to use where it falls in the watershed. This report suggests ways to capture valuable stormwater and keep it in the Kohlman Creek Subwatershed's hydrologic cycle and groundwater tables rather than letting it escape unused downstream.

2.0 Process

The process of creating recommendations for alternative stormwater practices in the Kohlman Lake watershed involved the following steps:

1. A GIS analysis of watershed characteristics including:
   - Hydrologic soil groups classification; (United States Department of Agriculture, or USDA, soils groups C and D were eliminated for consideration for infiltration basins. Areas with these soil types may be considered for biofiltration basins instead.
   - Well head locations; a setback of 50 feet was created for infiltration basins.
   - Depth to bedrock less than 12 feet.
   - Depth to water table less than 10 feet.
   - Streets scheduled for reconstruction.

2. The watershed was then inspected to survey suitable locations for implementation of best management practices (BMPs). Locations were mapped. Visual selection criteria used to identify best locations were areas that:
   - Are relatively flat.
   - Have few existing trees, or trees that would tolerate some root pruning.
   - Appear to have abundant parking; some of which might be eliminated.

3. The GIS analysis maps and the on-site watershed survey were synthesized through additional GIS mapping to determine suitable sites for BMP implementation. From this, priorities for implementation were identified. Also, street construction schedules were examined for the county and cities within the watershed and were mapped along with the BMP suggestions as this information may be helpful in deciding how to proceed with particular projects. For example, a retrofit project should not be launched in an area that will soon be redeveloped. However, the District could use these areas as opportunities to create treatment over and above what the volume reduction rule requires by partnering with cities, counties or other parties involved in reconstruction activities.

4. The estimated impact of 20 years of implementation of the volume reduction rule, in terms of water quality volume achieved through infiltration, was estimated. This total water quality volume was divided by 20 years to calculate an annual average. This annual average can be considered an annual target for infiltration projects. If this target is met, it is expected that

Kohlman Lake will meet the MPCA's proposed shallow lake criteria after 20 years of implementation (along with implementation of the other recommended CIPs).

5. The increase in volume reduction achieved by additional infiltration projects presented in this report were estimated as a total (the total water quality volume provided of all of the presented projects), as well as by drainage area and for individual targeted neighborhood projects.

6. Several neighborhoods were identified as the first round of candidates for an annual targeted volume reduction and public education/involvement programs that could be used to supplement the total volume reduction achieved each year. These areas were chosen because they are fairly flat, have space available in the street right-of-way or within the street, appear to have excessive impervious surface, and have soil types of hydrologic groups A or B which readily infiltrate. Each of these areas have roughly the same volume reduction potential.

7. Preliminary discussions with City of Maplewood staff (Erin Laberee, Assistant City Engineer) and North St. Paul staff (Dave Kotilinek, City Engineer) were conducted to discuss the possibility of implementing these projects in the future, and to understand what challenges the implementation of these projects (particularly the bump-out options) would face. This discussion dealt with design on a conceptual level, and were not targeted at specific project areas.

3.0 Results and Recommendations

Results of this study show many opportunities to implement BMPs in order to work toward the volume reduction goal. Those most suitable options for the Kohlman Creek Subwatershed include:

- Impervious surface reduction
- Infiltration basins
- Biofiltration basins
- Boulevard bump-outs with infiltration basins
- Permeable pavement
- Tree planting

Each is discussed below. Figure 3 shows the road reconstruction projects that are currently scheduled in the Kohlman Creek Subwatershed. No County road reconstruction projects are planned at present for the area. These areas are shown for two reasons: (1) they are areas in the near future that may be subject to the volume reduction rule through the permitting process, and (2) because some infiltration projects may be required of these areas, these areas may provide good opportunities to cost–effectively go over and above the volume reduction rule by using cost-sharing projects to enhance what is already required.

Figures 4a and 4b show potential volume reduction BMP implementation locations in the Kohlman Creek Subwatershed. Opportunities for tree planting and pervious pavement implementation are too numerous to map. Creation of programs to promote implementation of these BMPs wherever possible is recommended. The following sections describe each of these BMP options in detail. It should also be noted that the Maplewood Mall area has not been extensively evaluated for project options at this time. A feasibility study slated for 2008 will look at opportunities at Maplewood Mall in greater detail.

3.1 Impervious Surface Reduction

Reducing impervious surface results in decreased runoff, and increased infiltration. Both are positives for Kohlman Lake. Roads, driveways and parking lots are often designed for a worst case (high use) scenario to most fully accommodate extreme events for automobile movement and parking. This approach ignores the impervious surface impact on natural resources and stormwater management in particular. New development in the watershed should restrict impervious surfaces to that needed for every day use through revisions to city ordinances. In the future, ordinances should be evaluated for reasonable changes that would reduce impervious surfaces without greatly impacting the functionality of roads, driveways and parking lots.

Impervious surface in Kohlman Creek Subwatershed can be reduced in the following ways:

Roads: Situations exist in the Kohlman Creek Subwatershed where roads can be narrowed. Often parking lanes are built that are never or rarely used. One parking lane, as opposed to two, may accommodate the parking needs for many neighborhoods. The most economical opportunity for reducing road widths is when they are scheduled for reconstruction. Figure 3 shows locations where roads in the watershed are scheduled for reconstruction.

Driveways: There are two ways to limit driveway impervious surface: reduce length and reduce width. The only opportunity to reduce length is during new construction. In residential situations, reducing house setbacks reduces driveway length and is achieved through changes to city subdivision ordinances. Narrowing is the second way to reduce driveway imperviousness; achieved through necking down long driveways to one lane, creating "two track" driveways, or using pervious pavers in all or part of the driveway—especially in front of the third garage of a residence.

Parking Lots: Parking lots were not specifically evaluated for impervious surface reduction in this project, but through quick inspection it appears that some parking lots are over-sized; designed for the 'extreme event', rather than every day parking use. Parking lots in the watershed should be further evaluated for surface reduction and creation of infiltration basins. Also, city parking ordinances should be evaluated to consider reducing the number of required parking stalls.

Roofs: Roofs in industrial and retail facilities are a major source of stormwater runoff. The most practical solutions in these tight urban situations are implementation of extensive green roofs that hold as much as a 1 inch storm event which then evaporates. Green roofs should be considered in new ‘big box’ developments. Two or more story buildings also reduce the foot print of a building.

3.2 Infiltration Basins

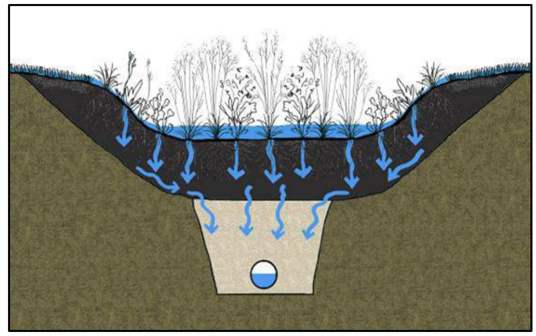
The Kohlman Creek Subwatershed has been evaluated for the potential to construct infiltration basins. In the Kohlman Creek Subwatershed, soils are mostly of United States Department of Agriculture (USDA) hydrologic group B, which is appropriate for infiltration basins. Infiltration basins are the most effective BMP presented in this document because they eliminate (or at least slow) water from the runoff system and thus eliminate (or at least reduce) phosphorus from the system. To be effective, they must be built to intercept runoff as close to its source as possible. Also, they are most effective when distributed throughout the watershed, not concentrated in regional treatment facilities. The survey of the watershed shows many locations for potential infiltration basins (as rainwater gardens) as shown on Figures 4a and 4b.

In residential situations, the basins should be constructed to accept runoff from the street along with roof and lawn runoff. Figure 5 shows a standard detail of an infiltration basin design for a rainwater garden. The estimated cost of a typical rainwater garden is shown in Table 1, below. Costs are based on a $10 per square foot cost for construction (estimated from Burnsville’s Rushmore Drive rainwater garden retro-fit project). The basin size is assumed to be eight feet by thirty feet. No use of volunteers was figured into the cost.

Table 1: Estimated Cost of a Rainwater Garden Construction in a Retro-Fit Situation

Rainwater Garden Retro-Fit Construction Activity	Estimated Cost (2007 Dollars) Per Rainwater Garden
Site Survey	$500
Soil Investigation	$500
Engineering Design	$1,500
Construction	$2,500
Construction Observation	$500
Total	$5,500

3.3 Biofiltration Basins



Biofiltration basins are constructed in the same manner as infiltration basins except that they have a drain tile installed in the subsoil below the basin. They function to filter stormwater and release it slowly downstream, rather than infiltrate stormwater and eliminate it from the drainage system. Biofiltration basins are constructed in areas where soils are too heavy to infiltrate stormwater rapidly; hydrologic group C and D soils. Locations for biofiltration basins are also shown on Figures 4a and 4b. Figure 6 shows a standard detail of an infiltration basin design for a biofiltration basin. The estimated cost of a typical biofiltration garden is shown in Table 2 below. The cost increase from the infiltration basin stems from construction of the trench which contains a drain tile and is filled with sand. The basin size is assumed to be eight feet by thirty feet. No use of volunteers was figured into the cost.

Table 2: Estimated Cost of a Biofiltration Garden Construction in a Retro-Fit Situation

Biofiltration Garden Retro-Fit Construction Activity	Estimated Cost (2007 Dollars) Biofiltration Garden
Site Survey	$500
Soil Investigation	$500
Engineering Design	$1,500
Construction	$3,500
Construction Observation	$500
Total	$6,500

3.4 Boulevard Bump-Outs With Infiltration Basins

Boulevard bump-outs are a method of creating space for infiltration basins in neighborhoods where space is limited due to topography, trees or other obstacles limit the ability to place them within the street right-of-way. Bump-outs create a double stormwater management advantage by eliminating pavement and creating space to construct infiltration basins. Possible locations of bump outs are shown on Figures 4a and 4b.

Bump-outs are shown only in areas where parking space can most likely be eliminated, based on an initial visual inspection. In many neighborhoods parking on both sides of the street (along with two driving lanes) is not necessary due to adequate driveway parking or low-density housing. Bump-outs are also used for slowing traffic, and can be particularly effective at slowing traffic at intersections. Figure 7 shows a standard detail of a street modification that would include a bump-out. The estimated cost of construction of a bump-out is shown in Table 3 below. Costs are based on a $10 per square foot cost for construction of the rainwater garden (estimated from Burnsville's Rushmore Drive rainwater garden retro-fit project). The basin size is assumed to be eight feet by thirty feet. No use of volunteers was figured into the cost.

Table 3: Estimated Cost of a Bump-out with a Rainwater Garden Construction in a Retro-Fit Situation

Bump-out with Rainwater Garden Retro-Fit Construction Activity	Estimated Cost (2007 Dollars) Per Bump-out with a Rainwater Garden
Estimated Cost of a Rainwater Garden Construction in a Retro-Fit Situation	$5,500
Bump-out Engineering and Design	$500
Pavement Removal	$500
New Curb	$1,000
Construction Observation	$1,000
Total	$8,500

3.5 Permeable Pavement

Some of the negative effects of pavement can be eliminated by replacing existing pavement with permeable pavement. Various permeable pavement types are available including permeable pavers, bituminous, and concrete. They work to infiltrate stormwater where it lands. A mosaic of permeable and impermeable pavement can be implemented in catchment areas where runoff is fairly free of particulate matter that will clog the pores. Permeable pavement is best used as an impervious surface reduction technique where permeable pavement completely replaces the impervious pavement. It is estimated, however, that permeable pavement can accept runoff from adjacent impervious pavement at about a ratio of 5:1, impermeable to permeable.

Whenever permeable pavements are planned, an adequate budget for their maintenance is necessary. Yearly vacuuming of the pavement at least twice a year is essential to their success. For winter maintenance, sand applications to permeable pavement should be avoided. If de-icing is necessary, some salt may be applied. However, it is possible that permeable pavement may require a much lower rate of application than impervious pavement, given its ability to infiltrate water on the surface whenever snow and ice intermittently during the winter months.

In this report, specific locations for permeable pavement are not specified, since they are too numerous and require a greater level of analysis. Cul du sacs, however, are identified for potential sites for permeable pavement. They are shown on Figures 4a and 4b. Figure 8 shows a standard detail of cross section of porous bituminous pavement. The estimated cost of a 1 ft^2 section of permeable pavement is shown in Table 4 below.

Table 4: Estimated Cost of a 1 ft^2 Permeable Pavement Section Construction in a Retro-Fit Situation

Permeable Pavement Construction Activity	Estimated Cost (2007 Dollars) Per ft^2 of permeable pavement
Total cost per sf of Permeable Pavement	$5
Total cost per sf of Permeable Pavers	$6

3.6 Estimated Phosphorus Load Reductions

Phosphorus Reduction from 20-Years of Volume Reduction Rule Implementation

It is important to note that in modeling the estimated effect of implementing the volume reduction rule over the next 20 years, as well as the construction of additional proposed projects, it was assumed that only impervious areas that were directly connected to the storm sewer system (impervious areas that did not first pass over pervious areas before entering the storm sewer system) would be captured in the infiltration area. This was considered to be a more realistic, and conservative, assumption. Also, in the past, the uncertainty in whether or not the infiltrated water actually reached the lake has been shown in modeling results. For the purposes of this report, only the more conservative assumption (that the infiltrated water does not reach the lake, thereby not providing a dilution benefit) was used.

If all the infiltration projects constructed as a result of the volume reduction rule over the next 20 years were ideally implemented (no cost cap adjustments and no poor soil conditions limiting the extent of the infiltration actually implemented on the site), the estimated water quality volume achieved could be as high as 63.7 acre-feet after 20 years of implementation. Based on P8 modeling, it appears that this water quality volume could provide the remaining phosphorus reduction from Kohlman Basin outflows needed for the lake to meet the MPCA's proposed shallow lake standard for phosphorus. This reduction, in conjunction with reductions from other capital projects discussed above, could result in improving the water quality in Kohlman Lake to the extent that it could be removed from the Impaired Waters List. However, given the uncertain nature of these required infiltration projects and their implementation, it is likely that additional, retrofit projects will need to be implemented (or that projects with their water quality volume equivalent be implemented) over the next 20 years on an as-needed basis, whenever implementation of the volume reduction rule alone does not meet the annual volume reduction goal.

Water Quality Volume Achieved in Additional Projects-With and Without Bump-Outs

The additional infiltration projects shown on Figures 4a and 4b could provide an estimated total of 13.5[2] acre-feet of runoff from impervious areas that could be intercepted and infiltrated during each storm event, over the entire Kohlman Creek Subwatershed[3]. Figures 9a and 9b show the estimated water quality volume (in acre-feet) that could be infiltrated from impervious areas as a result of infiltration projects in each drainage area throughout the Kohlman Creek Subwatershed. As shown on the figure, water quality volumes achieved as a result of these projects range from zero to 2.2 acre-feet. It is important to note that Figures 9a and 9b do not include the water quality volume that would be provided as a result of the implementation of the volume reduction rule. These projects would provide water quality volume over and above the levels shown on Figures 9a and 9b.

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[2] Only water quality volumes from infiltration projects (as opposed to filtration projects) are referred to in this text and on Figures 9a and 9b. While filtration projects would provide some sediment and phosphorus reduction, they do not provide a reduction of stormwater volume.

[3] If tree plantings and permeable pavement were also implemented throughout the watershed, even more interception would occur.

Construction of bump-outs may pose significant challenges to the District, Cities, Counties and neighborhoods in which they are planned. These changes to neighborhood streets will involve a higher level of communication with residents and corresponding governmental agencies.

Brief discussions with City officials in Maplewood and North St. Paul revealed the following concerns:

- Designs for bump-outs would have to take snow plowing and street sweeping into consideration, perhaps incorporating gradual curbs on which plows and sweepers could partially drive while negotiating turns.
- Fire department officials in the cities will need to be consulted so that requirements for fire truck traffic are met after bump-outs are constructed.
- Early public involvement and education in neighborhood projects will be critical to gain acceptance. Past projects in Maplewood (for traffic control purposes) have been met with resistance in some cases.

Despite these concerns, City officials in Maplewood and North St. Paul seemed optimistic that these types of collaborative projects with the District would be possible in the future.

However, depending on the level of challenge that implementation of bump-outs could face, it may be necessary for the District to pursue more traditional infiltration/volume reduction methods first in some areas (i.e., rainwater gardens) and coming back to bump-outs at a later date, once the process for implementing bump-outs has been streamlined. Figures 9a and 9b show the water quality volume that would be achieved in each drainage area both with (in yellow) and without (in blue) the bump-outs suggested for each drainage area. The total water quality volume that could be provided by the projects shown on Figures 9a and 9b, if the effect of bump-outs is excluded, is 5.5 acre-feet[4].

Table 5 shows the water quality volume achieved by the proposed projects for each individual drainage area in the Kohlman Creek Subwatershed. This water quality volume is shown in both with and without bump-outs.

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[4] Only water quality volumes from infiltration projects (as opposed to filtration projects) are referred to in this text and on Figures 9a and 9b. While filtration projects would provide some sediment and phosphorus reduction, they do not provide a reduction of stormwater volume.

Annual Water Quality Volume Goal

It is recommended that an annual water quality goal be created so that the success of infiltration project implementation can be tracked. In this way, the District will be able to evaluate whether infiltration projects outside of those required of redeveloping areas should be pursued in any given year, and if so, to what degree.

In order to meet the 60 μg/L phosphorus goal, a 20-year timeline is recommended. Based on the assumptions about how much water quality volume that the implementation of the volume reduction rule could achieve over 20 years (63.7 acre-feet), an annual infiltration volume goal can be defined as:

63.7 acre-feet / 20 years = 3.2 acre-feet per year.

Therefore, 3.2 acre-feet can be considered the target water quality volume of infiltration projects to be implemented each year, either as a result of the District's volume reduction rule, or other retrofit projects pursued by the District or other organizations or individuals. It should be noted that this target volume is specifically for infiltration of runoff from ***impervious areas*****,** and ideally, impervious areas that are directly connected to the conveyance system (usually a storm sewer) that delivers them to Kohlman Lake.

In order to put this goal into perspective, it is useful to consider the actual volume reduction that has been achieved in the Subwatersheds tributary to Kohlman Lake through implementation of the volume reduction rule since its inception on October 1, 2006, nearly a year ago. Table 6 shows the volume reduction achieved through the implementation of the volume reduction rule and the BMP Cost Share Program since October 1, 2006 for each permitted project in any Subwatershed area tributary to Kohlman Lake (3.7 acre-ft). Filtration BMPs implemented in these programs are not included here as they do not contribute to volume reduction.

3.7 Potential Challenges in Implementing Retro-Fit Infiltration Projects in Neighborhoods

Preliminary discussions with City of Maplewood and North St. Paul staff indicate an openness to pursue some of these projects cooperatively, including implementation of bump-outs. Erin Laberee (City of Maplewood, Assistant Engineer), however, stressed the importance of neighborhood education and involvement early in the process. Past implementation of bump-outs for traffic control in Maplewood have been met with resistance- not by street maintenance crews or other city staff, but rather by residents who don't like having the bump-outs on their streets or commuting routes. Erin

Laberee thought that this might be because the bump-outs were placed in roads that were already narrow (less than 30 feet wide) (personal communication). Starting bump-out implementation on wider roads with greater resident education and involvement early in the process may result in greater community acceptance of these projects.

Dave Kotilinek (City of North St. Paul) mentioned the importance of designing bump-outs with snow plowing and street sweeping in mind. He also thought bump-outs would be best placed on quiet, residential streets, rather than in commercial areas. He also mentioned some variations on the bump-out concept that could be used in residential areas- center islands located between driving lanes that could provide infiltration from street runoff.

Table 5: Water quality volume achieved by proposed projects in each individual Kohlman Creek drainage area.

Kohlman Creek Drainage Area	Total Area (acres)	Directly Connected Impervious Area (acres)	Water Quality Volume Achieved by Proposed Projects (Including Bump-Outs) TOTAL (ac-ft)	Water Quality Volume Captured by Proposed Projects (Including Bump-outs) INFILTRATION ONLY (ac-ft)	Water Quality Volume Captured by Proposed Projects (Including Bump-outs) FILTRATION ONLY (ac-ft)	Water Quality Volume Achieved by Proposed Projects (NOT Including Bump-Outs) TOTAL (ac-ft)	Water Quality Volume Achieved by Proposed Projects (NOT Including Bump-Outs) INFILTRATION ONLY (ac-ft)	Water Quality Volume Captured by Proposed Projects (NOT including Bump-Outs) FILTRATION ONLY (ac-ft)
SB18-01	54.2	8.0	0.10	0.10	0.00	0.09	0.09	0.00
SB18-02	163.8	20.3	0.25	0.25	0.00	0.13	0.13	0.00
SB18-03	66.5	6.7	0.14	0.14	0.00	0.00	0.00	0.00
SB18-04	84.7	14.0	0.23	0.23	0.00	0.05	0.05	0.00
SB18-05	193.3	36.9	1.23	1.19	0.04	0.36	0.35	0.01
SB18-06A	237.6	56.5	0.94	0.73	0.21	0.68	0.51	0.16
SB18-06B	67.8	36.2	0.00	0.00	0.00	0.00	0.00	0.00
SB18-07	113.2	29.1	0.24	0.21	0.03	0.11	0.10	0.01
SB18-08	39.5	6.3	0.32	0.32	0.00	0.03	0.03	0.00
SB18-09	81.9	27.4	0.23	0.23	0.00	0.14	0.14	0.00
SB18-09A	23.1	16.2	0.00	0.00		0.00	0.00	
SB18-10	183.6	62.2	0.78	0.40	0.37	0.47	0.19	0.27
SB18-11A	19.2	3.8	0.00	0.00	0.00	0.00	0.00	0.00
SB18-11B	16.0	4.1	0.31	0.00	0.31	0.21	0.00	0.21
SB18-11C	10.4	3.9	0.03	0.00	0.03	0.00	0.00	0.00
SB18-12	219.8	30.8	2.05	1.71	0.34	0.47	0.38	0.08
SB18-13	70.5	11.3	0.85	0.02	0.83	0.42	0.00	0.42
SB18-14	345.7	142.4	0.59	0.25	0.34	0.47	0.19	0.28
SB18-15A	241.7	45.4	2.65	2.17	0.48	0.83	0.83	0.00
SB18-15B	337.5	69.9	1.75	1.72	0.03	0.32	0.29	0.03
SB18-16	72.4	8.2	0.17	0.14	0.03	0.12	0.10	0.02
SB18-17A	59.6	11.8	0.15	0.04	0.10	0.15	0.04	0.10
SB18-17B	25.6	1.3	0.04	0.00	0.04	0.02	0.00	0.02
SB18-18	166.4	66.7	0.56	0.49	0.07	0.56	0.49	0.07
SB18-19	20.4	3.0	0.08	0.07	0.00	0.03	0.03	0.00
SB18-21	84.1	21.4	1.34	0.94	0.39	0.23	0.15	0.08
SB18-22	137.5	37.1	0.77	0.50	0.27	0.27	0.14	0.13
SB18-24	139.6	78.6	0.00	0.00	0.00	0.00	0.00	0.00
SB18-25	28.0	6.6	0.00	0.00	0.00	0.00	0.00	0.00
SB18-26	16.8	2.7	0.00	0.00	0.00	0.00	0.00	0.00
SB18-27	45.1	5.1	0.42	0.34	0.09	0.30	0.25	0.05
SB18-28	26.7	2.2	0.05	0.05	0.00	0.03	0.03	0.00
SB18-29	83.5	37.7	1.57	1.12	0.45	1.10	0.83	0.27
SB18-30	10.5	5.7	0.36	0.14	0.22	0.36	0.14	0.22
	Total Water Quality Volume (AF):		18.19	13.50	4.69	7.95	5.49	2.46

Note: "TOTAL" and "FILTRATION ONLY" columns are shaded because filtration projects, while providing some sediment and phosphorus reduction, do not truly result in a volume reduction of stormwater.
As a result, these projects would not be counted toward the volume reduction goal if implemented.

Table 6: Permits that Have Resulted in Volume Reduction in All Subwatersheds Tributary to Kohlman Lake During the First Year of Volume Reduction Rule Implementation

Permit #	Permit Name	Type	Subwatershed	Type of BMP	Volume Reduction (cf)	Notes
07-03	Church of St. Peter	Institutional	Kohlman Creek	Porous asphalt & Surface Infiltration	39,423	Excess volume provided
07-23	Cardinal Gardens	Residential	Kohlman Creek	Rain Gardens	7,416	Excess volume provided
07-29	Premiere Bank	Commercial	Kohlman Creek	Surface Infiltration Basin	13,512	Excess to be banked for future project
07-14	Costco	Commercial	Kohlman Lake	Underground Infiltration Trench & Rain Gardens	54,377	
07-31	Richie Place	Residential	Kohlman Lake	Underground rock infiltration trench	16,480	
07-05	Pond Overlook	Residential	Willow Creek	Surface infiltration basin	3,894	
07-17	McGough Office/Warehouse	Commercial	Willow Creek	Surface infiltration basin	24,320	
				Total (cf)	**159,422**	
				Total (AF)	**3.7**	

4.0 Implementation Recommendations

In order to meet the District's short-term and long-term goals for Kohlman Lake, assuming other recommended CIP projects are implemented, a minimum of 3.2 acre-feet (138,797 cubic feet) of water quality volume should be implemented each year in the areas tributary to Kohlman Lake.

Water quality volumes achieved through the implementation of the volume reduction rule in redeveloping areas and through the District's BMP Cost Share Program should be tracked on an annual basis. Where the volume reduction rule alone does not allow the District to meet the water quality volume goal, additional projects (such as the ones presented in this report) should be implemented.

Results of this study show that there are some good opportunities for implementation of additional infiltration and other volume reduction BMPs in the Kohlman Lake Subwatershed. In particular, it is recommended that the District pursue projects that have been grouped into specific neighborhood areas where focused education and volume reduction initiatives can be launched on an as-needed basis.

4.1 Neighborhood Stormwater Volume Reduction Initiative

Figure 4 shows neighborhoods that, at first look, show excellent potential for BMP implementation. These neighborhoods are labeled A through E in the figure. These areas are shown in greater detail on Figures 10, 11, 12 and 13. These areas have good potential because they are fairly flat, have space available in the street right-of-way or within the street, have excessive impervious surface, and have soil types of hydrologic groups A or B which readily infiltrate. These areas were only chosen as a first round of candidates that may be relatively easy to work with, given site conditions. In these areas, it would likely be possible to construct infiltration basins, bump-outs with infiltration basins, and retrofit with permeable pavers. Also, these are areas that are not currently slated for redevelopment, so they will not already be covered by the District's volume reduction rule.

It is suggested that an annual program be developed that begins by choosing one of the neighborhoods shown on Figures 10 through 13 to implement targeted neighborhood infiltration projects that including educating residents on the importance of stormwater harvest and infiltration, continues with design for specific BMP implementation (design), includes funding for implementation, and provides supervision and direction for construction. Projects should be constructed with monitoring and maintenance in mind in order to assess the performance of each project and to ensure that each project functions as intended in the years following construction.

The estimated water quality volume that could be achieved (with and without bump-outs) as well as the associated construction maintenance costs for the projects is shown for each neighborhood in Table 7 below.

Table 7: Water Quality Volume Achieved by Proposed Projects in Each Targeted Neighborhoods "A" Through "E"

Neighborhood Area	Total Area (acres)	Water Quality Volume Achieved (Rainwater Gardens and Bump-Outs) (ac-ft)	Water Quality Volume Achieved (Excluding Bump-Outs) (ac-ft)
A	27	0.30	0.12
B	37	0.41	0.12
C	31	0.12	0.07
D	78	0.49	0.14
E	50	0.08	0.03

Note: Water quality volumes from filtration BMPs are not included in this table.

Further investigation into specific implementation plans in each neighborhood will be necessary. Underground utilities and easements must be located in order to plan for BMP implementation, and soil borings must be conducted in each proposed infiltration basin location. The need for neighborhood education and involvement and collaboration can not be over-emphasized. When residents understand the benefits of stormwater management projects they are more willing to participate and take ownership of the projects in which they're involved.

The process of defining which projects to pursue will be multi-phased. This is intended to be an annual program that would be conducted as follows:

Year 1: Contact residents to gage support in two or three neighborhoods, determine which one neighborhood is the best candidate.

Conduct soil borings and utility locates in the target neighborhood.

Prepare preliminary design and obtain city approvals.

Obtain City/County agreements to maintain the BMPs planned for construction.

Year 2: Implement projects.

Start the process again (new "Year 1"): Contact residents to gauge support in two or three neighborhoods, determine which neighborhood is the best candidate.

4.2 Role of the Cities

City support for and involvement in these projects (both those pursued as a part of the District's volume reduction rule as well as those supplemental projects pursued to meet the annual volume reduction goal) will be critical. It is likely that the TMDL report, to be finalized this year for Kohlman Lake, will refer to the 20-year impact of implementing the volume reduction rule as a key factor in meeting the MPCA's proposed shallow lake standard. As such, it will be imperative that the cities cooperate in the process of finding locations for project implementation, opportunities for public education and the maintenance of the projects that are ultimately pursued. This is an example of stakeholder involvement in the TMDL process.

4.3 Recommended Feasibility Study- Maplewood Mall Volume Reduction Study

Infiltration/volume reduction options were not specifically evaluated for Maplewood Mall as a part of this project. It is recommended that Maplewood Mall and surrounding highly impervious area be evaluated in greater detail in order to develop a conceptual design that incorporates low impact development features to reduce phosphorus loads and runoff volumes to Kohlman Lake. The study/concept plan would likely be implemented by mall property owners and could be partially funded through the BMP cost share program and incentives through the City of Maplewood or funded by the District if determined to meet additional volume reduction needs.

The estimated costs of this feasibility study is $25,000.

4.4 Other Considerations

In moving forward with focused neighborhood projects it may be helpful in the future to consider these additional practices to improve the District's chances in meeting their water quality volume goals.

Ordinance Review

Sometimes city ordinances inhibit the possibility to implement BMPs. For example, ordinances might require wide streets and excessive street parking, parking requirements for businesses might not match the use of the facility, trees might not be allowed to be planted in public right-of-ways, and trees might not be required in parking lots, among others. It is suggested that RWMWD work with cities within the Kohlman Lake Subwatershed to make future changes to ordinances to better allow for implementation of BMPs, reduce impervious surface and promote Low Impact Development

(LID) practices. Materials from University of Minnesota Extension Service NEMO (Nonpoint Education for Municipal Officials) Program (where appropriate) could be used to educate policy makers about the need for new or improved city policies.

Tree Planting

Trees play a critical role in reducing stormwater runoff volume and peak intensity. Tree canopy intercepts much of the precipitation during a storm event, allowing the rainwater to evaporate, or slowly trickle down to the ground as stem flow where it is more readily infiltrated. Studies have shown that between 10 and 40 percent of all precipitation through the tree canopy is intercepted and removed from stormwater (Xiao, 2000).

Trees also enhance infiltration by loosening soil with their roots and creating natural channels for water infiltration. Trees also change the nature of the ground surface by creating ground clutter and forming natural depressions around the root system, which promotes storage and infiltration, in addition to slowing down runoff rates. There is an added water quality benefit for the rain that falls through the tree canopy and runs off as stormwater. The leaves and stems slow the rain, reducing the intensity of rainwater impact on the ground, reducing erosion, and thereby reducing sediment loading in stormwater runoff.

Because of these benefits, a street and parking lot tree planting program in partnership with cities within the watershed may be beneficial to help achieve the water quality volume annual goal. Multiple other benefits result from tree planting and indirectly benefit the watershed as well. This program proposal would assist cities in tree plantings on public property, while a second educational program would teach private land owners about appropriate tree selection and planting, and potentially provide discounted trees. Together these two tree planting programs would substantially increase the tree canopy in the watershed and restore a hydrologic cycle that more closely mimics presettlement conditions. Trees can also be planted in biofiltration and infiltration basins and added to parking lot infiltration islands.

The addition of tree boxes for stormwater collection and infiltration provides runoff volume reduction and improves tree health. This approach holds particular promise in retrofit situations in highly impervious areas, such as Maplewood Mall. The photo below was taken at City Hall in

Minnetonka and shows young trees planted to improve infiltration in an infiltration strip in the middle of a parking lot.

Figure 14 is a detail of a tree box constructed below an impervious section of sidewalk. A grate constructed around the tree trunk (not shown in the figure) would allow water to pass into the soil around the trees roots. An optional collection drain, below the tree, is shown in the detail.

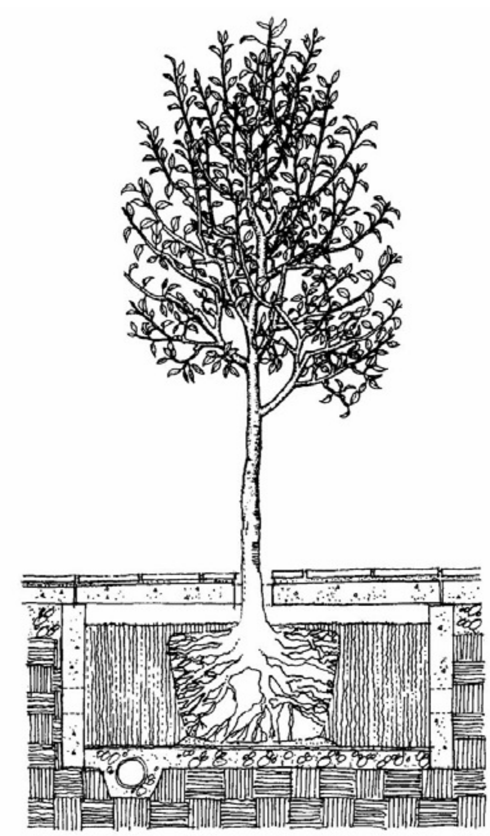

Figure 14: Detail of a tree box under a section of sidewalk.

It should be noted, however, that some studies have also shown that trees growing near directly connected impervious areas may actually increase the *concentration* of sediments and phosphorus in runoff during the fall, as leaves collect on streets (Waschbusch et al., 1999). This finding indicates the importance of street sweeping programs to remove fallen leaves from streets, as they accumulate.

Appendix A contains a discussion of the benefits of trees as cited by the United States Department of Agriculture. Appendix B contains a summary of a recent study by the City of Minneapolis on the stormwater volume reduction benefits of trees.

4.5 Monitoring

It will be important to monitor the long-term effectiveness of all of the different projects being constructed in the Kohlman Lake Subwatershed. A new permanent monitoring station has recently been installed at the outflow point of Kohlman Basin, just upstream of the culvert that carries Kohlman Basin outflows under Hwy 61 to Kohlman Lake. Now that a specific phosphorus reduction goal has been set for Kohlman Basin outflows (25 percent), this monitoring station and the P8 models set up for the area as a part of the Phalen Chain of Lakes SLMP can be used to determine whether or not the reduction goal has been met in any given time period.

The comparison between future monitoring data and P8 results can be conducted as follows:

1. Using monitoring results, calculate the annual load (or the load over some other time period) of phosphorus leaving Kohlman Basin.
2. Run the P8 model of Kohlman Basin for same time period and calculate the load that the model predicts for pre-project conditions.
3. Compare the two loads, and calculate the percent reduction that was achieved over the time period of interest.

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Waschbusch R.J., W.R. Selbig and R.T. Bannerman. 1999. "Sources of Phosphorus in Stormwater and Street Dirt from Two Urban Residential Basins in Madison, Wisconsin, 1994-1995". *United States Geological Survey Water Resources Investigations Report 99-4021.*

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Figures

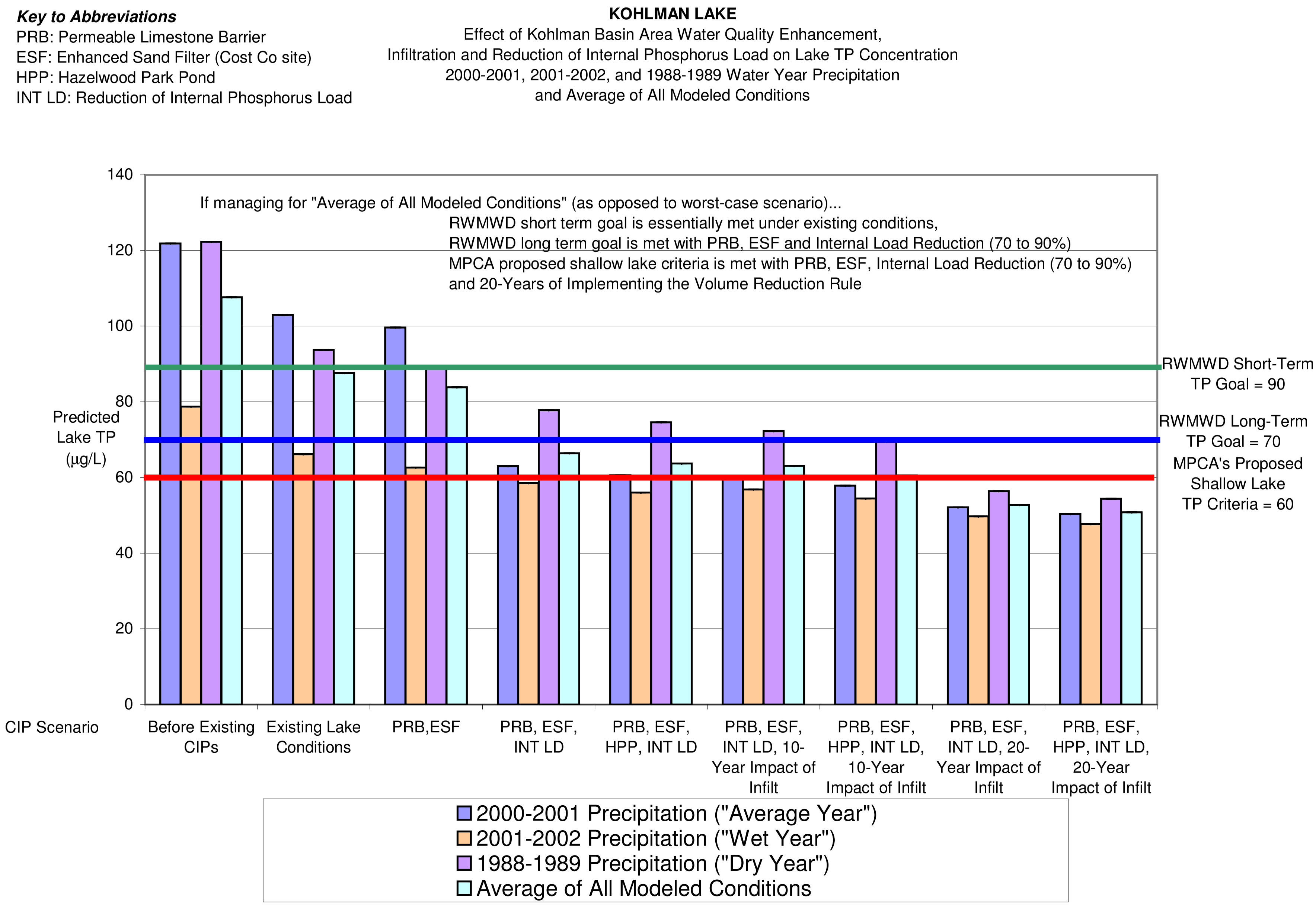

Key to Abbreviations
PRB: Permeable Limestone Barrier
ESF: Enhanced Sand Filter (Cost Co site)
HPP: Hazelwood Park Pond
INT LD: Reduction of Internal Phosphorus Load
KOHLMAN LAKE
Effect of Kohlman Basin Area Water Quality Enhancement,
Infiltration and Reduction of Internal Phosphorus Load on Lake TP Concentration
2000-2001, 2001-2002, and 1988-1989 Water Year Precipitation
and Average of All Modeled Conditions
If managing for "Average of All Modeled Conditions" (as opposed to worst-case scenario)...
RWMWD short term goal is essentially met under existing conditions,
RWMWD long term goal is met with PRB, ESF and Internal Load Reduction (70 to 90%)
MPCA proposed shallow lake criteria is met with PRB, ESF, Internal Load Reduction (70 to 90%)
and 20-Years of Implementing the Volume Reduction Rule
Predicted Lake TP (µg/L)
140
120
100
80
60
40
20
0
RWMWD Short-Term TP Goal = 90
RWMWD Long-Term TP Goal = 70
MPCA's Proposed Shallow Lake TP Criteria = 60
CIP Scenario
Before Existing CIPs
Existing Lake Conditions
PRB,ESF
PRB, ESF, INT LD
PRB, ESF, HPP, INT LD
PRB, ESF, INT LD, 10-Year Impact of Infilt
PRB, ESF, HPP, INT LD, 10-Year Impact of Infilt
PRB, ESF, INT LD, 20-Year Impact of Infilt
PRB, ESF, HPP, INT LD, 20-Year Impact of Infilt
2000-2001 Precipitation ("Average Year")
2001-2002 Precipitation ("Wet Year")
1988-1989 Precipitation ("Dry Year")
Average of All Modeled Conditions

Figure 1a

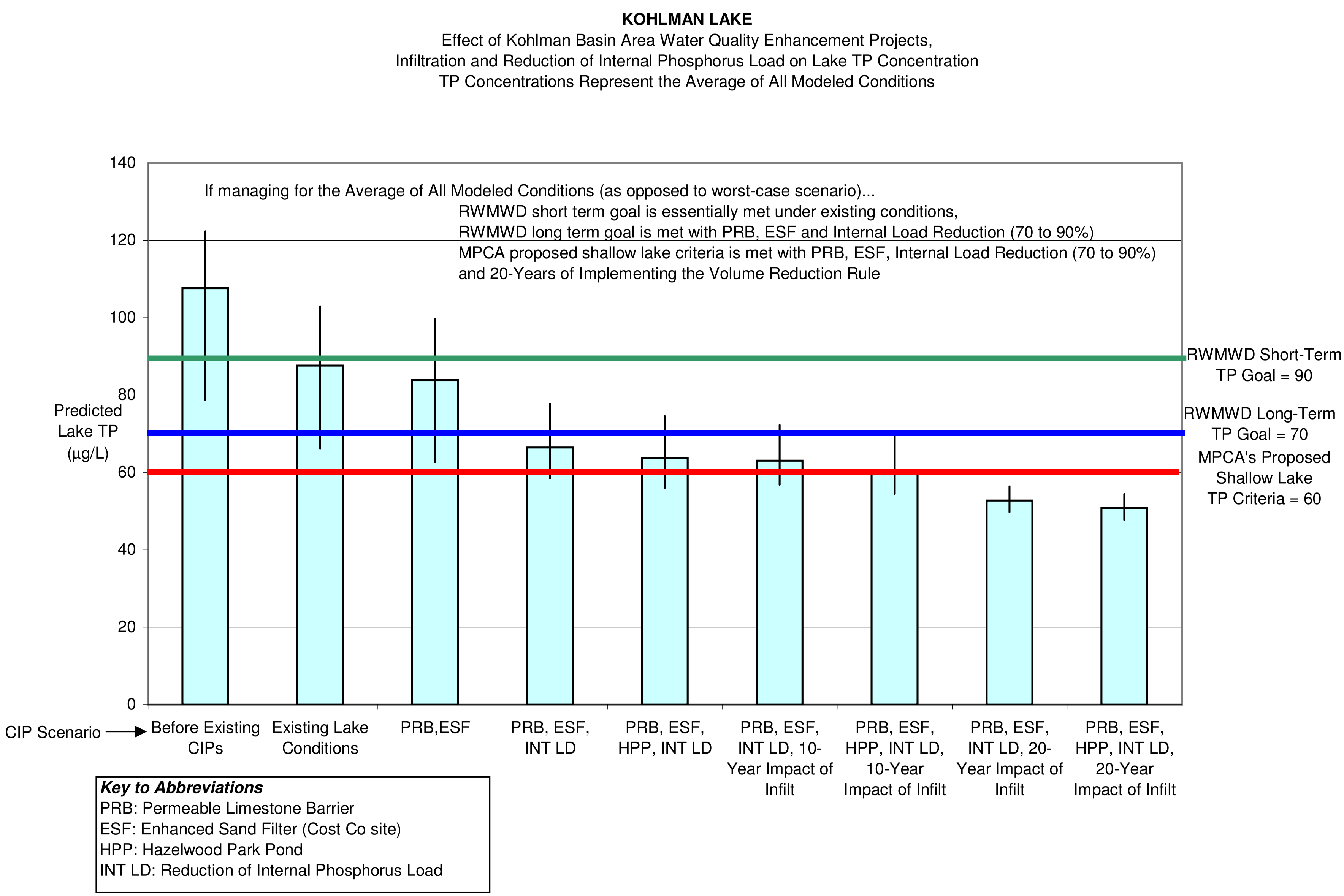

KOHLMAN LAKE
Effect of Kohlman Basin Area Water Quality Enhancement Projects,
Infiltration and Reduction of Internal Phosphorus Load on Lake TP Concentration
TP Concentrations Represent the Average of All Modeled Conditions
If managing for the Average of All Modeled Conditions (as opposed to worst-case scenario)...
RWMWD short term goal is essentially met under existing conditions,
RWMWD long term goal is met with PRB, ESF and Internal Load Reduction (70 to 90%)
MPCA proposed shallow lake criteria is met with PRB, ESF, Internal Load Reduction (70 to 90%)
and 20-Years of Implementing the Volume Reduction Rule
Predicted Lake TP (µg/L)
140
120
100
80
60
40
20
0
RWMWD Short-Term TP Goal = 90
RWMWD Long-Term TP Goal = 70
MPCA's Proposed Shallow Lake TP Criteria = 60
CIP Scenario
Before Existing CIPs
Existing Lake Conditions
PRB,ESF
PRB, ESF, INT LD
PRB, ESF, HPP, INT LD
PRB, ESF, INT LD, 10-Year Impact of Infilt
PRB, ESF, HPP, INT LD, 10-Year Impact of Infilt
PRB, ESF, INT LD, 20-Year Impact of Infilt
PRB, ESF, HPP, INT LD, 20-Year Impact of Infilt
Key to Abbreviations
PRB: Permeable Limestone Barrier
ESF: Enhanced Sand Filter (Cost Co site)
HPP: Hazelwood Park Pond
INT LD: Reduction of Internal Phosphorus Load

Figure 1b

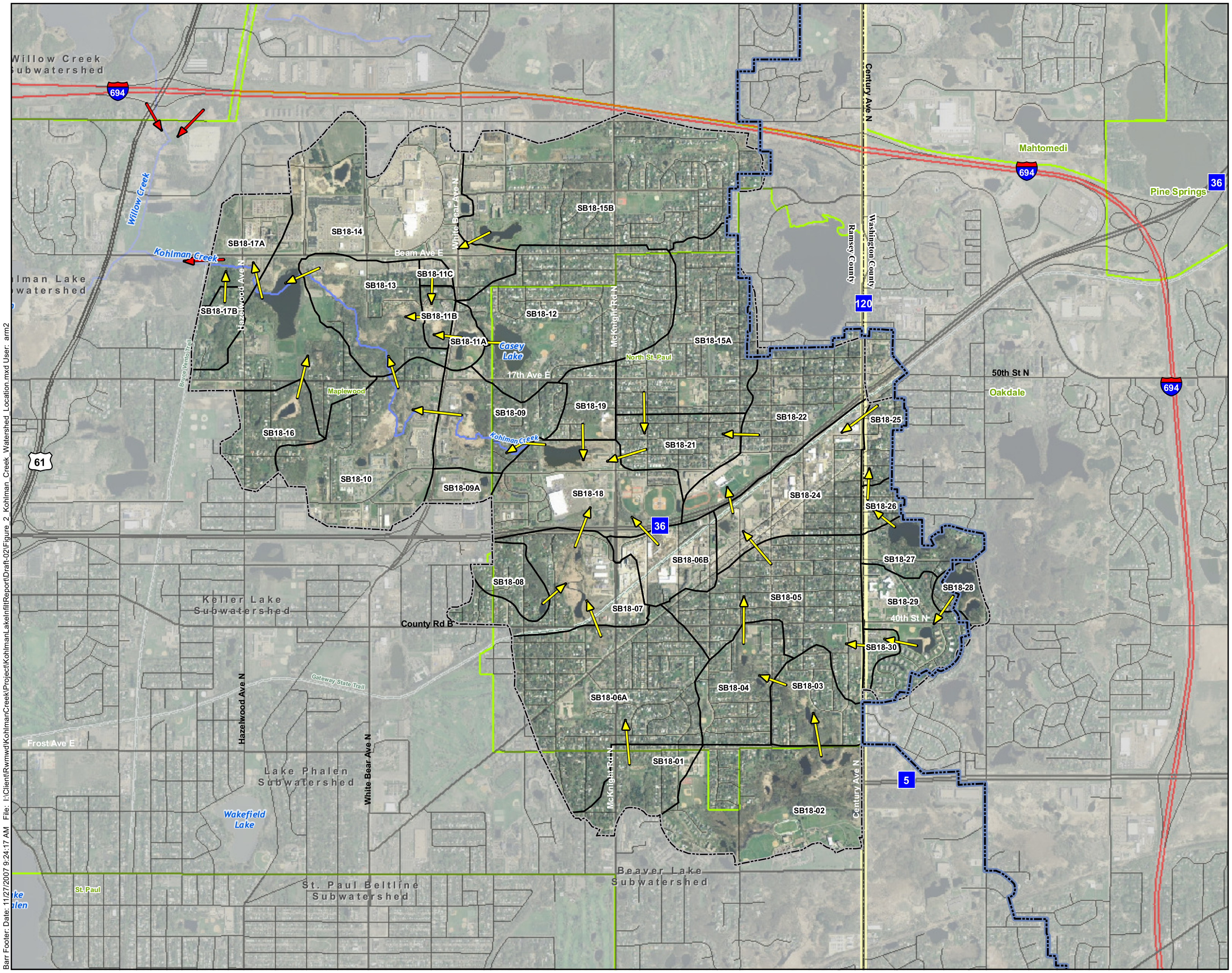
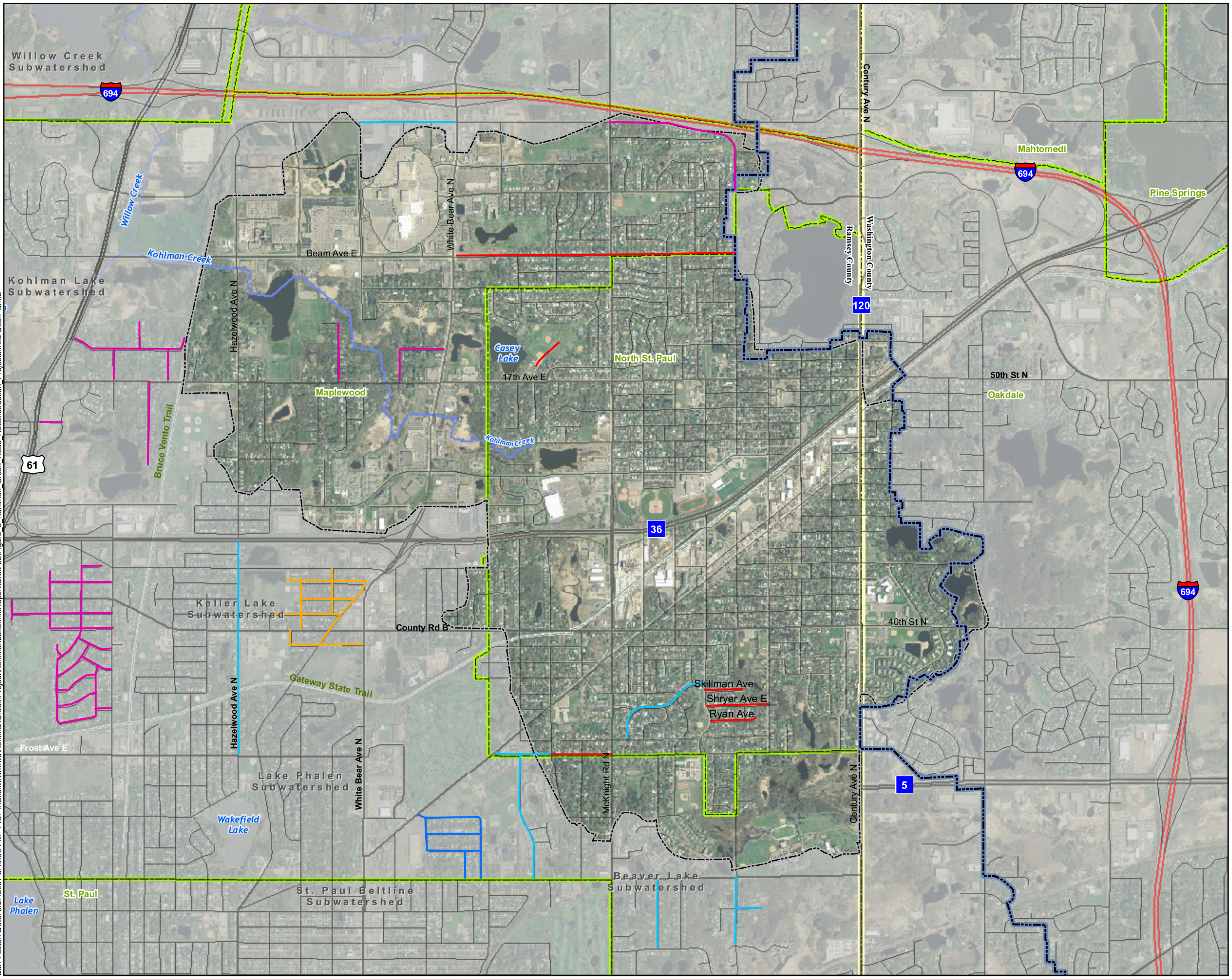


Figure 2
SITE LOCATION
KOHLMAN CREEK SUBWATERSHED
Ramsey-Washington Metro
Watershed District

Barr Footer: Date: 11/27/2007 9:24:17 AM File: I:\Client\Rwmwd\KohlmanCreek\Project\KohlmanLakeInfilReport\Draft-02\Figure_2_Kohlman_Creek_Watershed_Location.mxd User: arm2



Maplewood_NorthStPaul_Road_Construction by Year

- 2006
- 2007
- 2008
- 2009
- 2010
- Beyond 2010
- District Legal Boundary
- Subwatersheds
- Lake/River
- County Border
- Municipal Border

*Source: City of Maplewood 5 Year Capital Improvements Plan Street Rehabilitation & Reconstruction Projects Map, City of North St. Paul Capital Improvement Financing Plan.

2,000 1,000 0 2,000
Feet

500 250 0 500
Meters

Ramsey-Washington Metro Watershed District

Figure 3
ROAD RECONSTRUCTION PROJECTS
KOHLMAN CREEK SUBWATERSHED
Ramsey-Washington Metro
Watershed District

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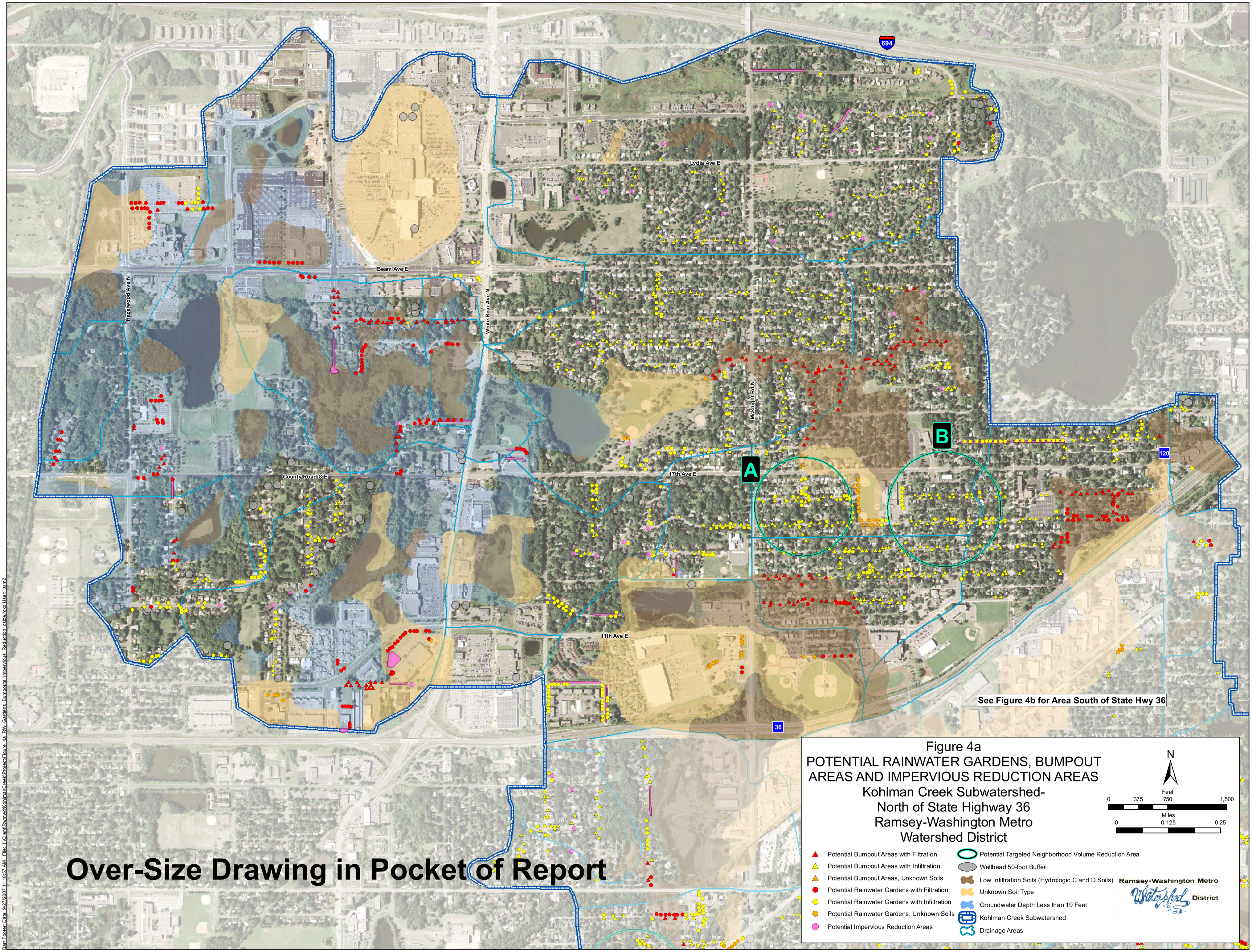


Figure 4a
POTENTIAL RAINWATER GARDENS, BUMPOUT AREAS AND IMPERVIOUS REDUCTION AREAS
Kohlman Creek Subwatershed-
North of State Highway 36
Ramsey-Washington Metro
Watershed District
Potential Bumpout Areas with Filtration
Potential Bumpout Areas with Infiltration
Potential Bumpout Areas, Unknown Soils
Potential Rainwater Gardens with Filtration
Potential Rainwater Gardens with Infiltration
Potential Rainwater Gardens, Unknown Soils
Potential Impervious Reduction Areas
Potential Targeted Neighborhood Volume Reduction Area
Wellhead 50-foot Buffer
Low Infiltration Soils (Hydrologic C and D Soils)
Unknown Soil Type
Groundwater Depth Less than 10 Feet
Kohlman Creek Subwatershed
Drainage Areas
N
Feet
0 375 750 1,500
Miles
0 0.125 0.25
Ramsey-Washington Metro
District
See Figure 4b for Area South of State Hwy 36
Lydia Ave E
Beam Ave E
Hazelwood Ave N
White Bear Ave N
Mcknight Rd N
County Road C E
17th Ave E
11th Ave E
694
120
36
A
B
Over-Size Drawing in Pocket of Report

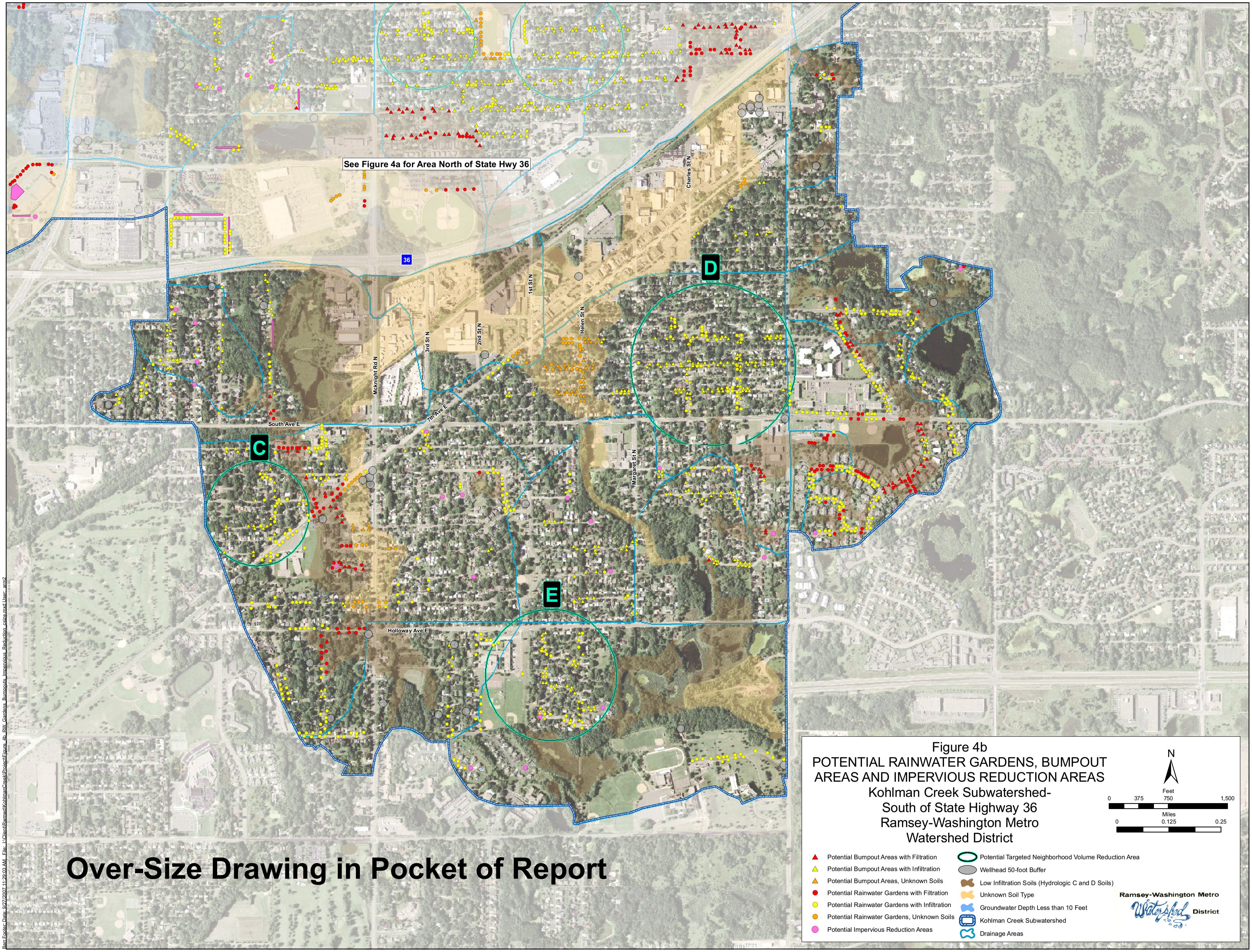
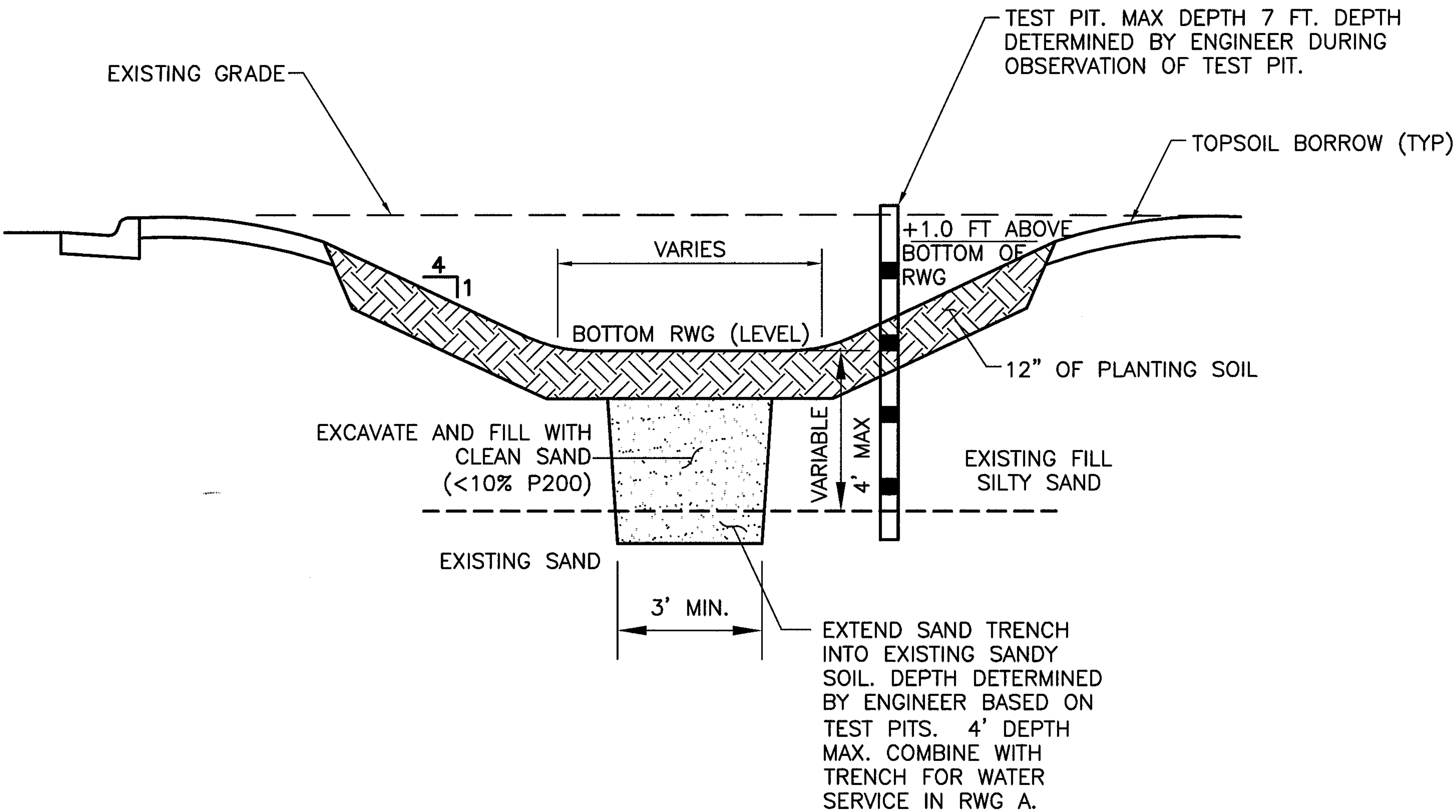


Figure 4b
POTENTIAL RAINWATER GARDENS, BUMPOUT AREAS AND IMPERVIOUS REDUCTION AREAS
Kohlman Creek Subwatershed-
South of State Highway 36
Ramsey-Washington Metro
Watershed District

Over-Size Drawing in Pocket of Report



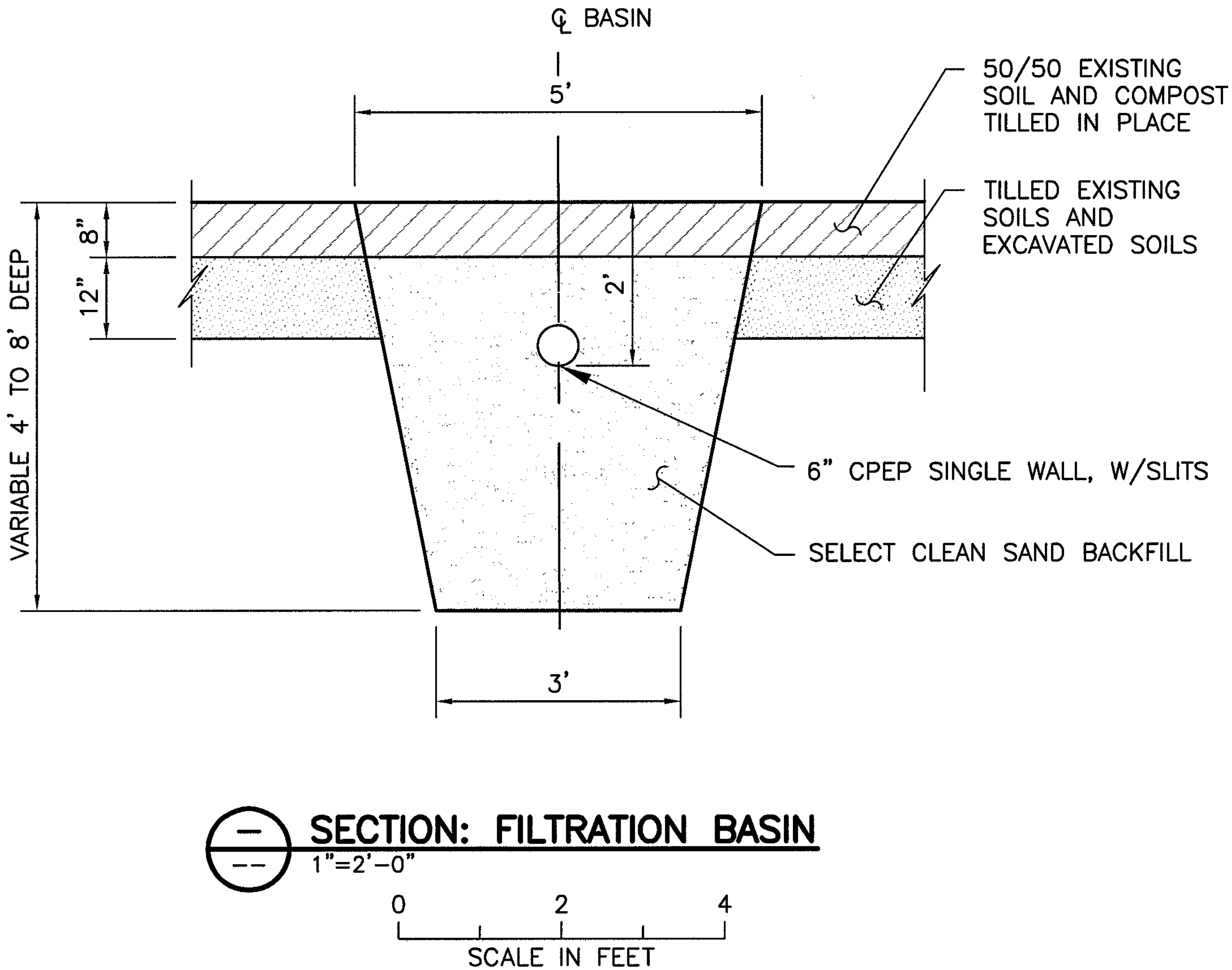
NOTE:

ALL SUBCUT AND PLACEMENT OF SAND BACKFILL AND PLANTING SOIL SHALL OCCUR AFTER THE EXTERIOR OF THE BLDG IS FINISHED TO AVOID COMPACTION OF THE SOIL DURING CONSTRUCTION.

SECTION: RAINWATER GARDEN EXCAVATION (TYP.)

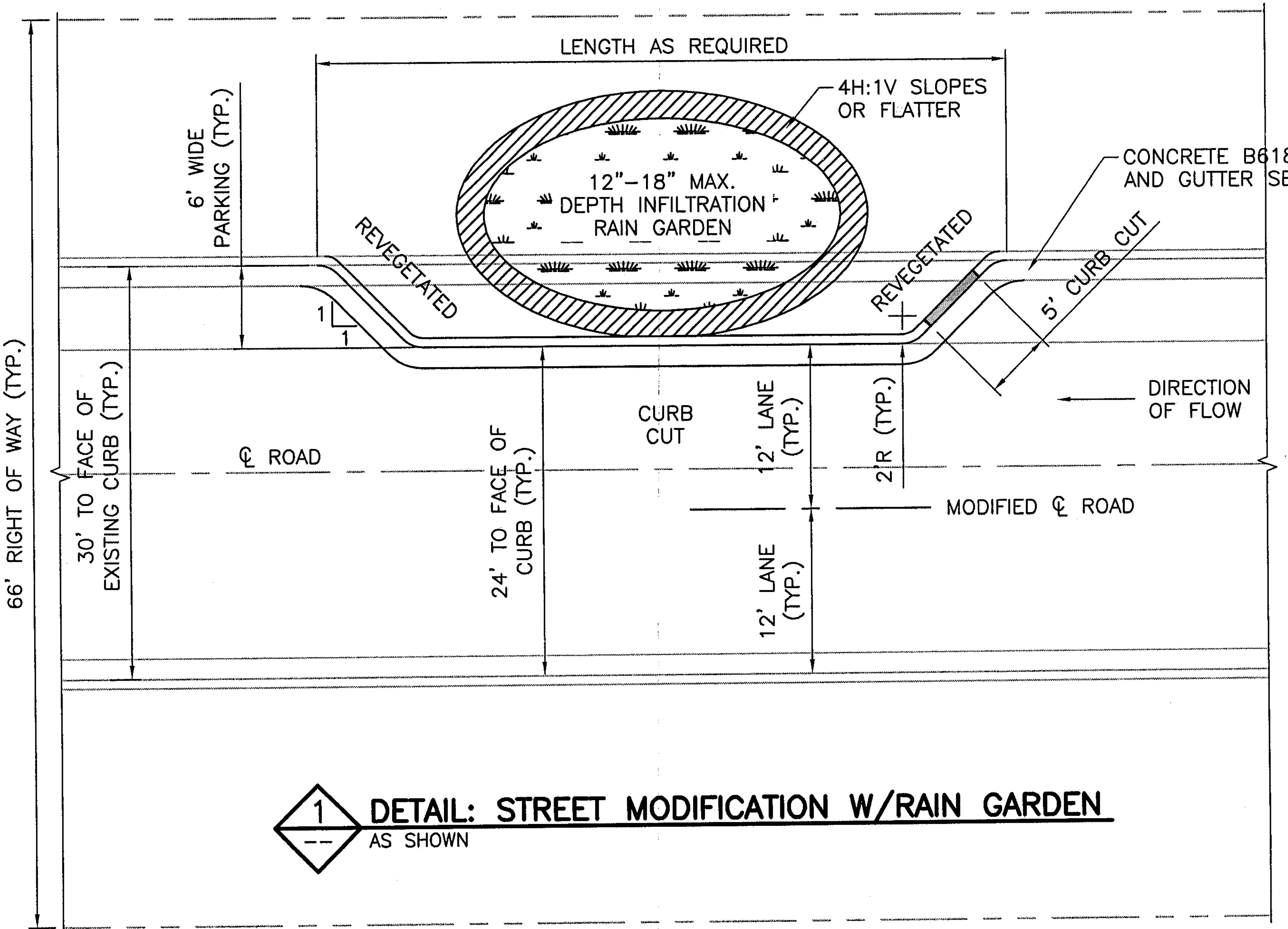
NOT TO SCALE

FIGURE 5



℄ BASIN
5'
50/50 EXISTING SOIL AND COMPOST TILLED IN PLACE
TILLED EXISTING SOILS AND EXCAVATED SOILS
8"
12"
2'
VARIABLE 4' TO 8' DEEP
6" CPEP SINGLE WALL, W/SLITS
SELECT CLEAN SAND BACKFILL
3'
SECTION: FILTRATION BASIN
1"=2'-0"
0
2
4
SCALE IN FEET

FIGURE 6

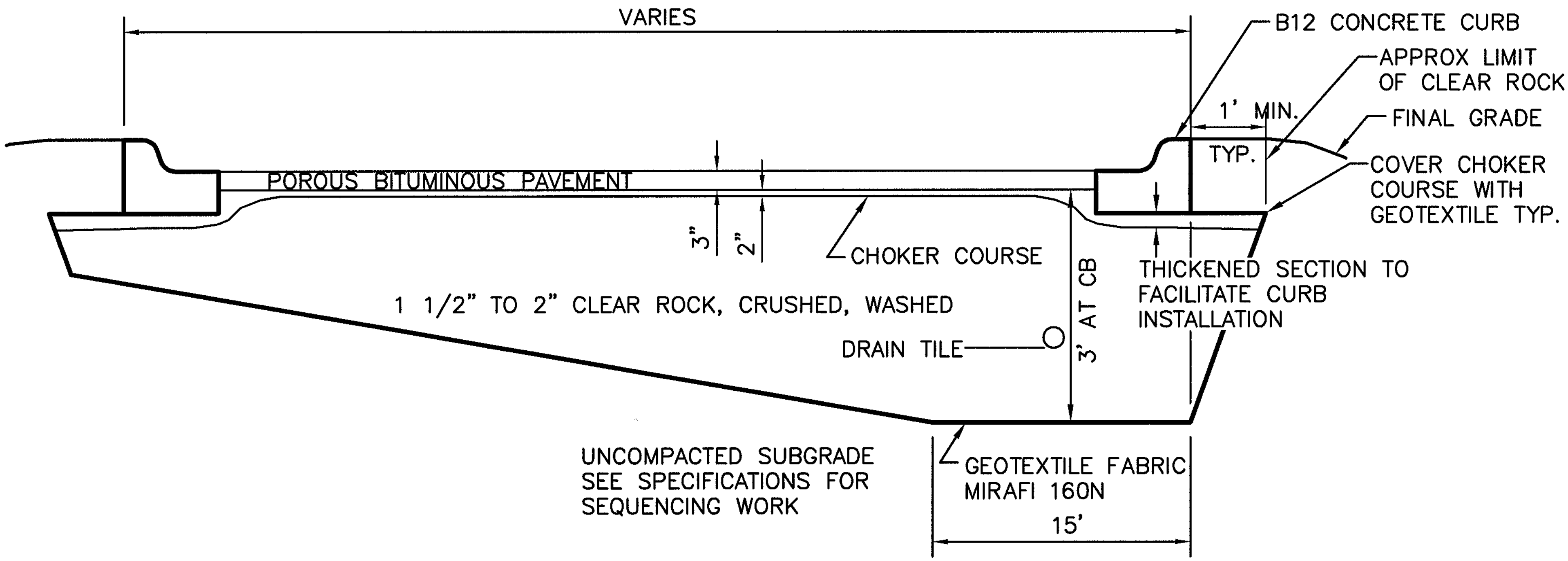


NOTE:

EXISTING STREET WIDTH ASSUMED. MODIFICATIONS TO WIDTH SUBJECT TO LOCAL MINIMUM WIDTH REGULATIONS FOR TRAFFIC DESIGN.

FIGURE 7

GGN M:\cad\Client\RWMWD\Street Impervious Reduction.dwg Plot at 1 11/16/2007 15:42:53



SECTION: POROUS BITUMINOUS PAVEMENT

NOT TO SCALE

FIGURE 8

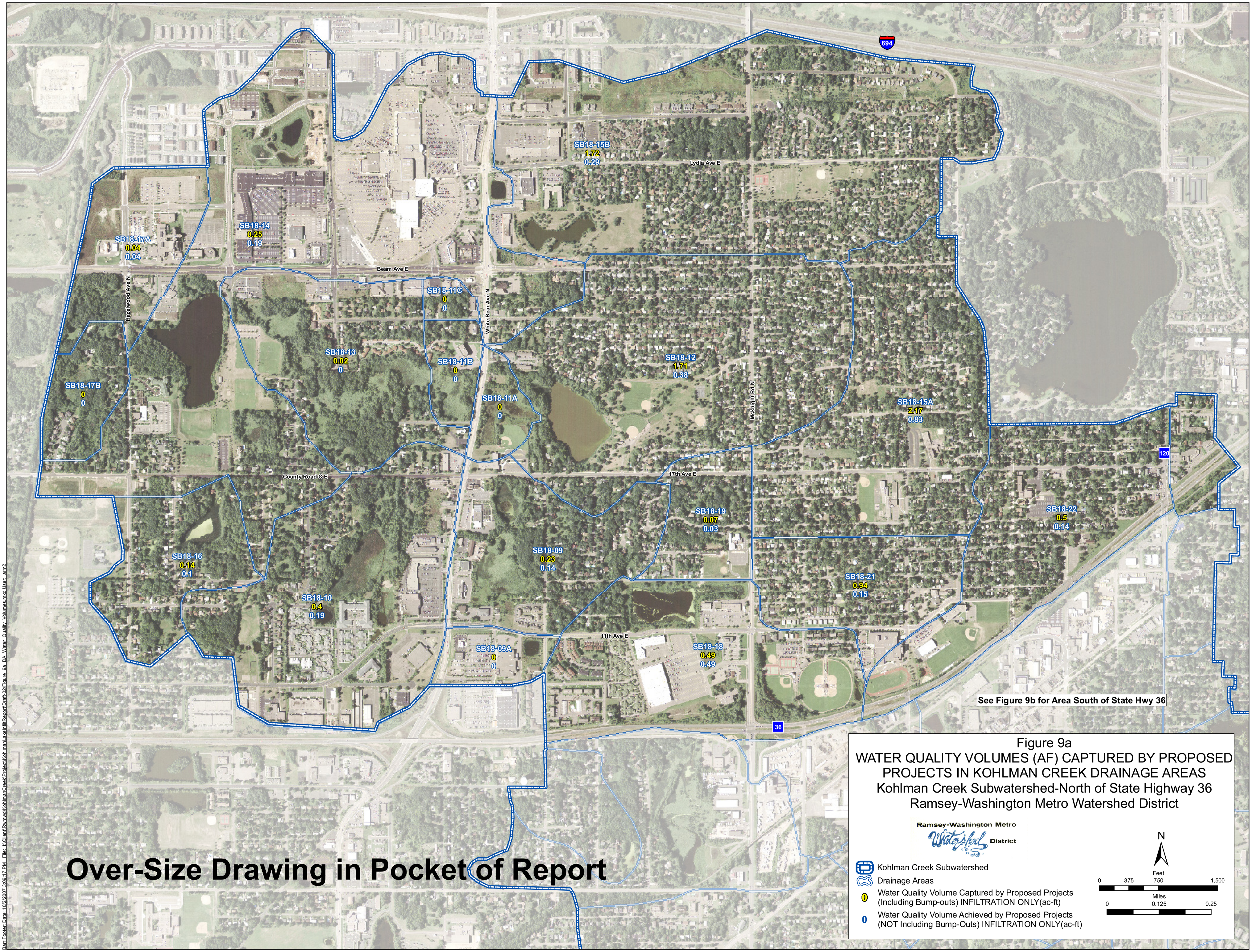
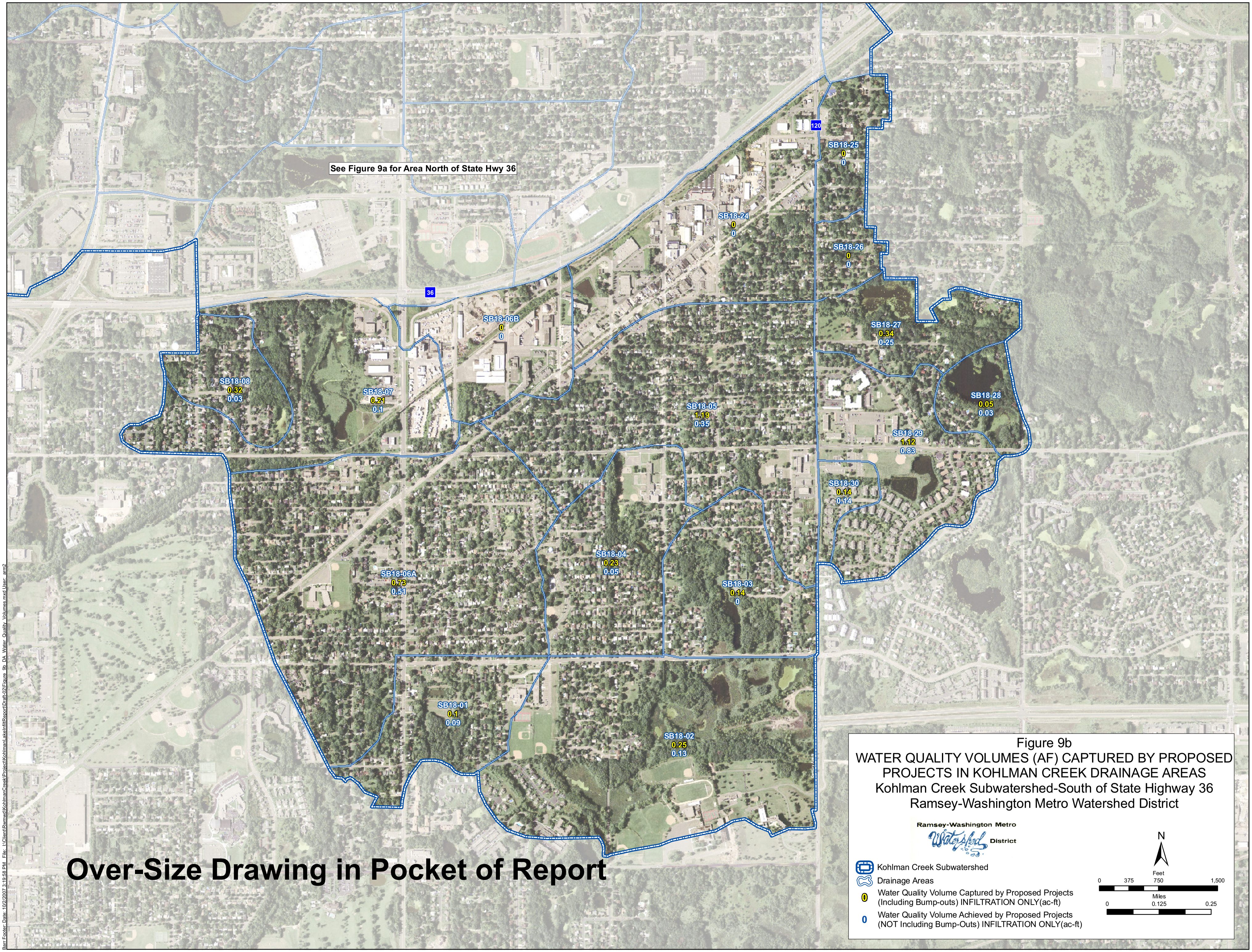
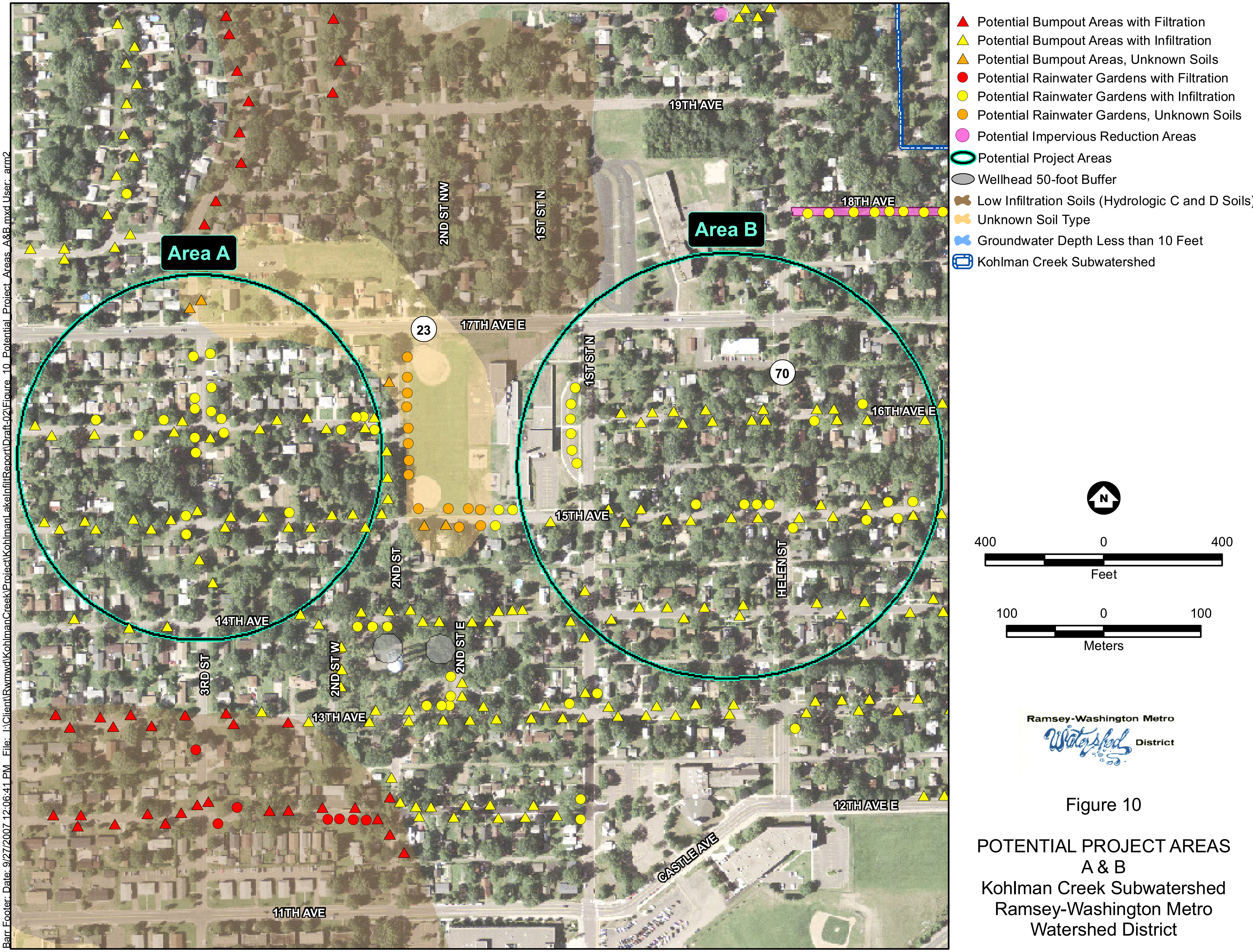


Figure 9a
WATER QUALITY VOLUMES (AF) CAPTURED BY PROPOSED PROJECTS IN KOHLMAN CREEK DRAINAGE AREAS
Kohlman Creek Subwatershed-North of State Highway 36
Ramsey-Washington Metro Watershed District
Ramsey-Washington Metro Watershed District
Kohlman Creek Subwatershed
Drainage Areas
Water Quality Volume Captured by Proposed Projects (Including Bump-outs) INFILTRATION ONLY(ac-ft)
Water Quality Volume Achieved by Proposed Projects (NOT Including Bump-Outs) INFILTRATION ONLY(ac-ft)
N
Feet
0 375 750 1,500
Miles
0 0.125 0.25
See Figure 9b for Area South of State Hwy 36
Over-Size Drawing in Pocket of Report
SB18-15B 1.72 0.29
SB18-14 0.25 0.19
SB18-17A 0.04 0.04
SB18-11C 0 0
SB18-13 0.02 0
SB18-11B 0 0
SB18-12 1.71 0.38
SB18-17B 0 0
SB18-11A 0 0
SB18-15A 2.17 0.83
SB18-22 0.5 0.14
SB18-19 0.07 0.03
SB18-16 0.14 0.1
SB18-09 0.23 0.14
SB18-21 0.94 0.15
SB18-10 0.4 0.19
SB18-09A 0 0
SB18-18 0.49 0.49
Lydia Ave E
Beam Ave E
Hazelwood Ave N
White Bear Ave N
County Road C E
17th Ave E
Mcknight Rd N
11th Ave E
694
120
36



Over-Size Drawing in Pocket of Report



Ramsey-Washington Metro Watershed District

Figure 10

POTENTIAL PROJECT AREAS
A & B
Kohlman Creek Subwatershed
Ramsey-Washington Metro
Watershed District

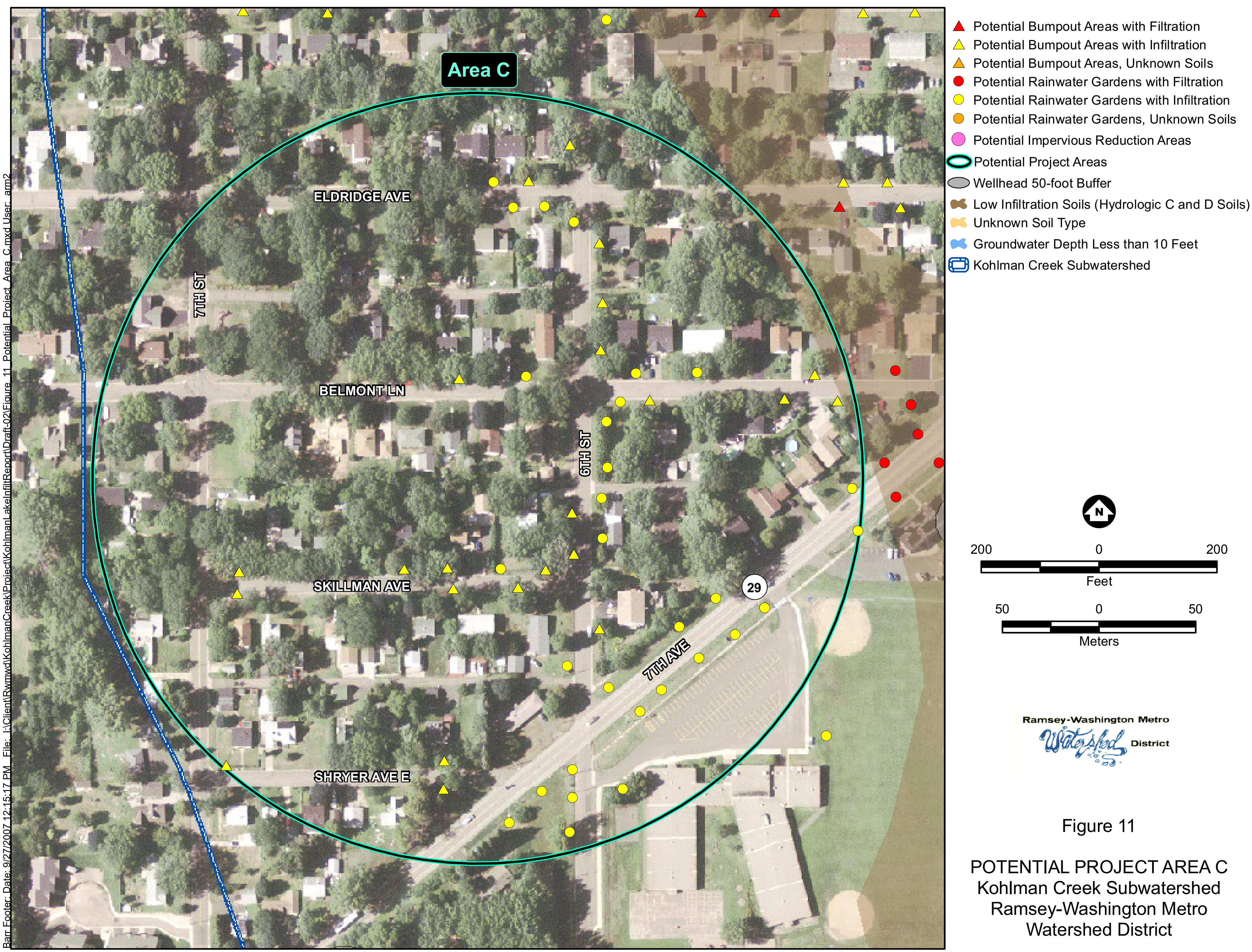


Figure 11

POTENTIAL PROJECT AREA C
Kohlman Creek Subwatershed
Ramsey-Washington Metro
Watershed District

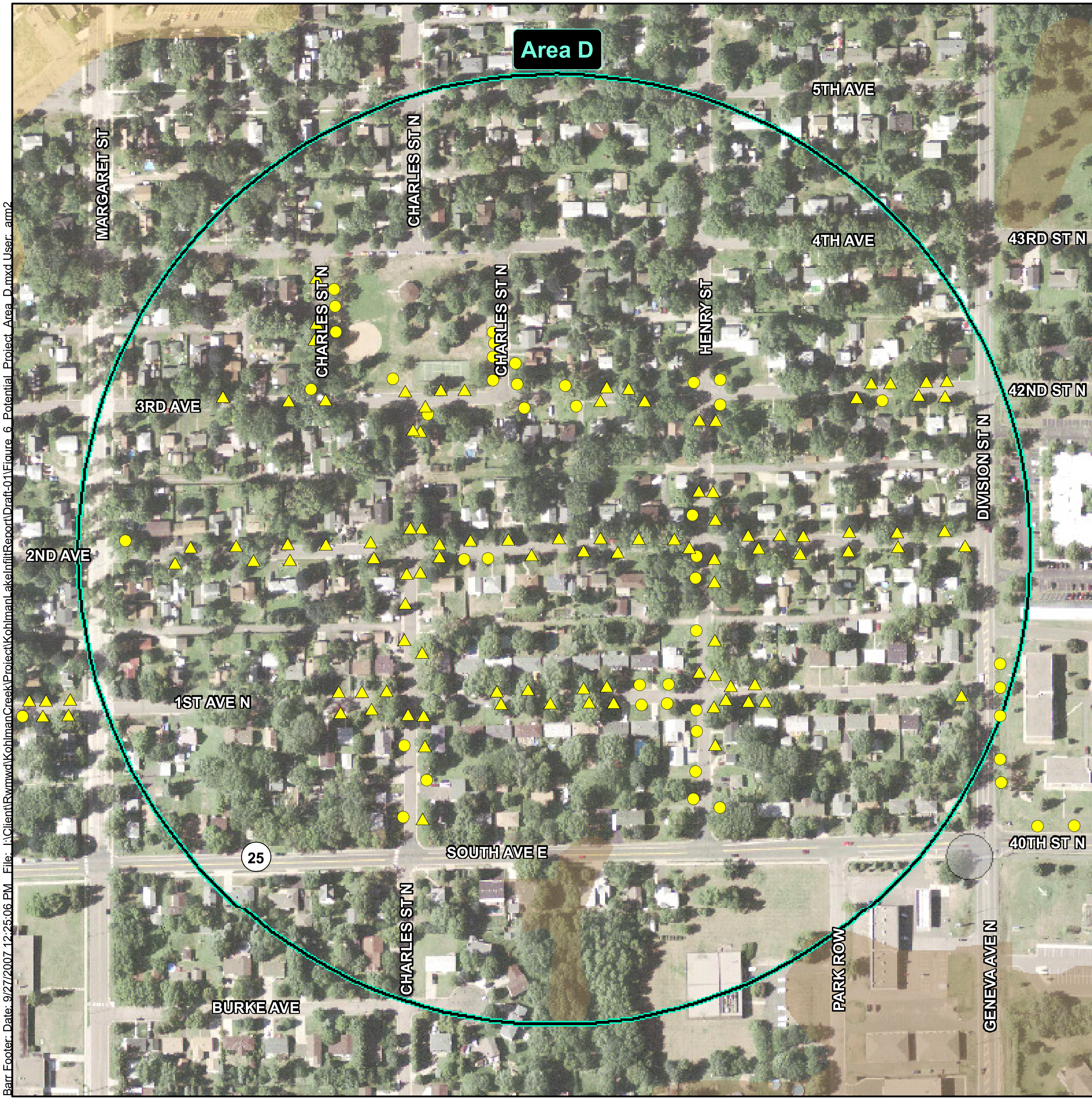
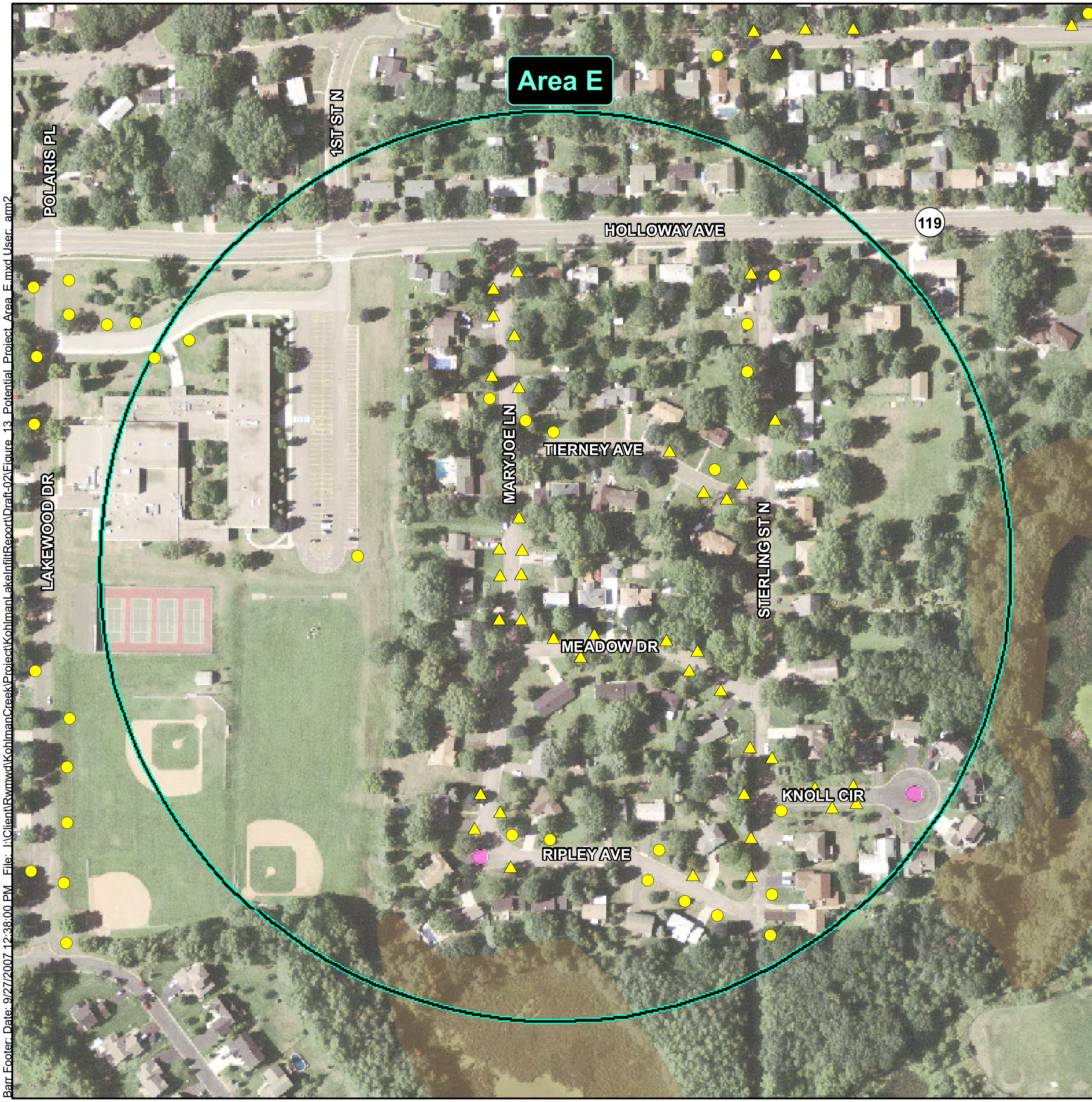


Figure 12

POTENTIAL PROJECT AREA D
Kohlman Creek Subwatershed
Ramsey-Washington Metro
Watershed District

Barr Footer: Date: 9/27/2007 12:25:06 PM File: I:\Client\Rwmwd\KohlmanCreek\Project\KohlmanLakeInfiltReport\Draft-01\Figure_6_Potential_Project_Area_D.mxd User: arm2



- Potential Bumpout Areas with Filtration
- Potential Bumpout Areas with Infiltration
- Potential Bumpout Areas, Unknown Soils
- Potential Rainwater Gardens with Filtration
- Potential Rainwater Gardens with Infiltration
- Potential Rainwater Gardens, Unknown Soils
- Potential Impervious Reduction Areas
- Potential Project Areas
- Wellhead 50-foot Buffer
- Low Infiltration Soils (Hydrologic C and D Soils)
- Unknown Soil Type
- Groundwater Depth Less than 10 Feet
- Kohlman Creek Subwatershed

N

250 0 250
Feet

75 0 75
Meters

Ramsey-Washington Metro Watershed District

Figure 13

POTENTIAL PROJECT AREA E
Kohlman Creek Subwatershed
Ramsey-Washington Metro
Watershed District

Appendices

Appendix A

The Benefits of Trees

Excerpt from United States Department of Agriculture Brochure on the Benefits of Trees

Appendix A: The Benefits of Trees

Excerpt from United States Department of Agriculture Brochure on the Benefits of Trees

Trees provide many benefits to the environment and community. The past few decades of tree research has led to document, and quantify the benefits of trees. Early on, researchers were quantifying the amount of greenhouse gases trees remove from the atmosphere (about ½ on of carbon dioxide per tree per year) and pollutants (about 4.3 pounds of pollutants per tree per year). Since then, researchers have begun to document an ever growing list of benefits that may not be so obvious.

Quick Facts

- Trees remove pollutants and greenhouse gasses
- Trees reduce the cost of electricity for cooling
- Trees improve the flow of water into the groundwater table and reduce the flow of water into the storm water system
- Trees are good for business
- Trees add to a property's value
- Tree benefits are three times their

Benefits to the Environment

In addition to the direct removal of greenhouse gases and pollutants, mentioned above, trees:

- Reduce temperatures by shading streets, sidewalks and other hardscapes, resulting in reduced use of electricity for cooling and a corresponding reduction of any non-renewable fuels used to generate that electricity. Furthermore, there is a reduction in the emission of greenhouse gases and pollutants associated with the use of fossil fuels.
- Increase the amount of water that reaches the groundwater table as rainfall follows tree root systems down below the soil surface.
- Intercept rain with leaves and branches reducing the amount of water that reaches the storm sewer system, particularly when properly placed to grow over streets, sidewalks, parking lots and rooftops. This reduces downstream the erosive force of large volumes of runoff to natural water bodies, and flooding.
- Add organic matter to the soil which further improves the water holding capacity of the soil.
- Improve the resiliency of soil to respond to rain events by removing water from the soil which can reduce saturated conditions which exacerbate storm water load. One mature tree can capture over 5,000 gallons of water in a year.
- Reduce soil erosion with dense root systems. Less soil, contaminated or clean, reaches the storm water system, creeks and rivers.

For these reasons, the Environmental Protection Agency recommends an average tree cover of 50 percent for suburbs in our area of the United States.

Benefits to the Community

Trees help promote pride in the community and a sense of place. Other benefits of trees affect us either directly or indirectly in our daily lives, or have direct effects on our roads, utilities and businesses. Here is some of what we know to be true:

- Street trees are an important factor in reducing road maintenance costs. Recently, researchers showed that streets shaded by medium-sized trees required less frequent resealing than streets fully exposed to the sun.
- Tree-filled neighborhoods show lower levels of domestic violence.
- Street trees can calm traffic and lower traffic speed by reducing the perceived width of street. Streets without trees have the opposite effect, appearing “wide open”.
- Trees help reduce noise levels.
- Trees are known to shorten hospital stays.
- Trees can reduce workplace stress.
- Trees can be used to screen unsightly views.
- Our trees are part of the legacy from those who came before us.
- Healthy trees in neighborhoods enhance property values.
- The sales price for a home increases by about 1 percent for each large front yard tree.
- But a single, large, specimen tree in a yard can add 10 percent to the property’s value.

Trees are also good for business. Surveys of shoppers in commercial districts with tree-lined streets reported that:

- They shop there more frequently.
- They shop for longer periods of time.
- They are more willing to pay for parking.
- They spend, on average, 12 percent more on goods than they do in areas without trees.

Adding it All Up

When the benefits that can be quantified are weighed against the cost of trees (i.e., purchase, planting, pruning, and removal), these **benefits outweigh the cost by a margin of about three to one**. This doesn't include the benefits we cannot quantify such as community pride or reduction in stress. Communities continue to reap these benefits. These benefits started with proper planting of trees on streets and other public property, and by encouraging appropriate planting on private property. It is important to continue planting trees in the watershed and be sure the urban forest is properly maintained to prevent an erosion of these benefits and an increase in costs associated with neglect.

Appendix B

City of Minneapolis Study on the Benefits of Trees

Appendix B: City of Minneapolis Study on the Benefits of Trees

In June 2005, the City of Minneapolis published a study on the benefit that trees provide to the community (McPherson, 2005). One of the benefits that were analyzed was a reduction in stormwater infrastructure costs due to tree interception. The city first determined how much water is intercepted by each species of tree and found a total reduction in stormwater runoff for each species. The city then calculated a total stormwater infrastructure cost savings of $0.027/gallon based on the 20-year life-cycle cost of a 5-acre pond. This is a more expensive assumption than other studies have used due to the higher costs of land acquisition in an urban area. Approximately half of the cost in the assumption is based on the land acquisition costs.

The study determined that annually Minneapolis's city-managed trees intercept and evaporate 44.75 million cubic feet of rainwater, or 1,685 gallons per tree. The study found that different species of trees saved between $4 (Gingko) and $190 (American elm) each, and the average tree saved $46 per year in stormwater infrastructure costs. The trees that performed best had larger leaves and stem area.

Minneapolis calculated that the total stormwater savings for all the trees under its care is $9,071,809, while the total costs associated with planting, maintaining and removing the trees is $9,209,041 (roughly equal). However, other benefits are not included in this calculation- if savings based on energy demand reduction, reduced CO_2, improved air quality and enhanced aesthetics are included, trees can be worth three times their investment. When these other benefits that can be quantified are weighed against the cost of trees, these benefits outweigh the costs by a margin of about three to one.

Using the methodology in the Minneapolis study, the addition of 774 trees (of varying species) in the Kohlman Basin watershed would provide the same water quality benefit as a stormwater pond with a storage capacity of 1 acre-foot. Even higher savings would be realized by planting trees with larger leaves. To maximize the stormwater removal, trees should be planted to canopy impervious surfaces. Trees would be most effectively placed along streets, in parking lots, and alongside buildings.