Washington County

Targeting Reuse Irrigation in Washington County

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HOUSTON engineering, inc.

In collaboration with Houston Engineering, Inc.

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CLEAN WATER LAND & LEGACY AMENDMENT

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Overview

Washington County received support from the Clean Water Fund, via the Board of Water and Soil Resources (BWSR)'s Watershed-based Implementation Funding Program, to identify potential project sites for stormwater reuse irrigation projects in the county to support the county's 2014-2024 Groundwater Plan. The goal of the county's Groundwater Plan is to manage the quality and quantity of groundwater in Washington County to protect health and ensure sufficient supplies of clean water to support human uses and natural ecosystems. Groundwater provides 100 percent of the county's drinking water supply.

In recent years, there has been growing concern over the sustainability of groundwater supplies in Washington County and the larger Twin Cities metropolitan area. This concern spurred an increased effort to consider viable and effective solutions to promote groundwater recharge, protect groundwater supplies, and reduce non-essential consumption of potable groundwater supplies. Stormwater reuse irrigation projects (i.e. reuse irrigation projects) replace use of potable groundwater in public and private irrigation with harvested stormwater runoff. These practices also have additional benefits, including reducing urban runoff volume and nutrient delivery to surface water resources.

One challenge in pursuing reuse irrigation projects is the identification of where these projects should be placed to provide the greatest value and highest return on investments. This assessment identifies and prioritizes potential locations suitable for these reuse irrigation projects within Washington County. Identifying and prioritizing potential reuse irrigation project sites provides the data and information needed to pursue implementation of these projects.

The county funded this assessment to be utilized by its partners (watershed organizations, municipalities, etc.) to identify and partner on new reuse irrigation projects. Results of the assessment will be made available to watershed organizations and municipalities, who can in turn further refine qualitative criteria to meet their organization's unique goals (see **Attachment A** for possible data to use to further refine). While the county has a state approved Groundwater Plan, no one entity has the overall authority to implement all the necessary actions to protect and conserve groundwater. The county seeks support and values its partnerships to protect and conserve this valuable resource. This project was funded by Washington County and Clean Water Funds from BWSR's Watershed-based Implementation Funding Program.

Methodology

The county-scale assessment was developed with the goal of identifying technically feasible locations for reuse irrigation projects, followed by applying prioritization and ranking criteria to identify the most promising reuse irrigation project sites for future implementation. The assessment is comprised of two parts, summarized by flowchart in **Attachment B** and **Attachment C**. The first part of the assessment evaluates the technical feasibility of sites within the county for supporting reuse irrigation projects. During the second part, sites that are identified as technically feasible are prioritized and ranked using criteria that align with the goals of implementing reuse irrigation projects within the county. Both parts can be used by partners to site potential reuse irrigation projects.

Principally, goals for reuse irrigation projects as identified by the county are to decrease the use of potable groundwater for irrigation and protect the quality of groundwater supplies. Reuse irrigation projects have the potential to offset non-essential use of county potable groundwater resources by capturing and using surface runoff to satisfy a site's irrigation demand. Further, such projects can be implemented as a strategy to protect water use and facilitate broader county land use goals (Washington County, 2010). As a result, criteria such as a site's non-essential permitted groundwater use and proximity to wellhead protection areas and Drinking Water Supply Management Areas can be used within the assessment to identify the most promising sites for reuse irrigation projects, aimed at these identified goals.

A list of planning criteria was established for use within this assessment, using existing geospatial data (**Table 1**). The planning criteria are broken into two categories:

- *Technical planning criteria* are used to identify sites (parcels) within the county expected to be technically feasible for supporting a reuse project.
- *Qualitative planning criteria* are used to prioritize and rank parcels identified as technically feasible, based upon project goals.

Identification of feasible parcels and subsequent ranking is accomplished through use rules assigned to each technical and qualitative criterion (**Table 1**). For technical criteria, use rules guide the promotion of technically feasible parcels and exclusion of parcels lacking technical feasibility. Use rules related to qualitative criteria rank parcels, giving a higher rank to potential projects that promote goals of protecting county groundwater supplies and reducing consumption of groundwater.

The county held a stakeholder engagement meeting with the watershed organizations within the county to determine what qualitative criteria should be applied and what the final product should look like so it is most useful to the watershed organization. Those that could not attend were given the opportunity to comment via email or by phone. Comments were received from the Washington Conservation District, Carnelian Marine St. Croix Watershed District, Rice Creek Watershed District and South Washington Watershed District.

Technically Feasible Parcels

Technical criteria were applied first within the assessment. Parcels are preliminarily identified as technically feasible by estimating their "feasibility ratio," defined as the ratio of each parcel's irrigation supply to irrigation demand. These criteria are applied to ensure there is sufficient runoff to meet the parcel's irrigation demands (HEI, 2016). This feasibility ratio is determined through a series of calculations, made by applying the use rules of technical criteria (**Table 1**) utilizing their associated geospatial data (**Attachment B**).

The irrigation demand is the estimated amount of volume needed to irrigate the parcel's pervious area. Irrigation demand was determined by regression analysis described by the Metropolitan Council Stormwater Reuse Guide (2011) assuming a 26-week growing season (April 1st through September 30th). Irrigation supply is the annual volume from surface water runoff. The runoff calculations used a method

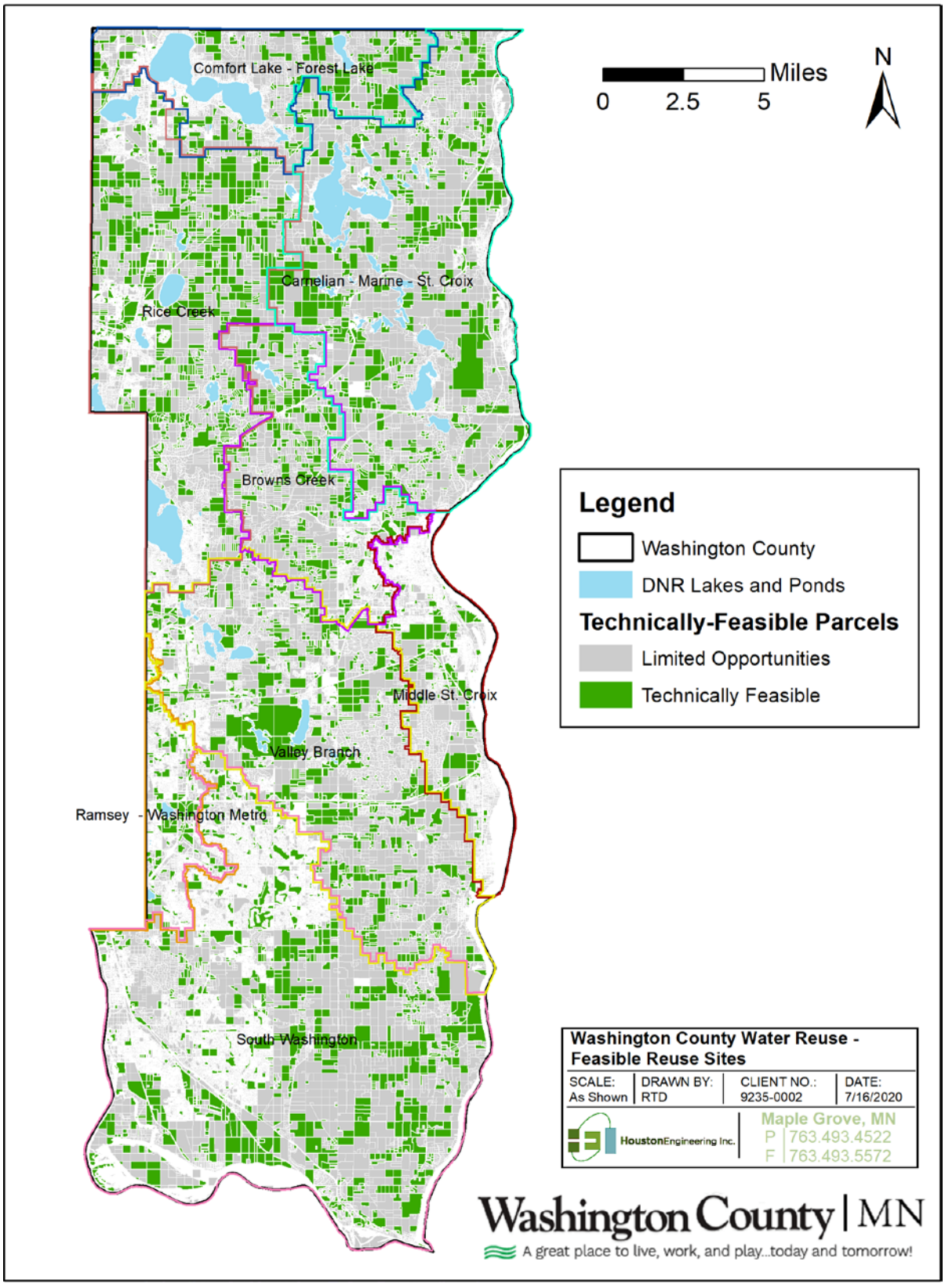
derived from Minnesota Pollution Control Agency (MPCA) Minimum Impact Design Standards (MIDS) with inputs from soil data, landcover data and impervious cover geospatial data. The runoff volume from the upstream area was calculated utilizing a flow accumulation grid derived from a partially hydro-conditioned digital elevation model (DEM) using LiDAR data. Land parcels are identified as "technically feasible" if the feasibility ratio is ≥ 1. A ratio greater than one suggests enough stormwater runoff reaches the site to irrigate the pervious area present.

Technically feasible parcels were screened to remove parcels with pervious area of less than three acres. This is intended to remove parcels with small potential demand for irrigation (i.e. residential small lot development) and maintain parcels with larger potential demand, such as recreational and open areas. Parcels previously deemed "technically feasible" based on the feasibility ratio yet fail to achieve this evaluation are no longer considered feasible for this assessment. The result of this evaluation is a final list of parcels within the county that are technically feasible for future reuse irrigation projects (**Figure 1**).

Table 1: Planning criteria, geospatial data, and use rules applied in the assessment.

Planning Criterion	Criterion Purpose	Geospatial Data Layer	Use Rules
Technical Criteria			
Irrigation Demand	Assess the potential magnitude of reduced groundwater use and stormwater runoff storage	Land Use, Land Cover, soils (UMN RSGAL, NLCD, SSURGO)	Parcels are feasible if irrigation supply is less than irrigation demand
Runoff Supply	Generate sufficient surface runoff volume to meet storage requirement of water reuse project	Land Use, Land Cover, soils (UMN RSGAL, NLCD, SSURGO), MIDS Annual Runoff Coefficients	Parcels with insufficient runoff and drainage area size are not feasible
Drainage Area Size	Generate sufficient surface runoff volume to meet storage requirement of water reuse project	Partially Hydro-Conditioned Digital Elevation Model (DEM) using LiDAR data	Parcels with insufficient runoff and drainage area size are not feasible
Parcel Pervious Area	Parcel pervious area directly related to irrigation demand	Washington County Parcel data	Parcels with insufficient pervious area to irrigate (less than 3 acres) are not feasible
Qualitative (Ranking) Criteria			
High Volume Groundwater User	Prioritize feasible parcels with high-volume water supply, non-crop irrigation or water supply permits	MPARS database (DNR Permitting and Reporting System; dnr.state.mn.us/mpars)	Parcels intersecting these features receive an additional ranking point.
Wellhead Protection Area (WHPA)	Prioritize feasible parcels within wellhead protection areas	Wellhead Protection Areas shapefile (MDH, available on gisdata.mn.gov)	Parcels intersecting Wellhead Protection Areas receive an additional ranking point
Drinking Water Supply Management Area (DWSMA)	Prioritize feasible parcels within DWSMAs	Drinking Water Supply Management Area shapefile (MDH, available on gisdata.mn.gov)	Parcels intersecting DWSMAs receive an additional ranking point
Emergency Response Area (ERA)	Prioritize feasible parcels within Emergency Response Areas	Emergency Response Area shapefile (MDH, available on gisdata.mn.gov)	Parcels intersecting the one-year time of travel for public water supply well receive an additional ranking point
Public Access Sites	Prioritize feasible parcels that are City or County owned, Commercial / Industrial, and Education (**Attachment D**)	County parcel records	Parcels receive an additional ranking point if City or County owned, Commercial / Industrial, and Education (**Attachment D**)
MLCCS Existing Turf Area	Determine the potential irrigation from managed turf areas within existing parcels (**Attachment D**)	Vegetated Land Cover (MLCCS)	Parcels with larger irrigation demand receive a higher rank

Figure 1. Parcels within Washington County that are technically feasible for reuse irrigation projects, as defined by the assessment.



Ranked and Prioritized Parcels

Qualitative criteria are used within the assessment to prioritize and rank parcels deemed technically feasible based on county reuse project goals, in this case to decrease the use of potable groundwater for irrigation and protect the quality of groundwater supplies. As shown in **Table 1** and **Attachment C**, five qualitative criteria were applied in this assessment for prioritizing and ranking potential reuse projects within the county. Parcels were ranked using a point system, with one point awarded for each qualitative criteria met. Parcels received a point if:

- Parcels intersected high-demand, non-essential irrigation users (millions of gallons/year; 'non-crop irrigation' or 'water supply' classification within MPARS);
- Parcels intersected wellhead protection areas;
- Parcels intersected a Drinking Water Supply Management Area (DWSMA);
- Parcels intersected emergency response areas (1-year emergency source water protection buffer); or
- Parcels included land use with water supply for public use and green spaces, specifically commercial, hospital, education, and recreational lands. (Parcels were also excluded for land uses not suitable for irrigation, such as wetlands and open water. See **Attachment D** for 'Use Classification' by parcel.)

The overall qualitative rank of technically feasible parcels was a sum of a parcel's qualitative ranking criteria. Technically feasible parcels received a qualitative ranking score from 1 to 5 (1 – Very Low; 5 – Very High). The result is a map depicting prioritized sites for reuse projects, based on the county's Groundwater Plan goals (**Figure 2**).

To further assist in implementation efforts, Very High and High ranking parcels were ranked again based on annual irrigation demand from MLCCS existing turf areas, utilizing Minnesota Land Cover Classification System (MLCCS). The top 20 prioritized parcels based on annual irrigation demand were summarized in **Figure 3** and associated attribute information is described in **Table 3**.

A desktop aerial photography (MnGeo WMS service 2016) review of the top 20 parcels was conducted. The intent of the desktop review was to ensure the accuracy of the assessment in only selecting sites that are practical to irrigate. It should be noted that the desktop review is limited by quality of the aerial photography used and land use may have changed since aerial photography was taken. A field visit is recommended to confirm the feasibility and viability for future implementation.

This methodology does not consider the presence of existing reuse irrigation systems. At least one site in the top 20 parcel list has preexisting water reuse projects in operation (Oneka Ridge Golf Course). In these instances, implementation of new reuse project facilities may not be warranted, however, sites with existing reuse projects can and should still be explored for opportunities to expand or improve existing reuse systems. It is also worth noting that through a grant from the Board of Water and Soil Resources (BWSR) the Rice Creek Watershed District (RCWD) developed the framework for this assessment methodology to identifying potential locations for stormwater reuse irrigation projects aimed at reducing reliance on groundwater (HEI, 2016). As ranking criteria differ between the RCWD

methodology and the methodology applied for Washington County, the list of most promising practices also have some differences.

Figure 2. Ranked potential reuse irrigation project locations based on county qualititative criteria.

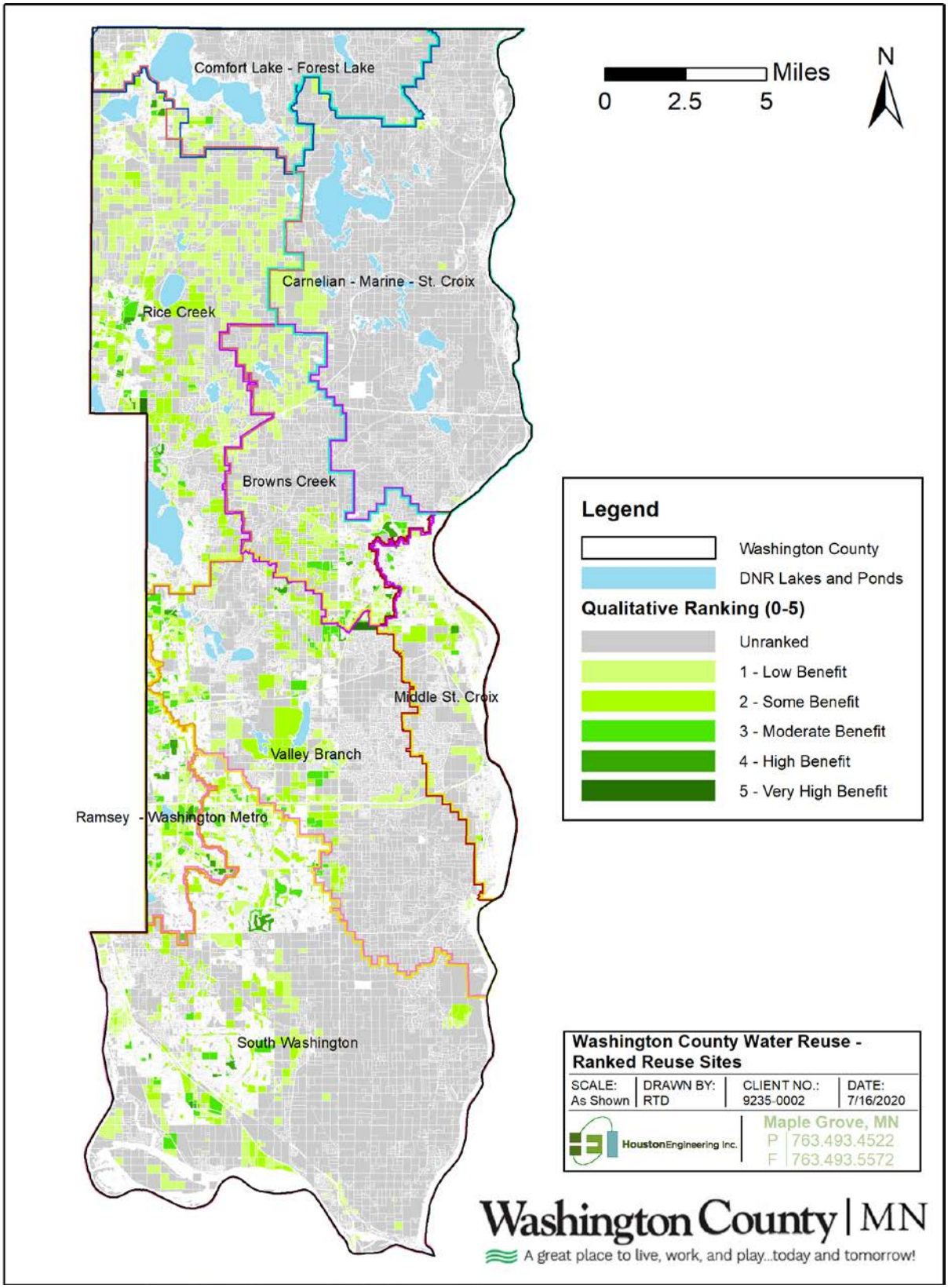


Figure 3. Top 20 potential reuse irrigation project locations within Washington County, based on criteria used in this assessment.

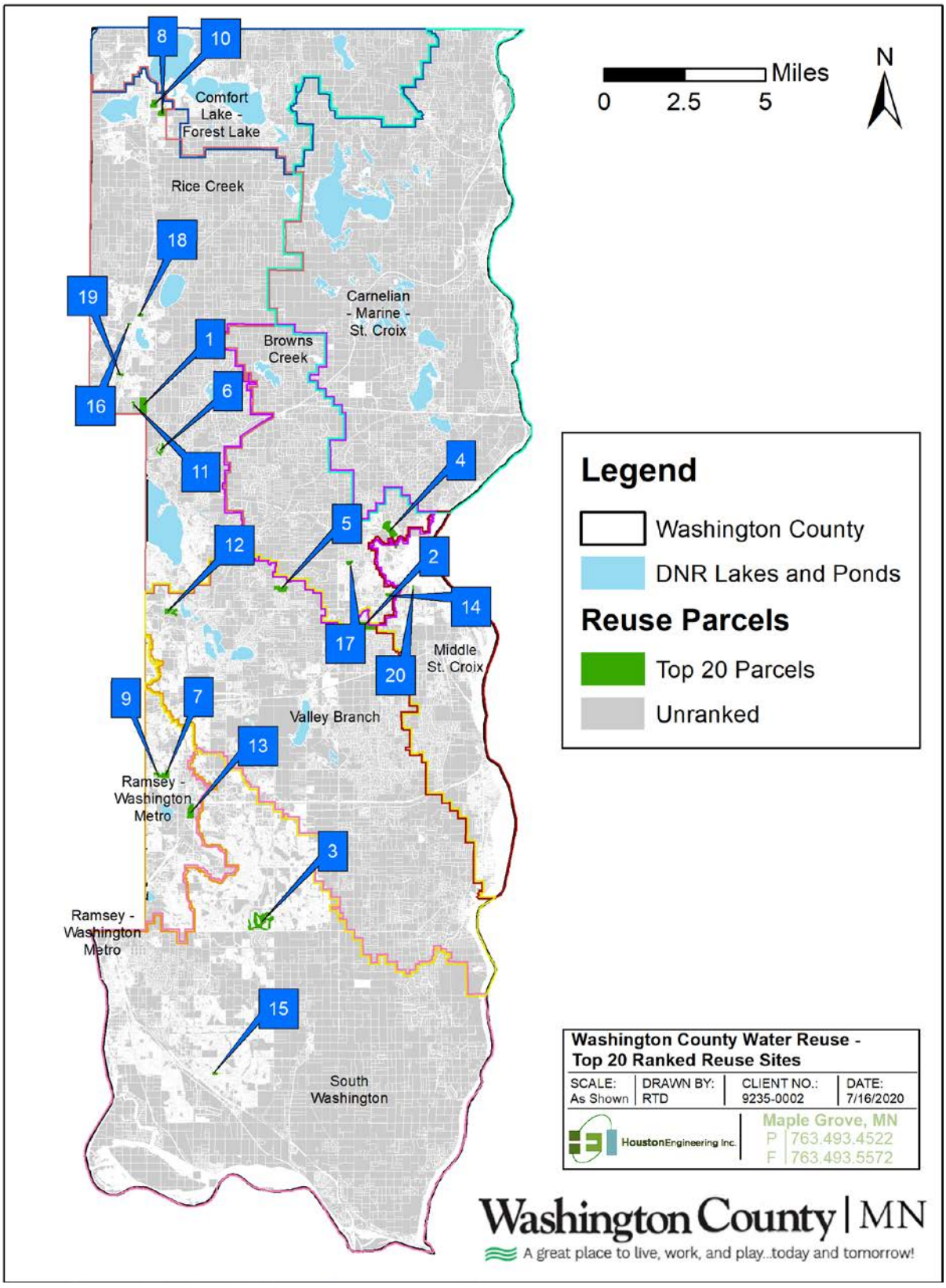


Table 2. Parcel Information for the top 20 potential reuse irrigation project locations within Washington County.

Practice ID	Qualitative Ranking Score	Owner	Pervious Area (acres)	Parcel Area (acres)	Minimum Growing Season Irrigation Volume (ft^3)*	Feasibility Ratio**	High-Volume Groundwater User	Watershed Organization or District
1	5	Oneka Ridge LLC	37.1	79.8	3,312,764	6.7	Y	Rice Creek
2	5	ISD 834 Stillwater	64.0	118.0	3,119,897	2.6	Y	Valley Branch
3	4	Prestwick Golf Club Inc	137.9	160.5	10,533,590	38.2	Y	South Washington
4	4	Oak Glen LLC	84.6	97.6	6,487,676	74.9	Y	Brown's Creek
5	4	Mogrow Inc	36.4	41.7	2,492,735	6.8	Y	Valley Branch
6	4	Dellwood Country Club LLC	28.6	33.7	2,111,216	32.7	Y	Rice Creek
7	4	ISD 622/NSP/MPWD/Oak	18.4	36.0	1,395,016	1.8	N	Ramsey Washington Metro
8	4	ISD 831 Forest Lake	16.8	32.2	1,163,582	1.2	N	Rice Creek
9	4	ISD 622/NSP/MPWD/Oak	17.2	22.5	1,086,730	2.0	N	Ramsey Washington Metro
10	4	WLP LLC	17.7	32.7	1,042,393	7.8	Y	Rice Creek
11	4	Oneka Ridge LLC	12.3	14.7	878,695	1.4	N	Rice Creek
12	4	P 4 Properties LLC	10.0	44.4	847,753	13.1	N	Valley Branch
13	4	Intrepid Holdings LLP	29.9	55.3	765,339	1.2	Y	Ramsey Washington Metro
14	4	Stillwater Health System	12.3	18.2	695,369	1.2	N	Brown's Creek
15	4	IND School Dist #833	7.6	11.3	580,806	1.1	N	South Washington
16	4	St John Bapt Cath	5.5	6.9	510,536	1.3	Y	Rice Creek
17	4	ISD 834 Stillwater	8.0	16.1	479,028	1.1	N	Brown's Creek
18	4	TPP LLC	5.9	10.6	411,813	1.7	Y	Rice Creek
19	4	Martin Prop LLC	5.1	13.1	364,145	2.6	N	Rice Creek
20	4	ISD 834 Stillwater	4.6	5.0	352,957	2.2	N	Middle St. Croix

***Determined by minimum parcel irrigation volume during technical feasibility.**
****Highest value reported for parcels deemed technically feasible by surface runoff conveyance assessments.**

Conclusion

This county-scale assessment was utilized to identify the most promising reuse irrigation project sites within the county, based upon project goals of decreasing the use of potable groundwater for irrigation and protecting the quality of groundwater supplies. Parcels within the county were subjected to a technical feasibility assessment. Parcels deemed feasible were then screened to eliminate projects that are likely cost prohibitive, based on small irrigation demands. The resulting technically feasible parcels for future reuse irrigation projects are shown in **Figure 1**.

Five qualitative criteria specific to promoting projects that align with project goals were used in the assessment. Ranked, feasible parcels are shown in **Figure 2** and the top 20-most effective practices shown in **Figure 3** and summarized in **Table 2**. Results from this process can be utilized by the county to accelerate targeting of potential reuse projects in the future, geared at accomplishing project-specific goals.

The information presented in this memorandum is a starting point to pursue potential stormwater reuse projects within Washington County. It's of note that some of these locations already have stormwater reuse projects either in development, or completed (e.g. Oneka Ridge Golf Course). Scaling desktop analysis will require coordination with municipal and corporate entities to gain an understanding of current or future water reuse projects. Further site-specific investigation of the technical feasibility assessment is strongly encouraged to ensure the site logistically supports implementation of stormwater reuse for irrigation, as data were assessed using an only partially hydro-conditioned digital elevation model and aerial photography. Site-specific investigation may include verification of irrigation supply and demand, or the feasibility of implementing infrastructure (storage ponds, tanks, pumps, irrigation lines and sprinklers). Other factors may be evaluated in the future through qualitative criteria ranking to accomplish reuse project prioritization and ranking, based on specific project goals. Further, the assessment may be utilized to structure outreach efforts to encourage and incentivize stormwater reuse for irrigation.

The assessment will be made available for county partners, watershed organizations and municipalities, to utilize. This includes the GIS data with all technically feasible sites and the further refined data based on the county's qualitative criteria assessment (**Attachment E**). Partners will be able to edit and implement further qualitative criteria to refine the list to include/highlight projects that also meet their organization's goals. The county hopes its partners will use these products to seek out partnerships and to implement reuse projects that protect groundwater quantity and quality and meet their goals.

References

Houston Engineering, Inc. (HEI). 2016. Stormwater Reuse Irrigation Assessment Methodology. A Report to Rice Creek Watershed District. HEI Project No. R15.5555-259-001 (Phase 1).

Metropolitan Council. 2011. Stormwater Reuse Guide. Available at: http://www.metrocouncil.org/Wastewater-Water/Planning/Water-Supply-Planning/Studies-Projects-Workgroups-(1)/Completed-Studies-Projects/Stormwater-Reuse-Guide.aspx

Washington County – 2030 Comprehensive Plan A Policy Guide to 2030 Land Use. Adopted by Board of Commisioners September 7, 2010.

Attachment A

Qualitative criteria are used to prioritize potential reuse project locations that are deemed technically feasible. Projects get prioritized if they align with local goals for reuse irrigation projects- for purposes of this project to protect county groundwater supplies and reduce consumption of groundwater. Washington County recognizes that its partnering watershed organizations and municipalities may have different organizational goals. As such, different qualitative criteria may be used to prioritize a different set of reuse irrigation projects within the county.

Below are a list of additional qualitative criteria that can be used to prioritize feasible parcels. A number of these qualitative criterion were discussed with the partnering watershed organizations during the conceptual phases of this project. These criteria can be used to prioritize parcels based on possible impacts of an implemented reuse irrigation project (beneficial and adverse) and social factors. Use rules can be used to identify parcels where potential projects might intersect sensitive areas on the landscape, or provide greater public benefits (e.g. proximity to the 100 year floodplain or protect surface water quality).

Table A-1: Additional qualitative criteria that can be applied to the assessment methodology (HEI, 2016)

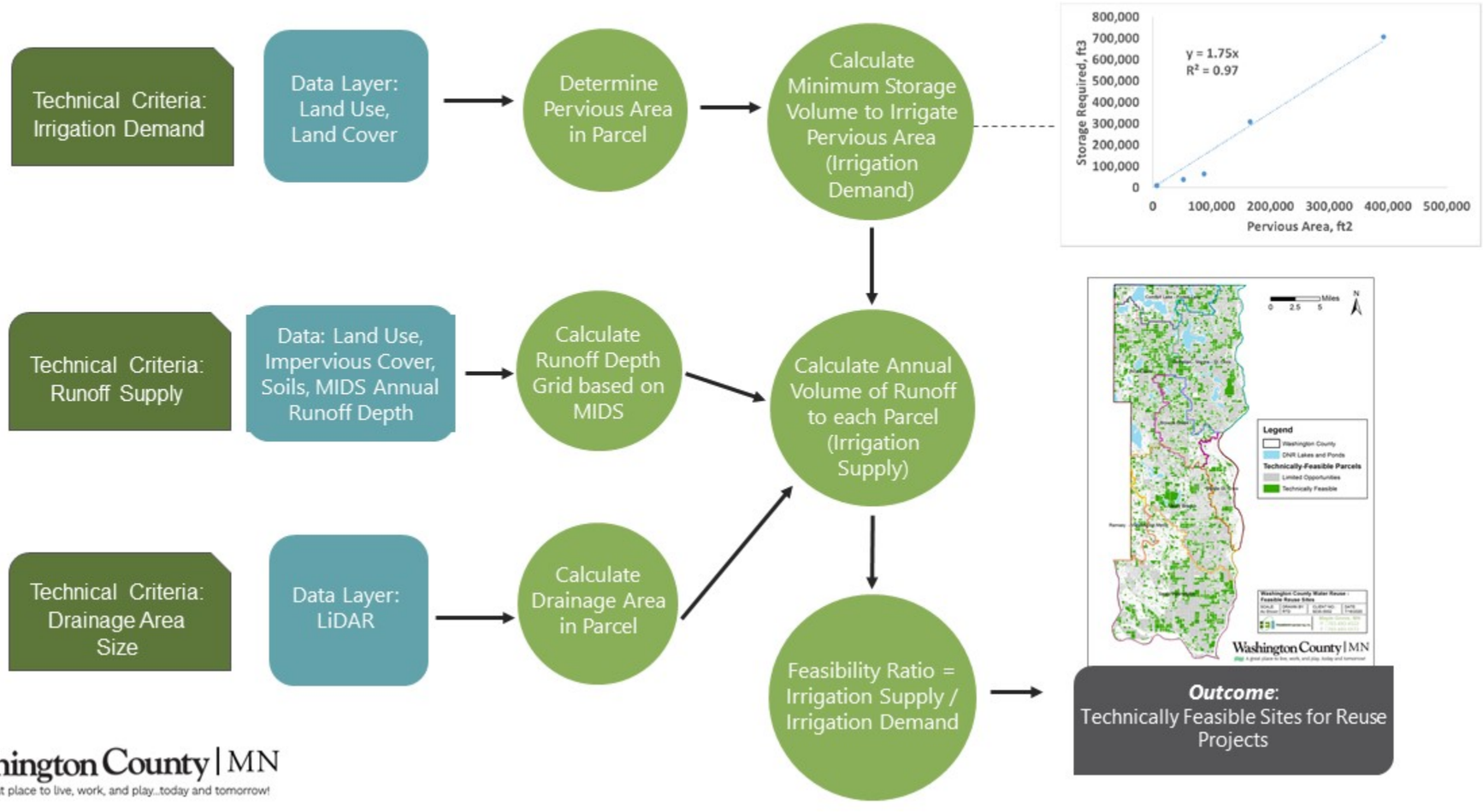
Planning Criterion	Criterion Purpose	Geospatial Data Layer	Potential Use Rules for Implementation
Presence of Known Water Quality Risk Factors	Evaluate if water quality of stormwater harvested for reuse may be adversely impacted by Superfund site	Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) database	Parcels intersecting these features receive the lowest rank
Proximity to Sensitive Landscape Features	Proximity upstream or downstream to sensitive landscapes features reliant on stormwater runoff as a source of water, or, within sensitive landscape features which would be disrupted by water reuse projects	Wildlife Management Areas	Parcels intersecting these features receive a more moderate rank
		Public Conservation Lands	Parcels intersecting these features receive a more moderate rank
		High Quality Wetlands	Parcels intersecting these features receive the lowest rank
		MCBS sites of biodiversity significance	Parcels intersecting these features receive a more moderate rank
Water Quality Benefit Index	Evaluate if site is upstream of impaired water and would therefore reduce stormwater discharge and pollutant load to the receiving water body	NWI Wetlands	Parcels intersecting these features receive a more moderate rank
		24K water features	Parcels intersecting these features receive a lower rank
		Impaired wetlands	Parcels intersecting these features receive a lower rank
		Impaired streams	Parcels intersecting these features receive a lower rank
		surface waters	Parcels intersecting these features receive a lower rank

Potential Local Flood Damage Reduction Benefits	Proximity to (and whether upstream of) flood prone areas to determine flood protection benefits from storage provided by water reuse projects	NWI Wetlands	Parcels intersecting these features receive a more moderate rank
		100 year floodplain	Parcels intersecting these features receive a more moderate rank. Parcels in near proximity to a floodplain may receive higher rank for flood reduction benefits.
		railroad	Parcels intersecting these features receive the lowest rank
		ditches	Parcels intersecting these features receive a lower rank
		24K water features	Parcels intersecting these features receive a lower rank
		surface waters	Parcels intersecting these features receive a lower rank
Likelihood of Treatment Needed Prior to Reuse	Evaluate probable quality of stormwater harvested for reuse, based on land use	County Parcels and MLCCS land cover	N/A
Above Ground Storage Capacity*	Evaluate ability to store water above ground, based on land use	County Parcels and MLCCS land cover	N/A
Presence of Existing Irrigation or Reuse*	Evaluate presence of existing reuse irrigation projects	Project specific geospatial data	Parcels intersecting these receive a lower rank if pursuing new projects, or higher rank if pursuing retrofits / expansion.
City Water Consumption*	Identify high users for city water	City water meter data	Parcels with high consumption receive a higher rank

*Criteria conceptualized as part of the assessment for Washington County

Attachment B

Identifying Parcels Technically Feasible for Reuse Irrigation Projects



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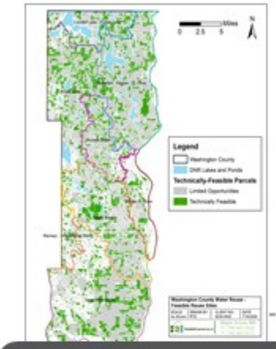
Attachment C

Ranking and Prioritizing Parcels Feasible for Reuse Irrigation Projects



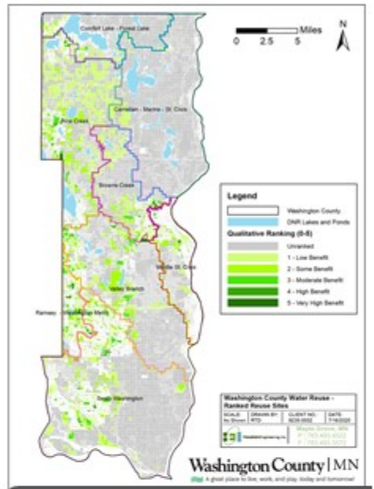
Outcome:
Technically Feasible Sites for Reuse Projects

Screen Parcels Less Than 3 Acres of Existing Turf

Qualitative Criteria: MLCCS Existing Turf Area

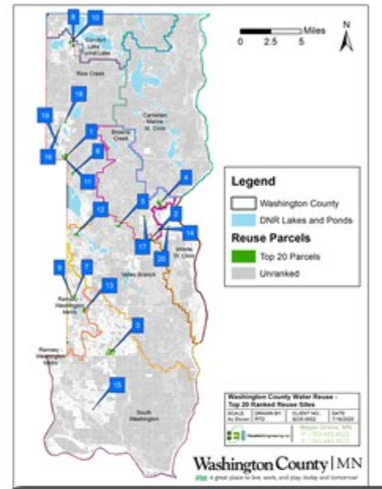
Qualitative (Ranking) Criteria

- High Volume Groundwater User — *Yes* → 1 point
- Wellhead Protection Area — *Yes* → 1 point
- Drinking Water Supply Management Area — *Yes* → 1 point
- Emergency Response Area — *Yes* → 1 point
- Public Access Sites — *Yes* → 1 point



Outcome:
Ranked Sites for Reuse Projects

Sum Qualitative Ranking and Categorize Very Low (1) – Very High (5)



Outcome:
Most Promising Sites for Reuse Projects

Rank Very High (5) and High (4) Based On MLCCS Existing Turf Area

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Attachment D

County Use Classification for parcels as identified in county parcel records (USE#_DESC for #1-4) were applied to prioritize land use types with greater public access (qualitative ranking benefit) and for exclusion of parcels generally incompatible with water reuse scenarios (e.g., wetlands, natural areas, crop fields, etc.).

USE#_DESC (for #s 1-4)	Priority Ranking	Exclusion Criteria
100 Res 1 unit	N	N
105 Res 2-3 units	N	N
110 Apt 4+units	N	N
125 SRR	N	N
140 Res V Land	N	N
200 Agricultural	N	Y
210 Ag 2-3 Units	N	Y
211 Rural Vacant Land	N	Y
252 Managed Forest Land	N	Y
300 Commercial	Y	N
305 Industrial	Y	N
315 Corn Ma _Pa	N	Y
318 Marina Recreational Land	N	N
320 Q Golf Course	Y	N
335 Comm Services-Non Revenue	N	Y
337 Comm Serv-Donations Congr Charter	N	Y
350 MH Park	N	N
352 MH Park Class I	N	N
355 MH Pub Util L _S	N	Y
360 Pub Util RR	N	Y
900 MiscNotReported	N	Y
901 Schools-Public	Y	N
902 Schools-Private	Y	N
904 Colleges-Public	Y	N
905 Colleges-Private	Y	N
911 Cemetery-Public	N	N
912 Cemetery-Private	N	N
915 Church	N	N
916 Church-Residence	N	N
917 Church-Other Res	N	N
918 Church - Other	N	N
920 Hospital-Public	Y	N
921 Hospital-Private	Y	N
930 ER Shelter	N	N
931 Charit Inst	N	N
937 Arena/FParkNProf	Y	N
940 Wetlands	N	Y
941 Forest Park Refuge	N	Y
950 MiscReported	N	Y
951 Federal Property	N	Y
952 State Property	N	Y
953 Co Srvc Ent	N	N
954 Nursing Homes	N	N
955 Co Srvc Other	N	N
956 Muni Srvc Ent	N	Y
958 Muni Srvc Other	N	Y
959 SP Tax District	N	N
962 T E Mis Co D 3	N	Y
963 T E Mis Co D 4	N	Y
965 T E Mis Co D 6	N	Y
966 T E Mis Co D 7	N	Y
967 T E Mis Co D 8	N	Y
979 T E Mis Co D 20	N	Y
981 State Acquired	N	Y
982 State Admin-DNR	N	Y
983 Co Admin-TaxForf	N	Y
984 Public Hunting	N	Y
990 InLieuTx Co D 1	N	Y
995 InLieuTx Co D 6	N	Y
NULL	N	Y

Following qualitative criteria, Very High and High ranking parcels were ranked based on MLCCS existing turf areas, utilizing Minnesota Land Cover Classification System (MLCCS). The following MLCCS codes were used to identify existing and managed turf suitable for irrigation.

C_NUM (MLCCS Code)	C_TEXT (Code Description)	C_ALPHA (Alphanumerical Code)
10000	Artificial surfaces and associated areas	1.
13000	Artificial surfaces with herbaceous dominant vegetation (25% to 96% vegetation cover)	1.hh.
13100	Artificial surfaces with perennial grasses with sparse trees	1.hh.CT.
13110	4% to 10% impervious cover with perennial grasses and sparse trees	1.hh.CT.i10.
13114	Short grasses and mixed trees with 4-10% impervious cover	1.hh.CT.i10.cGS.
13120	11% to 25% impervious cover with perennial grasses and sparse trees	1.hh.CT.i25.
13124	Short grasses and mixed trees with 11-25% impervious cover	1.hh.CT.i25.cGS.
13130	26% to 50% impervious cover with perennial grasses and sparse trees	1.hh.CT.i50.
13134	Short grasses and mixed trees with 26-50% impervious cover	1.hh.CT.i50.cGS.
13140	51% to 75% impervious cover with perennial grasses and sparse trees	1.hh.CT.i75.
13144	Short grasses and mixed trees with 51-75% impervious cover	1.hh.CT.i75.cGS.
13200	Artificial surfaces with perennial grasses	1.hh.CG.
13210	4% to 10% impervious cover with perennial grasses	1.hh.CG.i10.
13211	Short grasses with 4-10% impervious cover	1.hh.CG.i10.cGS.
13220	11% to 25% impervious cover with perennial grasses	1.hh.CG.i25.
13221	Short grasses with 11-25% impervious cover	1.hh.CG.i25.cGS.
13230	26% to 50% impervious cover with perennial grasses	1.hh.CG.i50.
13231	Short grasses with 26-50% impervious cover	1.hh.CG.i50.cGS.
13240	51% to 75% impervious cover with perennial grasses	1.hh.CG.i75.
13241	Short grasses with 51-75% impervious cover	1.hh.CG.i75.cGS.
13300	Artificial surfaces with cultivated herbaceous vegetation (Gardens)	1.hh.CN.
13310	4% to 10% impervious cover with cultivated herbaceous vegetation	1.hh.CN.i10.
13311	Vegetables with 4-10% impervious cover	1.hh.CN.i10.cVG.
13320	11% to 25% impervious cover with cultivated herbaceous vegetation	1.hh.CN.i25.
13321	Vegetables with 11-25% impervious cover	1.hh.CN.i25.cVG.
13322	Forbs (flowers) with 11-25% impervious cover	1.hh.CN.i25.cFB.
13330	26% to 50% impervious cover with cultivated herbaceous vegetation	1.hh.CN.i50.
13340	51% to 75% impervious cover with cultivated herbaceous vegetation	1.hh.CN.i75.
13342	Forbs (flowers)with 51-75% impervious cover	1.hh.CN.i75.cFB.
14000	Artificial surfaces with less than 25% vegetation cover	1.mv.
14100	Buildings and/or pavement	1.mv.BP.
14110	76% to 90% impervious cover	1.mv.BP.i90.
14111	Buildings with 76-90% impervious cover	1.mv.BP.i90.cBD.
14112	Pavement with 76-90% impervious cover	1.mv.BP.i90.cPV.
14113	Buildings and pavement with 76-90% impervious cover	1.mv.BP.i90.cBP.
14120	91% to 100% impervious cover	1.mv.BP.i99.
14121	Buildings with 91-100% impervious cover	1.mv.BP.i99.cBD.
14122	Pavement with 91-100% impervious cover	1.mv.BP.i99.cPV.
14123	Buildings and pavement with 91-100% impervious cover	1.mv.BP.i99.cBP.
23000	Planted or maintained herbaceous vegetation	2.ph.
23100	Planted or maintained grasses with sparse tree cover	2.ph.CT.

C_NUM (MLCCS Code)	C_TEXT (Code Description)	C_ALPHA (Alphanumerical Code)
23110	Upland soils with planted or maintained grasses and sparse tree cover	2.ph.CT.pUS.
23111	Short grasses with sparse tree cover on upland soils	2.ph.CT.pUS.cGS.
23121	Short grasses with sparse tree cover on hydric soils	2.ph.CT.pHS.cGS.
23200	Planted or maintained grasses	2.ph.CG.
23210	Upland soils with planted or maintained grasses	2.ph.CG.pUS.
23211	Short grasses on upland soils	2.ph.CG.pUS.cGS.
23220	Hydric soils with planted or maintained grasses	2.ph.CG.pHS.
23221	Short grasses on hydric soils	2.ph.CG.pHS.cGS.
23300	Planted or maintained grasses and forbs	2.ph.CF.
23310	Upland soils with planted or maintained grasses and forbs	2.ph.CF.pUS.
23311	Short grasses and forbs on upland soils	2.ph.CF.pUS.cGS.
23320	Hydric soils with planted grasses and forbs	2.ph.CF.pHS.
23321	Short grasses and forbs on hydric soils	2.ph.CF.pHS.cGS.

Attachment E

Data schema for project geodatabase ***WashingtonCountyMN_WaterReuse_HEI_2020*** and tax parcel analysis for the shapefile ***Parcels***. County tax parcel information was retained and attributes summarized in Minnesota Geospatial Advisory Council Parcel Data Standard 2019 methodologies. Technical and qualitative analysis attributes (and aliases) are summarized.

	Parcel Attribute (Alias)	Parcel Attribute	Description of Attribute
Quantitative Criteria	**Annual Runoff Coefficient (Rv)**	**Rv**	Runoff coefficient for each parcel
	Total Annual Rainfall Depth (inches)	**P**	Rainfall depth for each parcel from the Minnesota Climatology Working Group (1971-2000)
	Annual Runoff Depth (inches)	**RO_D**	Annual runoff depth based on land use and runoff curve number for the parcel
	Irrigation Area (acres)	**IA_ac**	Estimate of irrigatable acres based on Land Use Land Cover
	Supply - Max Annual Runoff Volume (ac-ft)	**Sup_vol**	Surface water supply of the parcel based on Land Use Land Cover
	Tech Feasibility Ratio (Supply/Demand)	**Ratio**	Ratio of surface water supply to the irrigatable acres of the parcel based on Land Use Land Cover
	Annual Demand (ac-ft)	**D_AcFt**	Estimate of annual water demand for irrigatable acres in acre feet based on Land Use Land Cover
	MLCCS Irrigation Area (acres)	**MLCCS_Irrig_area**	Ratio of irrigatable acres to the total area of the parcel based on MLCCS land use
	MLCCS Annual Demand (ac-ft)	**MLCCS_Demand**	Estimate of annual water demand for irrigatable acres in acre feet based on MLCCS land use
Qualitative (Ranking) Criteria	**Query 1 - Technical Feasibility ≥1**	**Met2Query1**	Identification of parcels with surface runoff greater than annual demand (0 - fails; 1 - succeeds)
	Query 2 - Parcel >3 acres	**Met2Query2**	Exclusion of parcels supporting smaller water reuse projects with irrigatable ≤3 acres (0 - fails; 1 - succeeds)
	Query 3 - MPARS (bin)	**Met2Query3**	Parcels that met minimum parcel standard and are a high water use entity per the MPARS database (0 - fails; 1 - succeeds)
	Query 3A - MPARS (type)	**Met2Query3A**	Parcels that met minimum parcel standard and are a high potable water use entity identified as 'non-crop irrigation' or 'water supply' within the MPARS database.
	Query 4 - DWSMA (bin)	**Met2Query4**	Parcels that met minimum parcel standard and are within a DWSMA (0 - fails; 1 - succeeds)
	Query 4A - DWSMA (type)	**Met2Query4A**	Parcels that met minimum parcel standard and are within a DWSMA; parcels are identified by the 'WHP_TYPE_C' and 'CZ_TYPE_C' for both surface- and ground-water DWSMAs *
	Query 5 - Wellhead Protection (bin)	**Met2Query5**	Parcels that met minimum parcel standard and are within a Wellhead Protection Area (0 - fails; 1 - succeeds)
	Query 5A - Wellhead Protection (type)	**Met2Query5A**	Parcels that met minimum parcel standard and are within a Wellhead Protection Area; parcels are identified by the 'WHP_TYPE_C' *

Parcel Attribute (Alias)	Parcel Attribute	Description of Attribute
Query 6 - Emergency Response Area (bin)	**Met2Query6**	Parcels that met minimum parcel standard and are within an Emergency Response Area (0 - fails; 1 - succeeds)
Query 6A - Emergency Response Area (type)	**Met2Query6A**	Parcels that met minimum parcel standard and are within an Emergency Response Area for 'CZ_TYPE_C' *
Query 7 - Zoning Prioritization (binary)	**Met2Query7**	Parcels that prioritize land use with greater public access or are characterized by landscapes with greater open areas (see Attachment C)
Land Use Exclusion	**LUexclude**	Parcels with land used that are noncompatible or for which irrigation is traditionally not needed (see Attachment C)
Qualitative Ranking (0-5)	**QualRank**	Sum of qualitative ranking (0 - meets only technical standards; 5 - is prioritized by all five qualitative screening criteria of queries 1-5)
Qualitative Rank (passes land use)	**QualRankDem**	Ranking of parcels that meet land use criteria by qualitative demand and annual water demand (for each 'Qualitative Ranking (0-5)' group)

*see Table 1 for Mn Geo metadata source