Wenck File #0002-222

August 2014

Clearwater Harbor Wastewater Treatment Facility
Nitrogen Mitigation and Analysis Plan
MPCA Permit #MN0065226

Prepared for:

CLEARWATER RIVER WATERSHED DISTRICT

Prepared by:

WENCK ASSOCIATES, INC.
1800 Pioneer Creek Center
P.O. Box 249
Maple Plain, Minnesota 55359-0249
(763) 479-4200

Table of Contents

<u>TABLES</u>

<u>Figure</u>

Certification

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineering under the laws of the State of Minnesota.

August 18, 2014

8-18-14

Norman C. Wenck, PE

Registration No. 8946

MINNESOTA PROFESSIONAL 8946 8-18-14 ENGINEER NORMAN C. WENCK

1.0 Introduction

1.1 HISTORY OF THE FACILITY

The Clearwater River Watershed District (CRWD) began the Clearwater River chain of Lakes Restoration project in 1980 to improve the water quality of the surface waters of the District. An element of that study was a septic leachate survey of Grass Lake in 1989 which identified septic leachate plumes indicating failing septic systems.

The Hidden River Treatment Facility was constructed by the District in 2000 at the request of the developer of the Hidden River subdivision. The facility was constructed in conjunction with the construction of the streets of the subdivision.

The Clearwater Harbor facility was construction in 2005 in response to a petition from Stearns County. The County stopped issuing building permits in the project area until acceptable wastewater services could be provided.

1.2 FACILITY DESCRIPTION

The Clearwater Harbor Wastewater Treatment Facility (Facility) is located in the NW ¼ of Section 32, Township 122 North, Range 27 West, Lynden Township, Stearns County, Minnesota. This is a Class C Facility.

MPCA Permit #MN0065226 covers two separate wastewater treatment systems with separate names. The two systems are located next to each other and are owned by the Clearwater River Watershed District. Both the Hidden River wastewater treatment system and the Clearwater Harbor wastewater treatment system are covered under the permit for the Clearwater Harbor Facility. The two treatment systems have a combined permitted average wet weather flow (AWWF) of 45,000 gallons per day (gpd); however, in 2013 the average combined daily flow was 18,000 gpd.

Table 1.1 Major components of the Facility

Hidden River	Clearwater Harbor
31 Individual Septic Tanks	4 Lift Stations
1 Lift Station	3-15,000 gallon Septic Tanks
1-20,000 gallon Recirculation and Holding Tank	1 Recirculation Tank
1 Recirculating Media Filter – sand/gravel	1 Recirculating Media Filter – sand/gravel
1 Dosing Lift Station	1 Subsurface Drain Field with Multiple Trenches
1 Subsurface Drain Field with Multiple Trenches	

1.2.1 Hidden River Wastewater Treatment System

The existing Hidden River treatment system services a 31 single family housing development. The system for this development consists of individual septic tanks, a collection system, a lift station, one

20,000 gallon recirculation tank, one 3,300 square foot recirculating sand filter, a drainfield dosing lift station, and 3,600 linear feet of drain field trenches. This system is permitted for an AWWF of 17,000 gpd; average flow in 2013 was 4,000 gpd.

1.2.2 Clearwater Harbor Wastewater Treatment System

The existing Clearwater Harbor treatment system services an 81 single family housing development. The collection system for this development consists of eight-inch gravity sewer collection lines with four lift stations and four-inch force mains to the treatment system. The system consists of three 15,000 gallon septic tanks in series, a 30,000 gallon recirculation tank, a 5,600 square foot recirculating sand filter, and 6,400 lineal feet of drainfield trenches. The sand filter is dosed with four 50 gallon per minute pumps that alternate with two cells, each with five zones. Effluent passes through the sand filter to a splitter valve where 80 percent returns to the tank for further treatment. The remaining 20 percent enters a lift station, and is pumped to the drainfield system. This system is permitted for an AWWF of 28,000 gpd; average flow in 2013 was 14,000 gpd.

1.3 REQUIREMENTS

MPCA Permit #MN0065226 requires a Nitrogen Mitigation and Analysis Plan to be submitted to the MPCA within 90 days of permit issuance (June 5, 2014) with Plan implementation to begin within 30 days of submittal, and to attain compliance with the nitrate limit of 10 mg/L one day prior to permit expiration on May 31, 2019.

This plan addresses elevated nitrogen levels detected in groundwater monitoring well GW004. The plan evaluates methods to reduce amounts of nitrogen in the discharge and/or increase distribution of effluent to the groundwater. The Plan shall include, but not be limited to, analysis and selection of the following alternatives:

- Installation of additional treatment units to remove nitrogen from wastewater.
- Installation of additional disposal area to reduce the nitrogen loading rate.
- An evaluation of the groundwater monitoring well network to determine whether current wells are adequately placed and whether additional wells are necessary.
- An analysis of the operation and maintenance of the system. This analysis shall include, but not be limited to, application rates, seasonal loading and resting procedures, distribution effectiveness to maximize the area used and solids removed.
- A schedule outlining completion dates for proposed activities.

2.0 Groundwater Monitoring Wells

2.1 HYDROGEOLOGIC SETTING

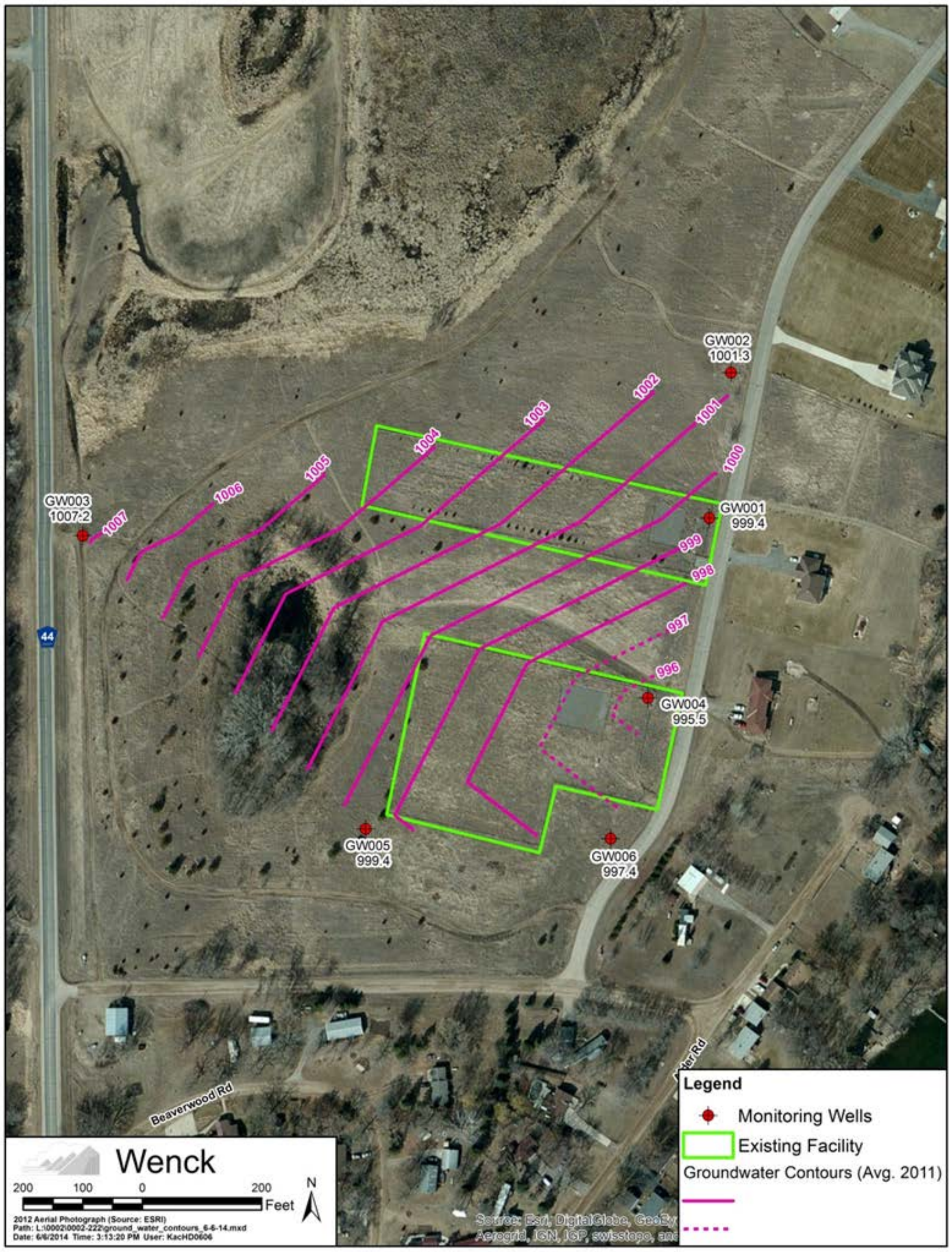
According to the Stearns County Geologic Atlas, the surficial geology in the area consists of the Des Moines Lobe Deposits consisting of glacial outwash deposits. The glacial outwash deposits consist of sand, gravel and cobbly gravel (Gary N. Meyer and Alan R. Knaeble, 1995). Based on numerous soil borings conducted on the property, soils consist of sand and gravel interbedded with two sandy clay layers. In general the stratigraphy at the site shows an approximately 21 to 29 foot thick layer of sand and gravel that overlies a clay unit ranging from approximately 14 to 43 feet in thickness. Potable water supply wells in the area range in depth of approximately 84 to 95 feet deep and appear to be screened in a confined sandy aquifer.

2.2 MONITORING WELL NETWORK

Currently, there are six groundwater monitoring wells located on the property. Wells GW001, GW002 and GW003 are associated with the Hidden River Wastewater Treatment System. Groundwater monitoring wells GW004, GW005 and GW006 are associated with the Clearwater Harbor Wastewater Treatment System. The wells range in depth from approximately 26 feet below grade (GW003) to approximately 41 feet below grade (GW005). With the exception of GW005 the groundwater monitoring wells are screened in an unconfined water table aquifer. Groundwater monitoring well GW005 appears to be screened predominantly within a clay layer (possible confining unit), with the very bottom partially screened in a sandy unit. Observed surficial groundwater flow is to the east-southeast towards Clearwater River.

Based on review of historical information it is our opinion that the monitoring well network is appropriate at this time and does not require the addition of any new wells. Review of past groundwater level data indicates groundwater monitoring well GW004 acts as the downgradient monitoring well for both treatment systems. Should there be any northerly or southerly shift in groundwater flow direction, groundwater monitoring wells GW001 and GW006 are currently positioned in downgradient locations (Figure 2.1).

Figure 2.1 System and Monitoring Well Locations, Average Groundwater Flow Direction



2.3 GROUNDWATER QUALITY

Total nitrogen has been monitored in the Clearwater Harbor system effluent and the groundwater monitoring wells since 2005. Since 2005 the average total nitrogen concentration observed in the effluent has been approximately 40 mg/l. Since 2005 the total nitrogen concentration observed in groundwater monitoring well GW004 has been approximately 22 mg/l. The historical data are summarized below in Table 2.1.

Table 2.1 Projected Nitrogen Reductions Provided

Year	Clearwater Harbor System Effluent (Yearly Ave. Total N Conc.)	Hidden River System Effluent (Yearly Ave. Total N Conc.)	Downgradient Groundwater Monitoring Well GW004 (Yearly Ave. Total N Conc.)	%Reduction (between CWH effluent discharge and monitoring well)	Annual Precipitation (inches)
2001	NR	NR	NR	-	29.57
2002	NR	NR	NR	-	44.72
2003	NR	NR	NR	-	26.77
2004	NR	NR	NR	-	31.67
2005	9	NR	6	32	41.47
2006	22	NR	14	36	23.38
2007	39	NR	17	56	27.82
2008	47	NR	28	41	25.00
2009	43	26	37	15	27.65
2010	56	44	18	68	32.94
2011	55	40	11	80	30.61
2012	34	46	25	26	28.50
2013	51	60	40	22	28.78
Average	**40**	**43**	**22**	**42**	**30.68**

Note: Annual Precipitation as measured in Corrina Township

Based on the above information there is an approximate reduction of total nitrogen from the effluent to the property boundary monitoring well, GW004, of approximately 42 % on average based on the past 9 years with a minimum of 15% in 2009.

It is important to note the alternatives presented herein do not take into account the existing level of dilution/ dispersion provided to achieve nitrogen standards at GW004. In other words, any reductions witnessed currently will provide an additional level of protection beyond what is provided by the alternatives discussed herein.

It is also important to note that a measured reduction in total nitrogen in groundwater monitoring well GW004 may take several years to achieve (see below). This is due to the time it takes for the effluent to travel from the end of pipe through the vadose zone (unsaturated zone between the surface and the water table) into the water table aquifer then horizontally through the groundwater to the observation well.

Estimated flow velocities were calculated from the following equations:

$V = Ki$ (Darcy Velocity or Flux)

$v = (K/n_e)*i$ (Seepage Velocity)

Where: V = Average groundwater flow velocity (ft/day) (cm/sec)

v = Average linear groundwater flow velocity (ft/day) (cm/sec)

K = Hydraulic conductivity (ft/day) (cm/sec)
n_e = Estimated porosity (%)
i = Estimated hydraulic gradient (ft/ft)

Inputs: K (values for sand and gravel, Fetter, 1994) = $10^{-3} – 10^{-1}$
n_e = (values for mixed sand and gravel, Fetter, 1994) = 20% - 35%
i = (average gradient observed between site well GW003 and GW004 in 2013) = 0.012

Using the above equations and general inputs the groundwater flow (Darcy) velocity for the unconfined water table aquifer on the site is estimated to range from an approximated low of 0.03 ft/day to an approximated high of 3.4 ft/day. This translates to a seepage velocity of an approximated low of 0.07 ft/day to an approximated high of 17 ft/day.

3.0 Operation and Maintenance

Since construction and Facility start-up the systems have been under the oversight of a Licensed Operator. Currently, Septic Check, Inc. is the Facility Operator. Mr. Brian Koski, President of Septic Check, Inc. and Wenck have been in communication since Septic Check assumed operation of the Facility. Mr. Koski has been consulted in the preparation of this Plan.

The MPCA believes the increased nitrate levels in GW004 is linked to the Facility. DMR Summary Reports for the past 5 years (Table 3.1) show the total nitrogen concentration leaving the treatment systems and entering the drainfields average 50 mg/L for Clearwater Harbor and 53 mg/L for Hidden River.

Table 3.1 Total Nitrogen Levels from DNR Summary Reports

Total Nitrogen (mg/L)		
Year	**Clearwater Harbor**	**Hidden River**
2009	52	26
2010	56	44
2011	55	40
2012	34	46
2013	51	61
Average	**50**	**53**

At the time of permitting and construction, a nitrogen limit was not in place; therefore, the design of the Facility was not specifically focused on removing nitrogen. The Facility was designed to treat sewage to an acceptable level where the drain fields could accept the effluent. All indications are that the drain fields are functioning properly and there remains a greater than 20 year useful life of those components.

The Facility design included the construction of a recirculating sand filter (RSF). An RSF is used to reduce the biological loading that would occur to the drain field to extend its useful life. RSF's have advantages in that they are generally less expensive to construct and require low power usage to operate compared to other technologies. A short coming to an RSF is that the sand media has a finite life and needs to be replaced when biomass accumulates in the sand. Operators of similar systems report that sand from an RSF needs replacement every 5-15 years depending on use.

The RSF's at the Facility are at the point in their lifecycle where the sand requires replacement. They can also be bypassed and abandoned, as their use is not mandatory. Efforts have been made to reduce the volume of effluent loading to the RSFs with some limited success. Biomass accumulation has reduced the permeability of the RSFs to render them non-effective. If there was not a nitrate issue in GW004, then short-term bypassing may be a tenable solution while a plan is established for replacement of the RSFs.

However, because of the nitrate issue, the MPCA will require either upgrading or replacing the RSFs with nitrogen reducing treatment technology, or identification of another solution to reduce nitrate levels in GW004. Section 4 presents the plan for mitigation of nitrogen at GW004.

4.0 Additional Treatment & Disposal

For average daily flows greater than 10,000 gallons per day (gpd) within a ½ mile radius of each Subsurface Sewage Treatment System (SSTS) owned by one entity, the system is classified as a Large Subsurface Wastewater Treatment System (LSTS) and permitting is completed through a Minnesota Pollution Control Agency State Disposal System (SDS) Permit.

Because the total daily wastewater flow discharging to the soil is greater than 10,000 gpd, the MPCA recommends the design follow the December 2013 Design Guidance for Large Subsurface Wastewater Treatment Systems upgrades. Table 4.1 lists specific LSTS constituents and limits for soil dispersal. BOD and TSS do not have particular limits per say; however these constituents have direct correlation to nitrogen removal and soil loading rates.

Table 4.1 MPCA LSTS Subsurface Discharge Effluent Limits

Constituent	Limit
$CBOD_5$	None, however for system performance this parameter should be low (i.e. less than 30 mg/L)
TSS	None, however for system performance this parameter should be low (i.e. less than 30 mg/L)
Permit alternative #1: Total Nitrogen	10 mg/L end-of-pipe
Permit alternative #2: Nitrate Nitrogen	10 mg/L @ property boundary
Fecal Coliform	None
Phosphorous	None

The MPCA nitrogen policy was chosen to ensure the state's groundwater is protected and to provide a consistent technical baseline during permitting. The nitrogen policy was adopted in 2007 and has affected many previously permitted LSTS in central Minnesota. The policy is based on safe drinking water standards set by federal and state laws (40 CFR part 141.62 and Minn. Rules 4717.7500, subp. 68).

The MPCA offers two nitrogen treatment performance permitting options:

1) Achieve total nitrogen less than 10 mg/L at the end-of-pipe prior to soil dispersal; or
2) An annual average nitrate-nitrogen limit of 10 mg/L placed at the property boundary (GW004).

The first permitting option ensures that permit requirements are met since the discharge from the system is less than the nitrogen policy limit. This alternative requires the LSTS meet an end-of-pipe (before soil dispersal) limit of 10 mg/L total nitrogen measured as an annual average. Typically, water quality sampling of monitoring wells is not required.

The second permitting option requires continued sampling of the groundwater monitoring network (this is the current permitting option). Permitting option #2 still requires a level of systemic total nitrogen reduction to achieve the nitrate-nitrogen property boundary limit. If during operation this limit is exceeded, the permittee must evaluate to identify potential problems and may need to apply additional technology/components to reduce total nitrogen, as necessary.

The Clearwater Harbor/ Hidden River LSTS will need to address nitrogen treatment by either supplemental components to treat total nitrogen to 10 mg/L end-of-pipe, or treating total nitrogen to greater than 10 mg/L end-of-pipe and monitoring nitrate-nitrogen at the property boundary via groundwater wells. If these limits are not met at the property boundary, additional components may be needed.

The sandy textured soils present across the treatment site provide minimal nitrogen uptake (42% on average, 15% in 2013). Water movement within the soil is rapid and dominantly vertical prior to groundwater recharge. Choosing the 10 mg/L total nitrogen end-of-pipe alternative nitrogen treatment eliminates uncertainty and year to year fluctuations in the nitrogen reduction between the drainfield and GW004, and would eliminate the need for sampling of monitoring wells.

Not all common pretreatment technologies will provide enough nitrogen reduction to meet the required limit and therefore special design considerations must be applied. Pretreatment devices have been evaluated and applied in combination to meet the nitrogen policy. The specific technologies and staging selected are discussed below:

4.1 NITROGEN MITIGATION PLAN

The selected nitrogen mitigation plan for the system will include modifications to the existing system operation to optimize drainfield distribution will be implemented first followed by gradient control and phytoremediation as described below.

Operational Adjustments to Existing System

Additional operational changes can be made to the existing systems to reduce nitrogen concentrations at GW004. These changes include modifications to drain field operation to more broadly distribute system effluent- in effect adding disposal area to reduce nitrogen loading rate. The system will be optimized with respect to application rates, seasonal loading and resting procedures, distribution effectiveness to maximize the area used and solids removed. These measures will provide an additional level of dilution prior to system effluent reaching the property boundary (GW004). This alternative includes a site visit from Wenck and Septic Check to implement system modifications and follow up monitoring as necessary to finalize operational adjustments.

Gradient Control

Gradient control involves installation of shallow extraction wells upgradient of the property boundary within the existing easement area to extract groundwater with nitrogen that exceeds the 10mg/ L limit.

This water is then treated through additional removal technologies such as phytoremediation which can include uptake by surface vegetation, woodchip bioreactors and/or wetland denitrification. This provides control of the local groundwater table and additional treatment.

Phytoremediation

Phytoremediation is the direct use of living green plants for in situ removal, degradation, or containment of contaminants in soils, sludges, sediments, surface water and groundwater. This can be achieved through trees, crops, wetlands, or bioreactors.

This plan involves using the combination of the large outlot easement for both systems, the sandy soils on site and the natural uptake of nitrogen in plants to achieve nitrogen load reductions. This alternative requires further design and evaluation, additional data collection (including soil borings), and characterizing shallow aquifer to finalize design alternatives. Phytoremediation offers several applications for remediation of impacted groundwater. Because this is a novel approach to addressing the widespread problem of nitrogen in groundwater due to LSTS, grant funding for implementation may be available.

5.0 Costs, Funding and Schedule

Table 5.1 summarizes the schedule and cost for the Nitrogen Mitigation Plan to achieve the state standard in GW004 plan. Several funding alternatives may be available to finance these alternatives, lessening the financial impact to residents of Clearwater Harbor and Hidden River. Residents will likely qualify for low-interest loans through the MPCA (1% over 10 years or better). Lower income residents may qualify for better rates, and some may qualify for individual grants. Grant funds may be available given that the solution provides a low-cost solution relative to other alternatives to a problem widely faced in Minnesota due to the MPCA's groundwater nitrogen policy.

Table 5.1 Schedule & Costs

	Gradient Control/ Pytoremediation		
	Description	**Estimated Probable Cost**	**Proposed Implementation Schedule**
Step 1:	Operational Modifications to Drain Field	$20,000	Fall 2014
Step 2:	Gradient Control/ Phytoremediation (Both	$170,000	Spring 2016
	Total:	**$190,000**	