June 7, 2013

M E M O R A N D U M

FROM: John Tindall
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SUBJECT: Staff Analysis for Draft Municipal Wastewater Reuse Permit M-182-03, Kootenai-Ponderay Sewer District

1. PURPOSE

The purpose of this memorandum is to satisfy the requirements of the Idaho *Recycled Water Rules*, IDAPA 58.01.17.400, for issuing reuse permits. This memorandum addresses draft Reuse Permit M-182-03, for the municipal wastewater treatment and reuse system owned and operated by the Kootenai-Ponderay Sewer District (KPSD). KPSD's treatment and reuse system is currently permitted under the terms of Reuse Permit LA-000182-02.

2. SUMMARY OF EVENTS

The Department of Environmental Quality (DEQ) issued Reuse Permit LA-000182-02 to KPSD on June 26, 2008. The draft permit is for continued operation of the wastewater treatment and reuse system owned and operated by KPSD. These facilities are located in Bonner County north of the city of Kootenai, ID. The purpose of the draft reuse permit is to renew Reuse Permit LA-000182-02, which expired on May 1, 2013.

A permit renewal application from KPSD was received on October 31, 2012, and largely serves as the basis for the terms and conditions contained in the draft permit. As required by the Idaho *Recycled Water Rules*, the draft permit will be presented for a public comment period. After the comment period has closed, DEQ will provide written responses to all relevant comments and prepare a final permit for KPSD's wastewater reuse facilities.

3. PROCESS AND SITE DESCRIPTIONS

The wastewater treatment processes discussed in the Staff Analysis for KPSD's previous permit have not changed since that time (DEQ, 2008). For complete discussions regarding these items, refer to the Staff Analysis for the draft version of Reuse Permit LA-000182-02, dated March 13, 2008.

KPSD has proposed a change to the irrigation site in the permit renewal application (see Appendix F, KPSD 2012). Four (4) additional hydraulic management units (HMUs) are proposed to be added on property owned by KPSD and adjacent to the existing permitted site. The existing irrigation system would be expanded and a booster pump station added to irrigate the new HMUs through portable hand-line irrigation pipe and rotator sprinkler heads with 85% efficiency.

KPSD serves the communities of Kootenai and Ponderay on the north shore of Lake Pend Oreille. KPSD is permitted to discharge treated wastewater to Boyer Slough during the non-growing season through its National Pollution Discharge Elimination System (NPDES) Permit, ID-002122-9. During the growing season, KPSD is currently permitted to irrigate poplars under Reuse Permit LA-000182-02.

The collection system consists of both gravity and pressure lines which convey a combination of septic effluent and raw sewage to the wastewater treatment plant (WWTP). The WWTP consists of a headworks, a primary aerated lagoon, a secondary aerated lagoon, storage reservoir, chlorination and dechlorination if discharging to

Boyer Slough. The irrigation site currently consists of six (6) HMUs over 15 acres of poplar and willow trees irrigated through a modified drip irrigation system. The four (4) proposed HMUs are adjacent and to the east of the existing HMUs. The total acreage proposed to be added for irrigation is 21.5 acres.

The irrigation site has a mild slope to the southeast. Based on a geotechnical report completed for KPSD by Terracon in 1998, the soil profile is the following: topsoil (0.5 - 1.5 feet below ground surface (bgs)); upper clay layer (1.5 – 3 feet bgs); sand (2 – 3.6 feet bgs); and a lower clay layer (4.5 – 6.5 feet bgs). Ground water is seasonally shallow and a current permit condition limits irrigation to only when the depth to ground water is greater than three (3) feet from the surface based on ground water monitoring wells on the site. Ground water flow direction has not been determined. Lake Pend Oreille is about 1.5 miles to the south and is the largest surface water body near the site.

4. PERMITTING DISCUSSION

The following sections outline the proposed terms of the draft renewal permit, based on changes to the current permit requested by the permittee, evaluations of past performance with current permit requirements, and/or updates required by changes to the Idaho *Recycled Water Rules* or any other applicable regulatory standards. Terms and conditions that are unchanged from the previous permit and remain applicable to the facility are also addressed in this document.

4.1 Compliance Schedule for Required Activities – Section 3 of Permit

Updated Plan of Operation (O&M Manual)
KPSD's previous permit required submittal of an updated Plan of Operation (O&M Manual), and DEQ received this updated submittal on October 21, 2009. DEQ reviewed the document and provided comments on January 5, 2010. KPSD has not responded to DEQ comments and submitted a revised document.

The addition of the new HMUs and irrigation systems for those HMUs will require modifications to the existing O&M Manual.

It is recommended that the O&M Manual be updated. Compliance Activity No. CA-182-01 requires an updated O&M Manual to be submitted within twelve (12) months of permit issuance.

Land Application Site Instrumentation Plan Update
The current permit required an updated "Land Application Site Instrumentation Plan" to be submitted by March 2009 (see CA-182-04). The plan was submitted in January 2012.

With the addition of four (4) new HMUs and three (3) new crops, there will be additional site instrumentation, such as soil moisture monitoring, required for these new areas.

It is recommended that the instrumentation plan will need to be modified. Compliance Activity No. CA-182-01 (Plan of Operation update) requires that KPSD submit a revised instrumentation plan no later than twelve (12) months after the permit issuance.

Quality Assurance Project Plan (QAPP)
Appendix E of the 2009 update to the KPSD O&M Manual includes a draft of the QAPP. It is not clear that the QAPP was ever implemented.

It is recommended that a QAPP be prepared and implemented. Compliance Activity No. CA-182-02 requires a QAPP be prepared and implemented within twelve (12) months of permit issuance.

Lagoon Seepage Testing

The Idaho *Wastewater Rules*, IDAPA 58.01.16, currently require all municipal wastewater lagoons to be seepage tested once every ten years (refer to IDAPA 58.01.16.493.02). DEQ records indicate that KPSD lagoons have not been seepage tested. The previous permit required that the four (4) KPSD lagoons be seepage tested by June 2012 (see CA-182-03).

DEQ approved the seepage testing procedure report for the KPSD lagoons on March 8, 2010. KPSD has not been able to complete the testing due to problems with isolating the lagoons to conduct the testing while being able to maintain adequate treatment capabilities. KPSD has proposed to submit an alternative plan to monitor ground water around the lagoons as a means of determining if any lagoon leakage is causing impacts to the ground water and whether the facility is in compliance with the Idaho Ground Water Quality Rule (IDAPA 58.01.11). To-date, the seepage testing has not been completed and a ground water monitoring plan has not been submitted.

It is recommended that the draft permit include Compliance Activity No. CA-182-03 to require that KPSD either complete the lagoon seepage testing or submit and implement a DEQ approved ground water monitoring plan for the four (4) KPSD lagoons by November 2013. Failure to meet this deadline may result in DEQ initiating enforcement action to achieve compliance.

Pre-Application Workshop

It is recommended that the draft permit include Compliance Activity No. CA-182-04 to require that a pre-application workshop be held with KPSD and DEQ Staff no later than one (1) year prior to permit expiration to discuss the compliance status of the facility and the content required for the reuse permit application package.

Permit Renewal Application

It is recommended that the draft permit include Compliance Activity No. CA-182-05 to require that a renewal permit application be submitted to DEQ no later than 180 days prior to permit expiration.

4.2 Permit Limits and Conditions – Section 4 of Permit

4.2.1 Hydraulic Loading Rates

The current permit authorizes poplars and willows to be used on the irrigation site. Hydraulic loading rates from 2008-2012 varied between 33.8 inches/acre (2009) to 7 inches/acre (2010). Based on calculated mean irrigation water requirements used in the last permit (see Equation 1 and Table 4.2.1 below) and the soil moisture readings recorded, the facility appears to have been irrigating substantially equal to the irrigation water requirements for the crops.

Equation 1: $IWR = P_{def} / E_i$ where,

P_{def} - the precipitation deficit and is synonymous with the net irrigation water requirement of the crop. The P_{def} is found at http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137
E_i - the irrigation system efficiency.

Table 4.2.1 Mean Irrigation Water Requirements* of Poplars and Willows by Growth Year from 2008 Permit

(in/acre)	First Year		Second Year		Third Year		Fourth Year +	
	Poplar	Willow	Poplar	Willow	Poplar	Willow	Poplar	Willow
May	1.06	0.86	2.04	1.72	2.31	2.58	3.02	3.44
June	2.76	1.39	5.29	2.77	5.98	4.16	7.82	5.54
July	4.05	1.88	7.76	3.76	8.77	5.64	11.46	7.52
August	3.65	1.53	6.99	3.06	7.90	4.60	10.33	6.13
September	2.03	0.87	3.89	1.75	4.39	2.62	5.75	3.50
October**	0.36	0.21	0.70	0.43	0.79	0.64	1.03	0.86
Total	**13.91**	**6.75**	**26.66**	**13.50**	**30.13**	**20.24**	**39.40**	**26.99**

*Based on ET data from http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137 for poplars and willows, a growth related irrigation requirement weighting factor and 85% irrigation efficiency.
**October values based on sum of average rainfall per day (0.05 in/day) and October IWR for poplars and willows.

KPSD has proposed to grow five (5) crops on the irrigation site in ten (10) HMUs:

1. Poplar trees with ages varying from newly planted cuttings to trees over four (4) years old;
2. Willow trees from which cuttings are taken annually by the Soil Conservations District for streambank stabilization projects;
3. Native cottonwood forest;
4. Native conifer forest; and
5. Fodder crop of orchard grass and alfalfa mix.

KPSD has requested that the irrigation rates be based on the use of soil moisture probes (also called tensiometers) as a method of demonstrating compliance with hydraulic loading permit limits based on the Irrigation Water Requirement (IWR) for a particular crop. The use of portable and permanent soil moisture probes is proposed. KPSD has had experience operating the irrigation site in this manner since 2001.

KPSD has also requested that the growing season be extended into October. The IWR numbers from the ET Idaho 2012 website that were used to build Table 1 for both hybrid poplars and willows are statistically negative for the month of October. However, in some years irrigation may be required to supplement low rainfall totals during the month of October and prevent the trees from being stressed. The KPSD annual reports from 2008-2012 show that irrigation has not been done in October. Since this facility relies on soil moisture monitoring probes to determine irrigation times and durations, it is proposed that the facility be permitted to irrigate during the first fifteen (15) days of October in accordance with the soil moisture probe readings when the soil is not saturated and there is visible crop stress. In addition, it is proposed in October that the facility only irrigate on days when the air temperature is above 50ºF and no standing water is left to freeze overnight.

It is recommended that KPSD be required to irrigate substantially equal to the IWR. This can be demonstrated through calculations for the particular crop (see Equation 1 above) or through the daily use of soil moisture probes to determine the moisture content of the soil in a HMU. Irrigation in October will require DEQ approval and demonstration that the conditions listed above are met.

The revised Plan of Operation and Site Instrumentation Plan will detail the procedures used by KPSD for scheduling irrigation.

Appendix 7.1 provides the calculations for determining the mean IWRs for the different crops. The estimated mean IWRs for each crop by month are shown below.

4.2.1.1 Poplars and Willows (15 acres)

Table 4.2.2 Mean Irrigation Water Requirements* of Poplars and Willows by Growth Year (inches/acre)

Month	First Year		Second Year		Third Year		Fourth Year +	
	Poplar	Willow	Poplar	Willow	Poplar	Willow	Poplar	Willow
May	1.10	0.88	2.10	1.77	2.38	2.65	3.11	3.09
June	2.82	1.46	5.40	2.92	6.10	4.38	7.98	5.11
July	4.22	2.00	8.09	3.99	9.14	5.99	11.96	6.99
August	3.68	1.55	7.05	3.10	7.97	4.65	10.42	5.43
September	2.08	0.85	3.98	1.71	4.50	2.56	5.89	2.99
October**	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Total	**13.89**	**6.74**	**26.62**	**13.49**	**30.10**	**20.23**	**39.36**	**23.61**

*Based on ET data from http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137 for poplars and willows, a growth related irrigation requirement weighting factor and 85% irrigation efficiency.
**TBD- To Be Determined. October irrigation will only occur if the soil moisture probes indicate the soil is not saturated and the trees show signs of leaf wilt. In addition, it is proposed that the facility only irrigate in October on days when the air temperature is above 50ºF and no standing water is left to freeze overnight.

The calculated mean IWRs in Table 4.2.2 are similar to those used in the current permit and KPSD's hydraulic loading rates from 2008 to 2012 were within these ranges. KPSD has not requested an increase to the hydraulic loading rate permit limits (KPSD, 2012).

4.2.1.2 Cottonwoods (10.9 acres)

Table 4.2.3 Mean Irrigation Water Requirements (IWR)* of Cottonwoods (inches/acre)

Month	IWR
May	2.34
June	5.43
July	7.81
August	6.42
September	3.22
Total	**25.23**

*Based on ET data from http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137 for cottonwoods and 85% irrigation efficiency.

KPSD has requested a hydraulic loading rate for the cottonwoods of 18.5 inches per acre for the growing season (KPSD, 2012).

4.2.1.3 Native Conifer Forest (5.6 acres)

Table 4.2.4 Mean Irrigation Water Requirements (IWR)* of Native Conifer Forest (inches/acre)

Month	IWR
May	2.42
June	6.20
July	11.49
August	10.36
September	5.68
Total	**36.15**

*Based on mean ET data from http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137 for Orchard (no cover) and Pasture (high maintenance) and 85% irrigation efficiency.

KPSD has requested a hydraulic loading rate for the native conifer forest of 26.5 inches per acre for the growing season (KPSD, 2012).

4.2.1.4 Grass/Alfalfa Hay (5 acres)

Table 4.2.5 Mean Irrigation Water Requirements (IWR)* of Grass/Alfalfa Hay (inches/acre)

Month	IWR (inches/acre)
May	2.91
June	5.32
July	7.25
August	5.36
September	3.52
Total	**24.36**

*Based on ET data from http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137 for grass hay and 85% irrigation efficiency.

KPSD has requested a hydraulic loading rate for the grass/alfalfa hay crop of 31.97 inches per acre for the growing season.

4.2.2 Constituent Loading Rates

The current permit does not have any constituent loading rates for nitrogen, phosphorus or chemical oxygen demand (COD). The annual loading rates are to be reported in the annual reports.

4.2.2.1 Nitrogen Loading Rates

4.2.2.1.1 Poplars and Willows

The 2008 Staff Analysis does propose a nitrogen (N) loading rate limit of 250 lbs.N/acre-year (DEQ, 2008).

KPSD annual reports show that nitrogen loading rates have never exceeded about 160 lbs.N/acre-year and have been as low as about 13 lbs. N/acre-year for the poplar and willow crops (KPSD, Annual Reports 2007-2012). Total nitrogen concentration in the wastewater is generally less than 30 mg/L

(KPSD, Annual Reports 2007-2012).

It is reported that mature poplars can require about 300 lbs.N/acre-year (WSU, 2005) and willow stems were shown to have uptake rates up to 65 lbs.N/acre-year (DEPA, 2003).

KPSD has not requested any change to the nitrogen loading limits for poplars and willows (HMUs 1-6).

It is recommended that a maximum nitrogen loading rate of 150% of typical uptake rates for poplars and willows be used (DEQ, 2007). Using a nitrogen demand for mature poplars of 250 lbs.N/acre-year, this would result in a maximum loading rate of 375 lbs.N/acre-year. Using a nitrogen demand for willows of 65 lbs.N/acre, this would result in a maximum loading rate of 97.5 lbs.N/acre-year.

4.2.2.1.2 Cottonwoods

KPSD has requested a nitrogen loading rate of 124 lbs.N/acre-year for the cottonwoods (HMU 10).

Nitrogen uptake rates of up to 240 lbs.N/acre-year have been reported for cottonwoods (DEQ, 2012).

It is recommended that a maximum nitrogen loading rate of 150% of typical uptake rates for cottonwoods be used (DEQ, 2007). Using a nitrogen demand for cottonwoods of 240 lbs.N/acre-year, this would result in a maximum loading rate of 360 lbs.N/acre-year.

4.2.2.1.3 Native Conifer Forest

KPSD has requested a nitrogen loading rate of 176 lbs.N/acre-year for the native conifer forest (HMU 9).

Approximately 20% of the tree canopy is open (KPSD, 2012). Using "Draft DEQ Guidance for Forests/Poplar Site Nutrient and Hydraulic Loading, July 2012" to estimate the maximum nitrogen loading rate, 155 lbs.N/acre-year was calculated (See Appendix 7.2).

4.2.2.1.4 Orchard Grass/Alfalfa Crop

KPSD has requested a nitrogen loading rate of 59 lbs.N/acre-year for the orchard grass/alfalfa crop (HMUs 7 and 8).

It is recommended that a maximum nitrogen loading rate of 150% of typical uptake rates be used (DEQ, 2007). Table 4.2.6 shows the recommended nitrogen loading limit based upon historical crop yield for Bonner County and the results of the tissue analysis from the 2007 growing season.

Table 4.2.6. Recommended nitrogen loading limits based on 2012 crop uptake data from Southside W&S District (Southside, 2013)

Crop Type	Guideline Loading Rate	Anticipated Yield* [T/acre]	% Nitrogen**	Recommended Permit Limit for N-150% of Crop Uptake [lbs.N/acre-yr.]
Orchard Grass/Alfalfa Hay	150% of uptake	2.0	1.9	114

*Estimate based on data provided by the USDA National Agricultural Statistics Service for alfalfa in Bonner County, 2001-2010 (USDA, 2013).
**Plant tissue analysis from Southside W&S District crop (timothy grass/alfalfa mix) in 2012 (Southside, 2013).

It is also recommended that plant tissue analysis for nitrogen content be required for each cutting from these HMUs. This will allow for a comparison of the amount of nitrogen removed and applied.

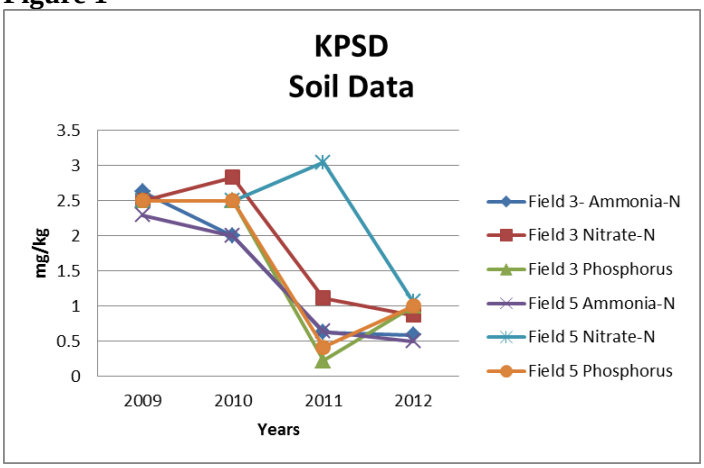
4.2.2.2 Phosphorus Loading Rate

There is no phosphorus (P) loading limit in the current permit because it was determined that there was a low risk of phosphorus from the irrigation of the poplars and willows impacting any near-by surface waters. There was a low risk of run-off from the irrigation site because the site is relatively flat and irrigation is not done in the non-growing season or during significant rain events. The nearest surface water is a seasonal tributary to Boyer Slough near the northeast corner of the site which is dry when irrigation starts in late June or July. Lake Pend Oreille is the largest nearby surface water and it is about 1.25 miles south of the site. There is also no known ground water/surface water interconnection nearby to move ground water into the surface water.

The phosphorus concentration in the irrigation water has varied between 5 to 6 mg/L and the average phosphorus loading rate is about 25 lbs.P/acre-year(KPSD, 2007-2012 Annual Reports). The P loading rates varied between 8.8 lbs.P/acre-year (KPSD, 2010 Annual Report) and 43 lbs.P/acre-year (KPSD, 2008 Annual Report).

Annual April soil sampling during the last permit cycle did not show any trend toward increasing soil phosphorus concentrations as shown in Figure 1 below. This lack of a trend indicates that the current phosphorus loading rates for the poplar and willow crops do not appear to be significantly changing the soil phosphorus concentrations (KPSD, 2007-2012 Annual Reports). Phosphorus not used by the crop can be leached into the ground water but there are also significant reactions in the soil (adsorption and precipitation) that will retain phosphorus in the soil. The sorption capacity of a soil is increased with fine textured mineral soils like clay and there is about 3.5 feet of clay in the top 6 feet of the soil according to the original soils report for the site prepared in 1998 by Terracon. The upper clay layer is reported to generally be between 1.5 to 3 feet below the ground surface so annual soil sampling would likely show increases over time in phosphorus soil concentrations of this layer if phosphorus loading rates were significantly exceeding phosphorus plant uptake rates.

Figure 1



KPSD has requested the following phosphorus loading rates for the crops to be irrigated (KPSD, 2012):

1. Poplars and Willows (HMUs 1-6) – No change from current permit
2. Cottonwoods (HMU 10) – 22 lbs.P/acre-year
3. Native Conifer Forest – 32 lbs.P/acre-year
4. Orchard Grass/Alfalfa Crop – 14 lbs.P/acre-year

Phosphorus loading rates on poplars were reported up to 26 lbs.P/acre-year without showing significant losses (SLU, 2011). Loading rates for the cottonwoods should be similar to the poplars. A typical native conifer forest site with understory can have a phosphorus loading rate as high as 27 lbs.P/acre-year (EPA, 2006). Orchard grass is estimated to consist of 0.20% dry weight as phosphorus (EPA, 2006). Annual plant tissue testing for phosphorus in the cuttings will provide data on crop uptake rates as compared to the amounts applied.

It is recommended that no phosphorus loading rates be included in the permit. Monitoring for phosphorus in the soil, irrigation water and plant tissue from the orchard grass/alfalfa crops will be required to evaluate the fate of the applied phosphorus.

4.2.2.3 Chemical Oxygen Demand Loading Rate

There is no Chemical Oxygen Demand (COD) loading limit in the current permit. Once per irrigation season COD monitoring of the irrigated water was required in the current permit. The COD loading rates have varied between 1.1 lbs.COD/acre/day (KPSD, 2010 Annual Report) to 4.6 lbs.COD/acre/day (KPSD, 2009 Annual Report). DEQ recommends that the yearly average loading rate for COD not exceed 50 lbs.COD/acre/day.

It is recommended that COD monitoring not be included in the draft permit. KPSD has shown that the historical COD loading rates are significantly less than the recommended maximum rate of 50 lbs.COD/acre/day and it is likely that KPSD will continue to have relatively low COD loading rates.

4.2.3 Buffer Distances and Disinfection Limits

KPSD's treatment and recycled water facilities in the current permit are classified as a Class D Recycled Water System (see Section 602.01, Table 1, of the *Recycled Water Rules*).

Since 2009, the facility has consistently complied with the total coliform disinfection limits in the current

permit (a maximum 5-day median total coliform count of 230 CFUs/100 ml. and a maximum single sample of 2,300 CFUs/100 ml. and once per month sampling). There were total coliform exceedances in 2007-2009.

The eastern borders of proposed new HMUs (HMUs 9 & 10 shown in Figure 3) will be closer than 300 feet from three (3) inhabited dwellings (the closest being about 120 feet to the east of HMU 10) as shown in Figure 2. The northern border of HMU 9 will be closer than 300 feet from one (1) inhabited dwell (see Figure 2). DEQ *Guidance* recommends that for the buffer distances of between 300 feet and 50 feet to an inhabited dwelling, an appropriate disinfection limit would be a maximum 5-day median total coliform count of 2.2 CFUs/100 ml. and a maximum single sample of 23 CFUs/100 ml. and once per week sampling (DEQ, 2007). The potable water supply for the homes is from the Oden Water Association and there are no private domestic wells closer than 500 feet to any of the HMUs (Closson, 2013). KPSD would have a difficult time meeting these more stringent disinfection limits with the existing treatment and disinfection systems.

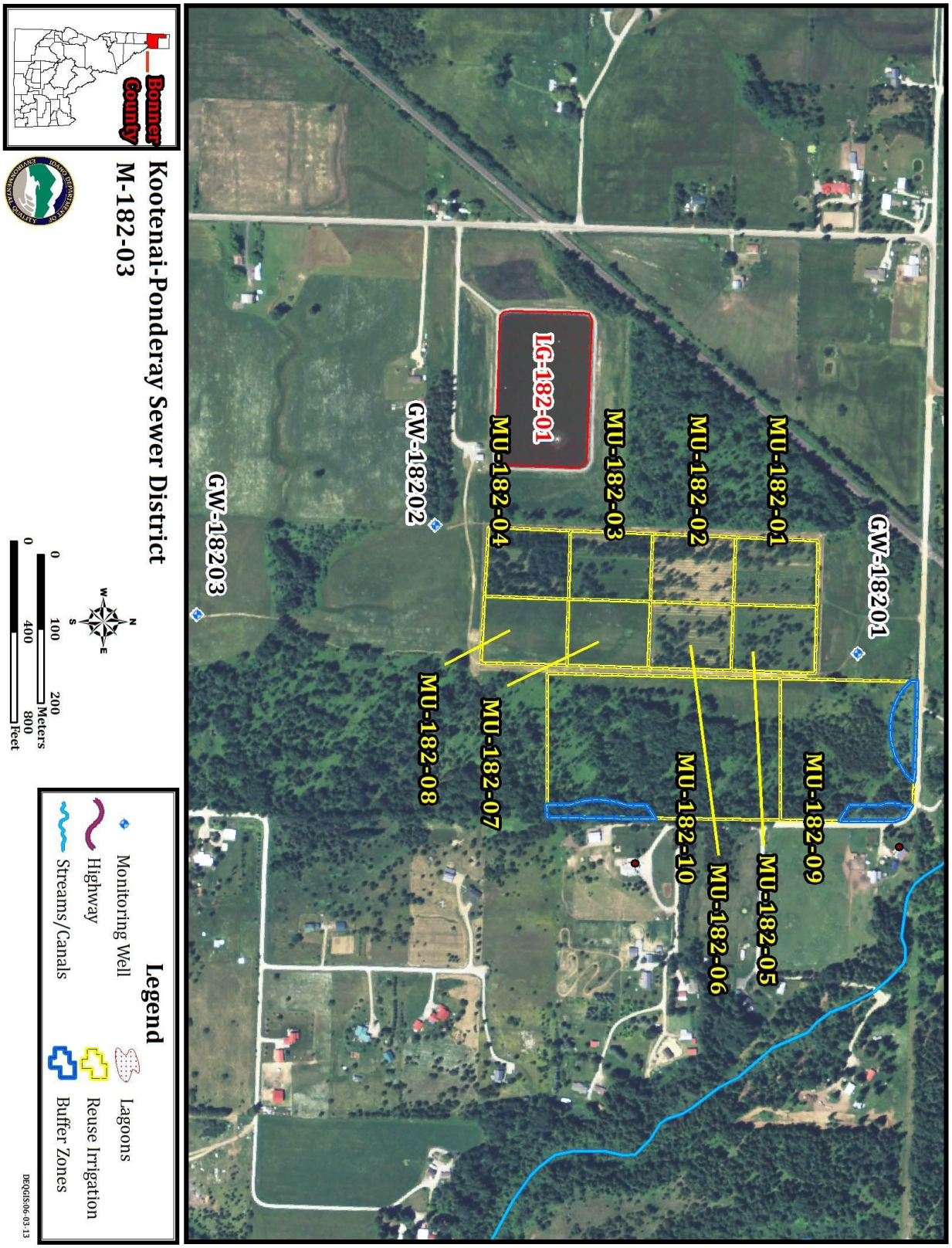
As an alternative to the more stringent disinfection limits and to provide adequate public health protection for the nearby homes, DEQ proposes that the Class C Recycled Water disinfection requirements (a maximum 5-day median total coliform count of 23 CFUs/100 ml. and a maximum single sample of 230 CFUs/100 ml., and once per week sampling) be used with coniferous and deciduous vegetative buffers. DEQ *Guidance* recommends that the previously listed disinfection limits be used when inhabited dwellings are between 300 to 500 feet from the irrigated area without a buffer being required (DEQ, 2007). The following alternative requirements are proposed:

1. The irrigated area must be at least 200 feet from the three (3) homes to the east of HMUs 9 and 10 with at least a 50 foot coniferous and deciduous vegetative buffer (no irrigation in the buffer) between the irrigated area and eastern side of both these HMUs; and
2. Where the homes to the east of HMUs 9 and 10 are closer than 300 feet from the irrigated areas, there must be at least a 50 foot coniferous and deciduous vegetative buffer (no irrigation in the buffer) between the irrigated areas and eastern side of both these HMUs; and
3. Any proposed thinning and/or harvesting of the vegetative buffer on the east side of HMUs 9 and 10 will require consultation with DEQ to determine if the vegetative buffer will continue to provide adequate public health protection; and
4. The irrigated area must be at least 300 feet from the one (1) home to the north of HMU 9 because there is currently not an adequate vegetative buffer to justify a reduced buffer distance.

The conifer and cottonwood vegetation on the eastern portions of both of the HMUs is well developed. HMU 9 has 526 conifer trees per acre and HMU 10 has 141 cottonwood trees per acre and 1,404 conifers per acre (KPSD, 2012). These trees will act as a barrier to prevent aerosol drift from migrating off the site. The proposed irrigation system to be installed in HMU 9 and 10 will consist of Nelson R33 sprinkler heads which are similar to impact sprinklers. Operating pressures for the irrigation have not been presented. Microbial risk modeling from aerosols produced during the irrigation of wastewater has been performed by DEQ. This modeling has shown that with Class C disinfection limits, as proposed here, using impact sprinklers and assuming a pressure of 80 psi at the sprinkler heads and daytime windy conditions, the total risk (airborne and ingestion pathways) of infection at between 300 feet to 50 feet from the irrigated area is lower than the “threshold” of 1 infection per 10,000 people exposed (DEQ, 2010). Coniferous and deciduous vegetation have achieved up to 50% aerosol removal by filtration. In addition, aerosol concentrations should be reduced when using these types of vegetative barriers by “several orders of magnitude through vertical dispersion and dilution” (EPA 1981).

Figure 2 – Homes Near HMUs 9 and 10

Figure 3- Existing and Proposed HMUs



KPSD will need to maintain these vegetative barriers in order to irrigate areas closer than 300 feet from the homes east of HMUs 9 and 10. Therefore, a minimum 200 foot buffer from the homes east of HMUs 9 and 10 with at least a 50 foot coniferous and deciduous vegetative buffer should result in an acceptable total risk of infection with the proposed irrigation system.

The site will be fenced with a four (4) strand barbed wire fence with the appropriate signage. Figure 4 shows the proposed buffers for HMUs 9 and 10.

The existing six (6) HMUs and the proposed two (2) new HMUs 7 and 8 are all greater than 500 feet from inhabited dwellings and 300 feet from areas accessible to the public. These HMUs can continue to be classified as Class D Recycled Water HMUs. KPSD experiences nitrite block (incomplete nitrification) in the storage lagoon water usually in July and August. This makes it difficult to consistently meet a total coliform disinfection limit of 23 CFU/100 ml. using chlorine. By keeping HMUs 1-8 as Class D Recycled Water HMUs, KPSD will have operational flexibility to manage the nitrite block periods while continuing to provide public health protection. Total coliform sampling will need to increase from once per month (as it is in the current permit) to weekly to provide consistency between the Class D and Class C portions of the irrigation site.

It is recommended that for all the HMUs, the following minimum buffer distances be incorporated into the permit:

- 100 feet from HMU to permanent surface water and intermittent surface water, if water is present
- 50 feet from HMU to irrigation ditches and canals
- 500 feet from HMU site to private water supply wells
- 1000 feet from HMU to public water supply wells

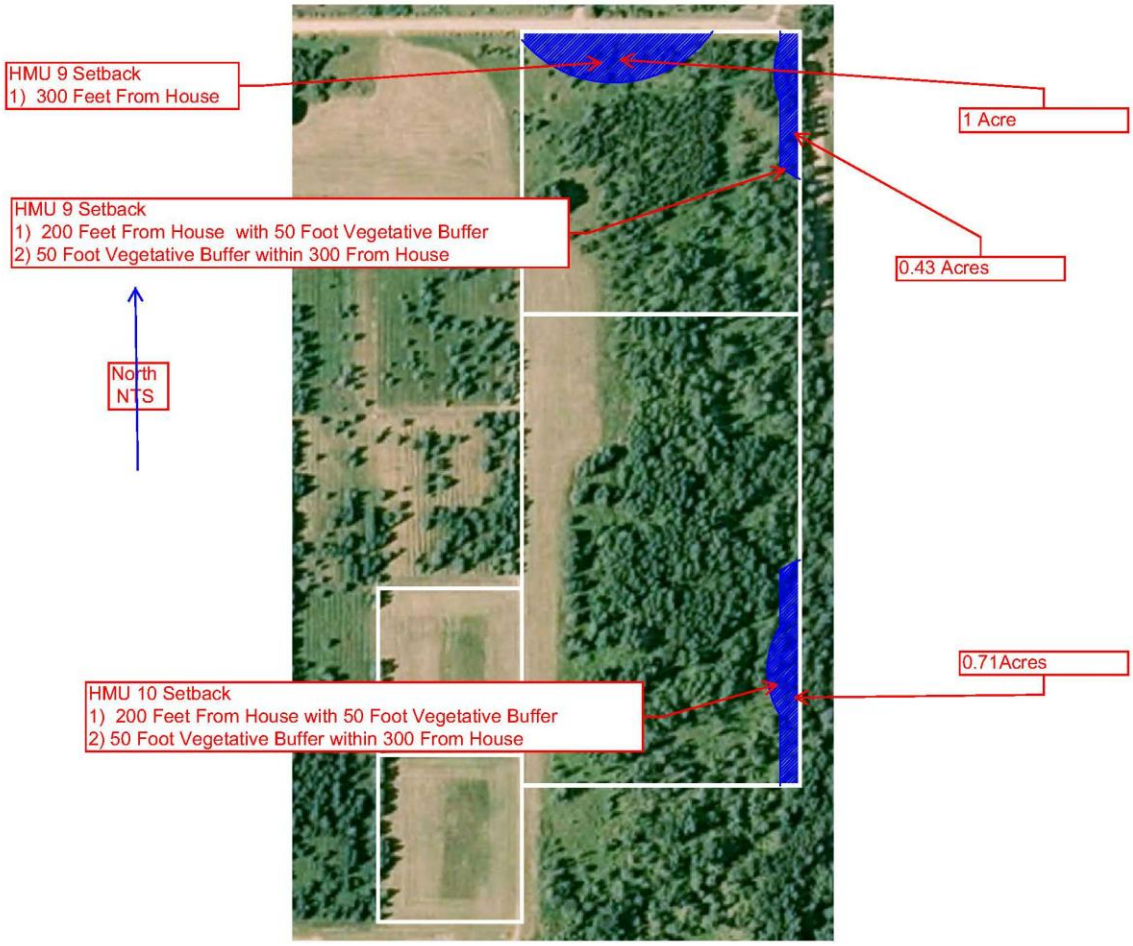
It is recommended that for HMUs 1-8, the disinfection limits for Class D Recycled Water (a maximum 3-day median total coliform count of 230 CFUs/100 ml. and a maximum single sample of 2,300 CFUs/100 ml., and once per week sampling) be incorporated into the permit with the following minimum buffer distances:

- 500 feet from HMU to inhabited dwellings; and
- 300 feet from HMU to areas accessible by the public.

It is recommended that for HMUs 9 & 10, the disinfection limits for Class C Recycled Water (a maximum 5-day median total coliform count of 23 CFUs/100 ml., a maximum single sample of 230 CFUs/100 ml., and once per week sampling) be incorporated into the permit with the following minimum buffer distances:

- 200 feet to the inhabited dwellings on the eastern side of HMU 9 and 10 and the irrigated areas; and
- 50 foot vegetated buffer along the eastern side of the HMU 9 and 10 when homes are closer than 300 feet to the irrigated areas; and
- 300 feet to the inhabited dwelling on the northern side of HMU 9; and
- 0 feet from HMUs 9 and 10 to areas accessible by the public

Figure 4- Proposed Buffer for HMUs 9 & 10

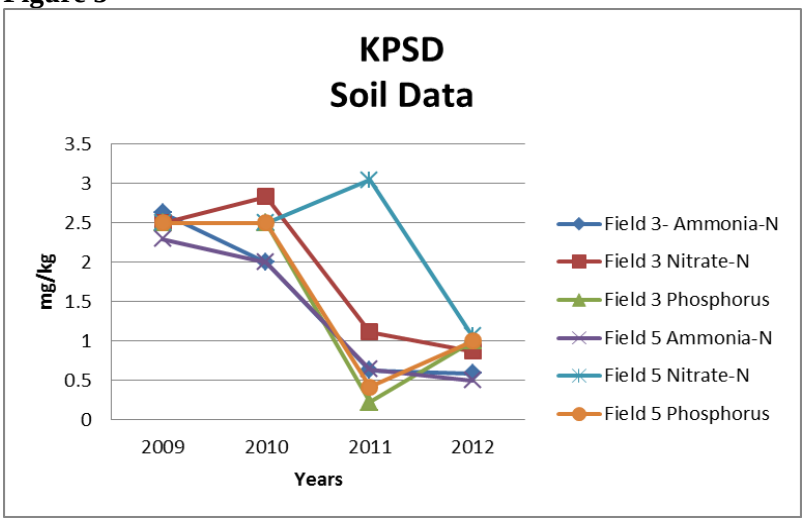


4.3 Monitoring and Reporting – Sections 5 & 6 of the Permit

4.3.1 Soil Monitoring

Soil monitoring has been required annually in April in the current permit for Fields 3 and 5 (MU-018203 and MU-018205) for ammonia-nitrogen, nitrate-nitrogen and plant available phosphorus at two (2) depths (0”-12” and 12”-24”). Poplars are grown in Field 3 and poplars and willows are grown in Field 5. The results indicate that there is not a trend of increasing soil concentrations of these constituents (see Figure 5). This information shows that the past nutrient loading rates (as presented in Section 4.2.2) are approximately in accordance with the plant uptake rates. Increases in these parameters would be expected if there were excessive amounts of nutrients being applied.

Figure 5



It is recommended that the same representative, annual soil sampling prior to the start of irrigation for the six (6) existing HMUs continue in MU-182-03 and MU-182-05 in the new permit. In addition, representative soil sampling in the new HMUs 7, 8, 9 and 10 should be initiated. New crops will be irrigated within these HMUs and it will be important to evaluate the soil data during the next permit renewal process. It is recommended that the soil sampling be done annually prior to the start of irrigation in MU-182-07 (representative of MU-182-07 and MU-182-08 for the hay crop), MU-182-09 (conifers) and MU-182-10 (cottonwoods).

4.3.2 Ground Water Monitoring

Currently, shallow ground water monitoring to measure static water level below the ground surface (bgs) is required to determine when seasonally high ground water is at least three (3) feet bgs. Monitoring is required daily during the first and last month of irrigation. Irrigation can only be done when all three (3) of the existing monitoring wells (see Fig. 6) show that ground water is at least 3 feet bgs. These monitoring wells have been used since the first reuse permit for KPSD was issued in 2001. The surface elevations of the monitoring wells vary from about 2154 feet for the north well to about 2122 feet for the south well. The surface elevations for the irrigated areas varies from about 2162 feet for the proposed north HMU 9 to about 2122 feet for the south part of proposed HMU 10. The locations and elevations of the existing monitoring wells should provide representative ground water depth data for the new and existing HMUs. Typically, once the depth of ground water falls below 3 feet bgs, it continues to drop

during the growing season (DEQ, 2008).

It is recommended that existing monitoring wells continue to be used to annually determine when irrigation can start. A minimum depth to ground water of 3 feet bgs will be required prior to starting irrigation. Monitoring will be required as needed prior to starting irrigation that the depth to ground water is at least 3 feet bgs and following that determination, no additional ground water monitoring will be required for that irrigation season.

4.3.3 Plant Tissue Monitoring

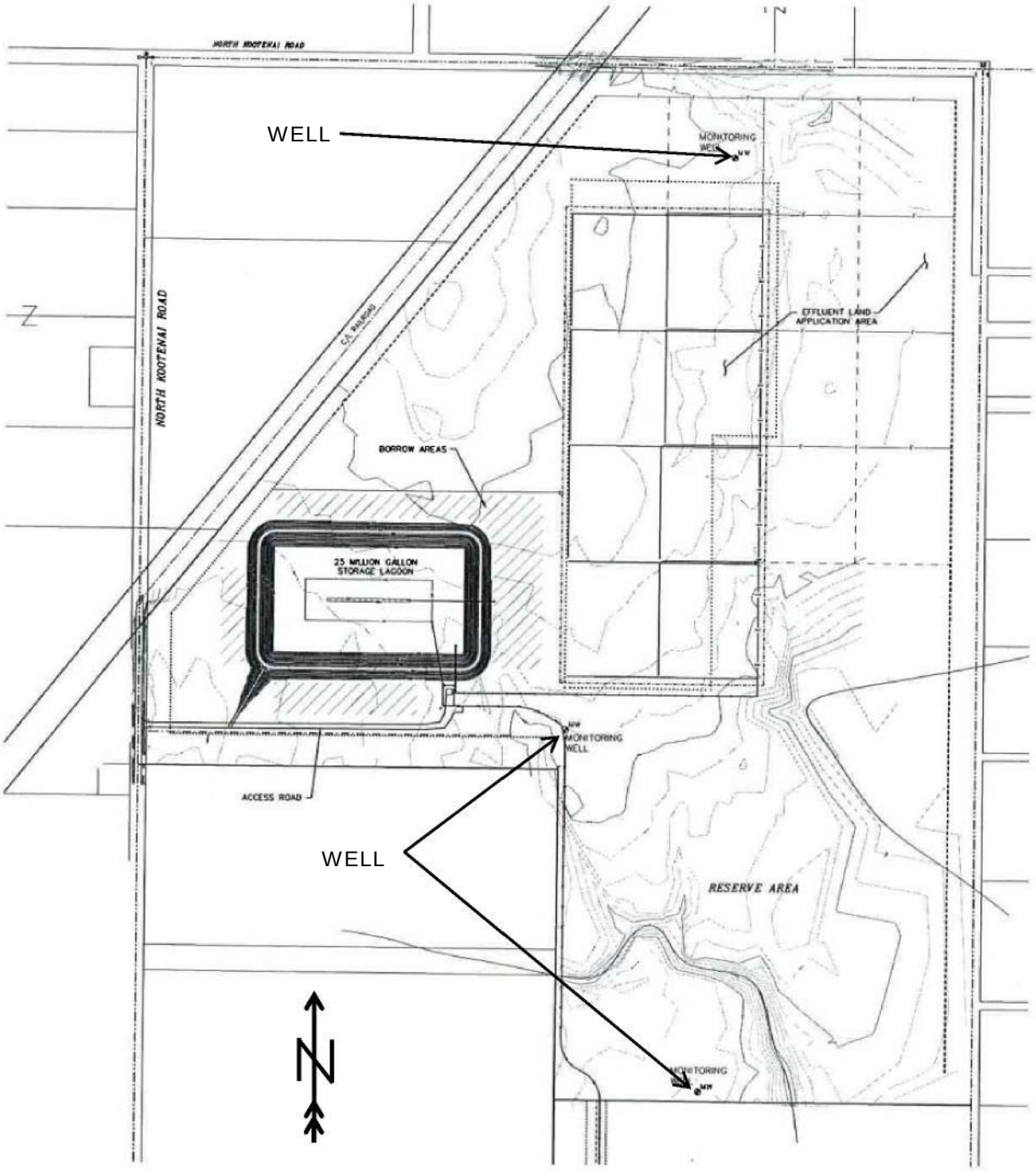
There are no requirements for plant tissue monitoring in the current permit. KPSD has analyzed samples of the willow cuttings when they are harvested to determine the pounds of nitrogen and phosphorus removed (KPSD, 2012). The two (2) new HMUs (MU-182-07 and MU-182-08) will be used to grow a hay crop. Typically plant tissue monitoring is done when fodder crops are grown to assess the nutrients removed with the crop and compare that to the nutrients applied.

It is recommended that plant tissue monitoring for total nitrogen and phosphorus for any crops removed from the irrigation site be included in the permit.

4.3.4 Annual Report

KPSD is also required to submit an annual report that includes 1) all monitoring conducted under the terms of the permit, 2) the status of compliance activities required by the permit, and 3) an interpretive discussion of the monitoring data with particular respect to any potential environmental impacts. The annual report is due by January 31st of each year, and should address operations conducted from January 1 through December 31 of the preceding year.

FIGURE 6 - KPSD MONITORING WELLS



5. RECOMMENDATIONS

Based on review of applicable state rules, staff recommends that DEQ issue draft Reuse Permit M-182-03 for a public review and comment period. The draft permit contains effluent quality requirements for the wastewater treatment system, as well as terms and conditions required for operation of the reuse system. Monitoring and reporting requirements to evaluate system performance and to determine permit compliance have been specified, and compliance activities have been incorporated into Sections 5 and 6 of the permit.

6. REFERENCES

DEQ, Staff Analysis KPSD Permit LA-000182-02, March 13, 2008.

DEQ, "Guidance for Reclamation and Reuse of Municipal and Industrial Wastewater", September 2007.

DEQ, "Draft DEQ Guidance for Forests/Poplar Site Nutrient and Hydraulic Loading", July 2012.

DEQ, "Microbial Risk Assessment-Modeling Results for Class A/B, C, D and E, Municipal Wastewater for Varying Meteorological Conditions, Nozzle Types and Operating Pressure". Memo to Richard Huddleston from Mike Cook and Jeffrey Fromm. January 20, 2010.

EPA, 1981. Environmental Protection Agency. Process Design Manual: Land Treatment of Municipal Wastewater Effluents. EPA/625/1-81-013. October 1981.

EPA, 2006. Environmental Protection Agency. Process Design Manual: Land Treatment of Municipal Wastewater Effluents. EPA/625/R-06/016. September 2006.

Kootenai-Ponderay Sewer District, Annual Reuse Permit Reports for Years 2007-2012.

Kootenai-Ponderay Sewer District, "KPSD Permit No. LA-000182-02 Renewal Application", October 31, 2012

Swedish University of Agricultural Sciences (SLU), "Quantifying environmental effects of Short Rotation Coppice (SRC) on Biodiversity, Soil and Water", IEA Bioenergy, Task 43, 2011:01, 2011.

Southside Water and Sewer District, "2012 Annual Wastewater Reuse Report", January 23, 2013.

Tim Closson, Kootenai-Ponderay Sewer District Manager, April 17, 2013 Email

USDA, National Agricultural Statistics Service (NASS), 2013
http://www.nass.usda.gov/Statistics_by_State/Idaho/Publications/County_Estimates/pdf/alfalfa.pdf

7. APPENDICES

7.1 IWR Formulation Methodology

7.1.2 Poplars and Willows

The IWR values for KPSD (Table 1) were derived from precipitation deficit (P_{def}) data available for hybrid poplars and willows from the ET_{Idaho} Sandpoint KSPT Station (http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137). Table 7 shows the data taken from the ET_{Idaho} website for both tree species.

Table 1.1 Precipitation Deficit (P_{def}) Data

	Poplars		Willows	
	mm/day	**in/month***	**mm/day**	**in/month***
January	-0.09	-0.11	-1.96	-2.39
February	0.04	0.05	-0.40	-0.49
March	0.11	0.13	0.05	0.06
April	0.2	0.24	0.72	0.88
May	1.64	2.00	2.10	2.56
June	4.35	5.31	3.59	4.38
July	6.31	7.70	4.75	5.80
August	5.5	6.71	3.69	4.50
September	3.21	3.92	2.10	2.56
October	-0.1	-0.12	-0.30	-0.37
November	-2.38	-2.90	-2.98	-3.64
December	-0.72	-0.88	-2.89	-3.53

* Calculated value (ET_{Idaho} data in mm/day / 25.4 in/mm ***** #days in month)

Since the facility is growing trees instead of a single-season crop such as alfalfa or hay, it was determined to make the IWR growth year specific. The United States Department of Agriculture (USDA) has published Technical Note No. 37, Hybrid Poplar: An Alternative Crop for the Intermountain West which includes ranges of the estimated water use for hybrid poplars based on the growth year (see table below).

Table 7.2 Estimated Water Use Ranges for Hybrid Poplars by Growth Year

Crop	Estimated water use (inches/acre-year)	Value used for calculation (inches/acre-year)**
Hybrid poplar (1st year)	10-14	12
Hybrid poplar (2nd to 3rd year)	22-26	23/26
Hybrid poplar (4th year to harvest)	32-36	34

*Based on table on page 6 of (USDA, 2001)
**Values are generally the average of the estimated range for each year

Willows have little crop data available, although several studies, including one done by the Danish Environmental Protection Agency (DEPA, 2003), have stated that they are high water users (>20 inches/acre-year). The ET_{Idaho} Sandpoint Station data shows willows with a mean P_{def} of about 21 inches from March to September. The following estimates of water use by willows were used in calculating the irrigation water requirements (IWRs).

Table 7.3 Estimated Water Use for Willows by Growth Year

Growth Year	Value used for calculation (inches/acre-year)**
1	6
2	12
3	18
4	21

From Table 7, only non-negative values were used for each species to determine the percentages of the total required water to be applied per month for each year of growth. As explained in Section 4.2.1, at the request of the permittee, irrigation in the first half of October will be allowed in accordance with the soil moisture probe readings when the soil is not saturated and there is visible crop stress. In addition, it is proposed that the facility only irrigate in October on days when the air temperature is above 50ºF and no standing water is left to freeze overnight.

The following tables show the calculation of the monthly irrigation rates for poplars and willows, respectively. Monthly irrigation values were calculated only for the proposed growing season (May 1 to October 15).

Table 7.4 Calculation of Monthly Irrigation Rates for Hybrid Poplars (inches/acre)

Month	P_{def}	Percent of Total P_{def}	1st Year 12"	2nd Year 23"	3rd Year 26"	4th Year 34"
February	0.04	0.17%				
March	0.13	0.52%				
April	0.24	0.92%				
May	2.00	7.77%	0.93	1.79	2.02	2.64
June	5.14	19.95%	2.39	4.59	5.19	6.78
July	7.70	29.90%	3.59	6.88	7.77	10.16
August	6.71	26.06%	3.13	5.99	6.78	8.86
September	3.79	14.72%	1.77	3.39	3.83	5.00
Total	**25.76**	**100.00%**	**11.8**	**22.63**	**25.58**	**33.45**

Table 7.5 Calculation of Monthly Irrigation Rates for Willows (inches/acre)

Month	P_{def}	Percent of Total P_{def}	1st Year 6"	2nd Year 12"	3rd Year 18"	4th Year 21"
March	0.06	0.30%				
April	0.85	4.15%				
May	2.56	12.51%	0.75	1.50	2.25	2.63
June	4.24	20.69%	1.24	2.48	3.72	4.34
July	5.80	28.29%	1.70	3.39	5.09	5.94
August	4.50	21.97%	1.32	2.64	3.96	4.61
September	2.48	12.10%	0.73	1.45	2.18	2.54
Total	**20.50**	**100.00%**	**5.73**	**11.47**	**17.20**	**20.07**

Dividing each value in Tables 10 and 11 above by 0.85 gives the IWRs as shown in Table 7.6 below, which represent the mean IWRs for each tree species by growth year at an irrigation efficiency of 85%. The irrigation system is discussed in Sections 3.

Table 7.6 Mean Irrigation Water Requirements* of Poplars and Willows by Growth Year (inches/acre)

Month	First Year		Second Year		Third Year		Fourth Year +	
	Poplar	Willow	Poplar	Willow	Poplar	Willow	Poplar	Willow
May	1.10	0.88	2.10	1.77	2.38	2.65	3.11	3.09
June	2.82	1.46	5.40	2.92	6.10	4.38	7.98	5.11
July	4.22	2.00	8.09	3.99	9.14	5.99	11.96	6.99
August	3.68	1.55	7.05	3.10	7.97	4.65	10.42	5.43
September	2.08	0.85	3.98	1.71	4.50	2.56	5.89	2.99
October**	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Total	**13.89**	**6.74**	**26.62**	**13.49**	**30.10**	**20.23**	**39.36**	**23.61**

*Based on ET data from http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137 for poplars and willows, a growth related irrigation requirement weighting factor and 85% irrigation efficiency.
**TBD- Too Be Determined. October irrigation will only occur if the soil moisture probes indicate the soil is not saturated and the trees show signs of leaf wilt. In addition, it is proposed that the facility only irrigate in October on days when the air temperature is above 50ºF and no standing water is left to freeze overnight.

7.1.3 Cottonwoods

Table 7.7 Precipitation Deficit (P_{def}) Data

	Cottonwoods	
	mm/day	**in/month***
January	-1.39	-1.70
February	-0.17	-0.19
March	0.11	0.13
April	0.38	0.45
May	1.63	1.99
June	3.91	4.62
July	5.44	6.64
August	4.47	5.46
September	2.32	2.74
October	-0.54	-0.66
November	-3.01	-3.56
December	-2.68	-3.27

* Calculated value (ET_{Idaho} data in mm/day / 25.4 in/mm ***** #days in month)

Table 7.8 Irrigation Water Requirements (IWR)* of Cottonwoods (inches/acre)

Month	IWR
May	2.34
June	5.43
July	7.81
August	6.42
September	3.22
Total	**25.23**

*Based on ET data from http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137 for cottonwoods and 85% irrigation efficiency.

7.1.4 Native Conifer Forest

Using the approach for calculating the IWR for native conifer forests recommended in the DEQ document titled "Guidance for Forested/Poplar Site Nutrient and Hydraulic Loading", the proposed native conifer forested area (HMU 9) mean precipitation deficit and IWR are as follows based an assumption that the site is covered by 80% native conifers and 20% understory (KPSD, 2012):

Table 7.9 Precipitation Deficit (P_{def}) Data

Month	Orchards (80%) Precipitation Deficit (P_{def}) Data		Grass Pasture-high main. (20%) Precipitation Deficit (P_{def}) Data		Composite P_{def}		IWR (85% eff.)
	mm/day	in/month	mm/day	in/month	mm/day	in/month	in/month
January	-0.35	-0.43	0.01	0.01	-0.28	-0.34	
February	0.09	0.10	0.06	0.07	0.08	0.09	
March	0.40	0.49	0.11	0.13	0.34	0.42	
April	0.83	0.98	0.93	1.10	0.85	1.00	
May	1.54	1.88	2.25	2.75	1.68	2.05	2.42
June	4.75	5.61	3.32	3.92	4.46	5.27	6.20
July	8.78	10.72	4.90	5.98	8.00	9.77	11.49
August	7.97	9.73	4.19	5.11	7.21	8.80	10.36
September	4.54	5.36	2.28	2.69	4.09	4.83	5.68
October	0.81	0.99	-0.61	-0.74	0.53	0.64	
November	-2.18	-2.57	-2.02	-2.39	-2.15	-2.54	
December	-1.48	-1.81	-0.27	-0.33	-1.24	-1.51	
						Total	**36.15**

*Based on mean ET data from http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137 for Orchard (no cover) and Pasture (high maintenance) and 85% irrigation efficiency.

Table 7.10 Irrigation Water Requirements (IWR)* of Native Conifer Forest (inches/acre)

Month	IWR
May	2.42
June	6.20
July	11.49
August	10.36
September	5.68
Total	**36.15**

7.1.5 Grass Hay Fodder Crop

Table 7.11 Precipitation Deficit (P_{def}) Data

	Grass Hay	
	mm/day	**in/month***
January	-0.02	-0.02
February	0.06	0.07
March	0.1	0.12
April	0.65	0.77
May	2.03	2.48
June	3.83	4.52
July	5.05	6.16
August	3.73	4.55
September	2.53	2.99
October	-0.44	-0.54
November	-2.29	-2.70
December	-0.34	-0.41

* Calculated value (ET_{Idaho} data in mm/day / 25.4 in/mm ***** #days in month)

Table 7.12 Irrigation Water Requirements (IWR)* of Grass Hay (inches/acre)

Month	IWR (inches/acre)
May	2.91
June	5.32
July	7.25
August	5.36
September	3.52
Total	**24.36**

*Based on ET data from http://data.kimberly.uidaho.edu/ETIdaho/stninfo.py?station=108137 for grass hay and 85% irrigation efficiency.

7.2 Nitrogen Loading Rate

Calculation of the net N requirement for the native conifer forest (HMU 9) (DEQ, 2012);

Equation 1 $$N_{rate} = \frac{(N_{uptake} - N_{cr})}{(1 - N_{loss})} = \frac{N_{req}}{(e_f)}$$

where:

N_{rate} = Nitrogen (N) loading rate

N_{loss} = N losses from denitrification and volatilization

e_f = uptake efficiency factor (1 - N_{loss})

N_{uptake} = N net uptake

N_{cr} = N credits

N_{req} = N_{uptake} - N_{cr} = N net requirement

$$N_{rate} = \frac{(N_{uptake} - N_{cr})}{(1 - N_{loss})}$$

Nutrient Uptake Calculations

Condition	**Value** (DEQ, 2012)
Assume similar to Douglas-fir juvenile plantation, < 25 years old; Forest canopy covers 80% of the site	88 lbs./ac N uptake (**Error! Reference source not found.**)
Partial herbaceous understory (20% coverage)	15 lbs./ac N uptake (**Error! Reference source not found.**)
Denitrification/volatilization rate	33%
Assume no appreciable change in soil storage from initial time of recycled water application to the end of permit cycle **(N_{cr} = 0)**.	0 lbs. N/ac credit

The values are then substituted into Equation 1 to calculate the estimated nitrogen loading rate:

$$N_{rate} = \frac{[(88 + 15) - 0]}{(1 - 0.33)} = 155 \text{ lbs. N/ac-yr.}$$