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Attorney for Petitioner

FILED
TETON COUNTY WYOMING
2022 NOV 28 AM 11: 19
CLERK OF DISTRICT COURT

IN THE DISTRICT COURT OF TETON COUNTY, WYOMING
NINTH JUDICIAL DISTRICT

PROTECT OUR WATER JACKSON HOLE	)	
	)	
Petitioner	)	
v.	)	
	)	
WYOMING DEPARTMENT OF	)	
ENVIRONMENTAL QUALITY	)	Civil No. 18806
	)	
Respondent.	)	

<u>PETITION FOR REVIEW OF AGENCY ACTION AND REQUEST FOR STAY UNDER RULE 12.05</u>

Petitioner, Protect Our Water Jackson Hole (POWJH), by and through its undersigned attorney and pursuant to Rule 12, W.R.A.P., W.S. § 35-11-1001(a) and W.S. § 16-3-114, hereby submits this Petition for Review of Agency Action.

<u>CHALLENGED AGENCY ACTION</u>

The subject of this petition is the unlawful decision of the Wyoming Department of Environmental Quality (WDEQ) authorizing the construction and operation of a commercial wastewater facility under an invalid general permit. The unlawfully-permitted wastewater facility is located on state trust land situated in the headwaters of Fish Creek, a highly protected Class 1 surface water already suffering water quality impairment from *E.coli* discharged from other septic systems in the watershed. A copy of the final agency decision is attached as Exhibit A. W.R.A.P. Rule 12.06(e).

JURISDICTION AND VENUE

Pursuant to Rule 12.03 W.R.A.P., W.S. § 35-11-1001 and W.S. § 16-3-114, venue is appropriate in this court because the commercial wastewater facility unlawfully authorized by WDEQ is located in Teton County, Wyoming. Petitioner is a 501(c)(3) tax exempt, Wyoming non-profit corporation based in Teton County. Its mission is to serve as a powerful advocate for the protection of ground and surface waters in Teton County, Wyoming. POWJH and its predecessor organization, Friends of Fish Creek, have invested heavily in efforts to restore and protect water quality in Fish Creek and its tributaries. POWJH and its members and supporters are adversely affected by the unlawful agency action challenged herein. In accordance with Rule 12.04, this Petition has been filed within 30 days of the October 28, 2022, publication of the final agency decision.

Petitioner has exhausted its administrative remedies because the process for administrative review of a WDEQ decision does not provide for a stay of the action pending appeal.[1] W.S. §35-11-112(a). *Darby v. Cisneros,* 509 U.S. 137 (1993). See DEQ Rules of Practice and Procedure (0008) Chapter 1: General Rules, Section 8, Appeals to Council, reference # 020.0008.1.12032018.

[1] Due to concurrent filing deadlines, Petitioner POWJH has filed a Petition for Review with the EQC to protect its appeal rights under W.S. § 35-11-801(d). See Exhibit B.

SPECIFIC ISSUES OF LAW PRESENTED FOR REVIEW

1) Is the WDEQ's decision to authorize a commercial wastewater system under an invalid general permit lawful under W.S. § 16-3-114(c) and applicable DEQ rules?

2) Did the DEQ violate W.S. § 35-11-801(d) by rendering public participation meaningless when it requested comments from the public after it had already made its decision to authorize the wastewater system?

3) Is the wastewater system authorized by WDEQ under the general permit excluded from coverage under one or more of the exclusions listed in the general permit in Part II.D. Facilities Not Covered Under This Permit?

4) Did the DEQ violate mandatory horizontal setback distances from surface waters and public water supply wells applicable to commercial wastewater systems required by Water Quality Rules and Regulations (WQRR), Chapter 25, Section 19(e), Table 7?

5) Did the DEQ violate WQRR, Chapter 11, Part C, and otherwise act unlawfully under W.S. § 16-3-114(c) by failing to require a demonstration that "any discharge or seepage from the wastewater facility will not cause a violation of the Surface and/or Groundwaters of the State in accordance with Chapter 1, "Quality Standards for Wyoming Surface Waters" and Chapter 8, "Quality Standards for Wyoming Groundwaters"?

6) Did the DEQ's authorization to construct a commercial wastewater system under the general permit violate WQRR Chapter 1 by failing to prevent further degradation of Class 1 surface waters and adjacent wetlands in the Fish Creek drainage?

7) Did the DEQ's authorization to construct a commercial wastewater system in the headwaters of Fish Creek violate the Wyoming Environmental Quality Act, the Clean Water Act, and the implementing regulations of those acts by authorizing a discharge of *E.coli* and other dangerous pollutants directly into the ground and surface water, further exacerbating the existing *E.coli* impairment documented in the DEQ's combined 305(b)/ 303(d) water quality assessment?

BRIEF STATEMENT OF RELEVANT FACTS AND ALLEGATIONS

The WDEQ authorized the construction and operation of a commercial wastewater system to serve a geodesic dome motel complex under construction on state trust land near Teton Village. Under the streamlined permitting process administered by the WDEQ, the issuance of the NOTIFICATION OF COVERAGE, Permit No. 2022-274 (NOC), was purportedly predicated on a general permit issued on June 19, 2017 for a five-year term ending on June 19, 2022. Exhibit C. A "general permit" is a type of permit "issued by the department of environmental quality which authorizes a category or categories of discharges or emissions." W.S. § 16-3-101(b)(xi).

The general permit states: "This permit becomes effective on the date of issuance and shall be reviewed every five years, modified as needed and reissued in accordance with the Wyoming Water Quality Rules and Regulations Chapter 3, Section

7(c)." (Emphasis added). WQRR Chapter 3, Section 12(d) repeats this requirement. Despite this requirement, the WDEQ has not reissued the general permit. The WDEQ explains on its website that "DEQ develops and issues a new general permit every 5 years for each of the four types of facilities listed below. The general permits were last issued June 19, 2017, and are valid until June 19, 2022." See https://deq.wyoming.gov/water-quality/water-wastewater/permitting/general-permits/. (emphasis added). Since the general permit's five year term ended June 19, 2022, the legal basis for the NOC is nonexistent, and the WDEQ's decision approving the septic system, Permit No. 2022-274, must be vacated.

Pursuant to W.S. § 35-11-801(d), "[a]ll department authorizations to use general permits under this section shall be available for public comment for thirty (30) days." The WDEQ invited public comment on October 28, 2022, several weeks after the October 6, 2022, issuance of the NOC. Despite the apparent futility in providing comments on a previously issued NOC, Petitioner submitted comments to the WDEQ. Exhibit D.

Even if, *arguendo,* the general permit can somehow be considered valid beyond its June 19, 2022, expiration, it still does not provide the underlying legal authority to support the issuance of the NOC. The applicability of any of the eight exclusions listed in Part II.D would remove the NOC from coverage; in this case, no fewer than five apply:

1) Systems that do not meet the definition of a small wastewater facility;
2) Class V injection wells and facilities regulated by the Underground Injection Control Program under DEQ's WQRR, Chapter 27;

3) Small wastewater facilities regulated by local governments in accordance with W.S. § 35-11-304;

4) Facilities that have or are required to obtain an individual permit in accordance with WQRR Chapter 3; and,

5) Facilities that do not meet the minimum design and construction standards of WQRR Chapter 25.

As discussed below, every single one of the above-listed exclusions apply here, and each independently removes the NOC from coverage under the general permit, as follows.

1) Due to its complex hydrologic and engineering needs, the system is not, by definition, a small wastewater system. W.S. § 35-11-103(c)(ix).

2) When calculated correctly, combined design flows for this "geodome" hotel complex, welcome center and two employee housing units exceed 2,000 gallons per day, triggering a requirement for an individual Class V discharge permit under WQRR Chapter 27.

3) Small wastewater systems in Teton County are regulated by the county under a delegation agreement with the WDEQ (W.S. § 35-11-304), which removes the contested wastewater facility from coverage under the general permit. See Exhibit E.

4) The advanced engineering of the wastewater system designed by WDEQ, combined with complex hydrology of the area and significant environmental constraints, which include groundwater flowing on the surface at various time of the year and existing

E.coli impairment in the Class 1 surface waters at the headwaters of Fish Creek, requires the use of an individual permit.

5) As shown in the attached engineer's drawings (exhibit F), the wastewater facility fails to meet minimum design and construction standards, including not complying with the minimum mandatory setback distances from surface water (100') and public water supply wells (500'). WQRR Chapter 25, Section 19(e) Table 7.

Beyond the lack of coverage under the general permit, the WDEQ failed to provide any evidence that the demonstration required by WQRR Chapter 11, Part C, Section 25 (protection of ground and surface water quality) was made. The DEQ's failure to require compliance with this rule is a violation of Chapter 11 and therefore unlawful under W.S. § 16-3-114(c).

The contested wastewater facility is located in the headwaters of Fish Creek, a WDEQ-designated Class 1 surface water protected by strict anti-degradation requirements. Pursuant to Chapter 1, Appendix A, the entire Fish Creek drainage is designated Class 1, along with all adjacent wetlands. The regulatory objective with respect to Class 1 surface waters is to protect and maintain water quality that existed at the time of designation which, with respect to Fish Creek, is over forty years ago. The DEQ's October 6, 2022, authorization to construct this facility without proper environmental safeguards violates WQRR Chapter 1 by failing to prevent degradation in Class 1 surface waters and adjacent wetlands in the Fish Creek drainage.

Finally, the authorization of a commercial septic system in Fish Creek violates the Wyoming Environmental Quality Act and its implementing regulations by introducing *E.coli* and other pathogens into the ground and surface water further exacerbating an existing *E.coli* impairment documented in the DEQ's combined 305(b)/303(d) water quality assessment (2020). The WDEQ's decision allowing a discharge of *E.coli* and other dangerous pollutants into a tributary of Fish Creek is arbitrary and capricious and unlawful agency action within the meaning of W.S. § 16-3-114(c).

COMPLIANCE WITH W.R.A.P. RULE 12.04

A transcript was not produced as there was no testimony given.

REQUEST FOR STAY

In accordance with W.R.A.P. Rule 12.05, and for the reasons stated above, Petitioners request that this court stay the implementation of DEQ's NOTIFICATION OF COVERAGE—Permit No. 2022-274 pending a final determination regarding the allegations set forth herein.

Respectfully submitted this 28th day of November, 2022.

Dan Heilig

Daniel F. Heilig
9 Juniper Dr.
Lander, WY 82520
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heiliglaw@gmail.com

Attorney for Petitioner Protect Our Water Jackson Hole

APPENDIX

Exhibit A— Final Decision: NOTIFICATION OF COVERAGE, Permit No. 2022-274

Exhibit B— Petition for Review to Environmental Quality Council

Exhibit C— General Permit

Exhibit D— POWJH comment letter to DEQ

Exhibit E— Teton County/DEQ Delegation Agreement executed under W.S. § 35-11-304

Exhibit F— Engineer's drawings

CERTIFICATE OF SERVICE

This is to certify that on the 28th day of November, 2022, a true and correct copy of the foregoing Petition for Review of Agency Action was served by U.S. Mail, postage prepaid, and by email to the following:

Todd Parfitt, Director
Department of Environmental Quality
200 West 17th St.
Cheyenne, WY 82002
todd.parfitt@wyo.gov

Dan Heilig

From: Dan Heilig wyst1300@gmail.com
Subject: NOTIFICATION OF COVERAGE
Date: November 4, 2022 at 9:31 PM
To: Dan Heilig wyst1300@gmail.com

Department of Environmental Quality

To protect, conserve, and enhance the Quality of Wyoming's Environment for the benefit of current and future generations.

DEQ

Mark Gordon, Governor — Todd Parfitt, Director

NOTIFICATION OF COVERAGE

October 6, 2022

Oscar Covarrubias & Ryan Thomas
Mountain Ventures
784 Resort Drive
Midvale, UT 84049

RE: Teton Village Resort - Onsite Wastewater System Improvements Project, Permit No. 2022-274, **Teton County**

Dear Mr. Covarrubias & Mr. Thomas:

The Department of Environmental Quality (DEQ) has reviewed and approved the above application for coverage under the small wastewater facility general permit at NE ¼ SE ¼, Section 36, T42N, R117W (43.560 Lat / -110.823 Long) in accordance with Chapter 3, Section 7 of the Wyoming Water Quality Rules and Regulations (WQRR) and hereby issues this Notice of Coverage (NOC).

This NOC involves constructing an onsite septic system and pressure-dosed mounded septic system to serve thirteen glamping sites and an office building.

DEQ authorizes you to construct, install, or modify the facility in accordance with Chapter WQRR Chapter 25, the general permit, and the materials submitted in your application package. Please note Part V, Standard Permit Conditions, of the general permit, particularly the Right to Access and Reporting Requirements sections. A copy of the general permit is available on the DEQ webpage: http://deq.wyoming.gov/wqd/permitting-2/resources/general-permits-2/.

If you have any questions, please contact James Brough at 307-335-6961 or james.brough@wyo.gov.

Sincerely,

James Brough

James Brough, P.E.
Northwest District Engineer
WDEQ/WQD

Ec: IMS, Cheyenne (pdf)
Robert Rousselle, Ensign Engineering & Land Surveying, 45 West 10000 South, Suite 500, Sandy, UT 84070

EXHIBIT
A

BEFORE THE ENVIRONMENTAL QUALITY COUNCIL
OF THE STATE OF WYOMING

IN THE MATTER OF THE APPEAL OF PROTECT OUR WATER JACKSON HOLE FROM NOTIFICATION OF COVERAGE— PERMIT NO. 2022-274	))))	Docket No. ________

APPEAL OF NOTIFICATION OF COVERAGE - Permit No. 2022-274

Protect Our Water Jackson Hole (Petitioner), by and through its undersigned attorney, submits this Notice of Appeal and Petition challenging the NOTIFICATION OF COVERAGE Teton Village Resort—Onsite Wastewater System Improvements Project, Permit No. 2022-274, Teton County, issued by the Department of Environmental Quality/Water Quality Division dated October 6, 2022, for failure to comply with the terms of the General Permit and violations of the Wyoming Environmental Quality Act and the DEQ's water quality rules and regulations.

I. Name and Address of Petitioner and Petitioner's Attorney.

Protect Our Water Jackson Hole
P.O. Box 1014
Wilson, WY 83014

Petitioner is represented in this matter by Daniel Heilig, 9 Juniper Drive, Lander, WY 82520. Correspondence and information related to this Petition should be served on the undersigned counsel at the Lander address shown above.

II. Action Upon Which Hearing is Requested. Petitioner hereby appeals the issuance of the "NOTIFICATION OF COVERAGE, Teton Village Resort - Onsite Wastewater System Improvements Project, Permit No. 2022-274, Teton County, WY" issued by James Brough, P.E., Northwest District Engineer, Wyoming Department of Environmental Quality/Water Quality Division, dated October 6, 2022. Notification of Permit No. 2022-274 was published on the WDEQ's website on October 28, 2022.

III. Statement of Facts and Specific Allegations.

Petitioners have standing to appeal this decision

1. W.S. § 35-11-801(d) provides that "[a]ny aggrieved party may appeal the authorization as provided in this act."

2. W.S. § 35-11-112(a)(iv) authorizes the Environmental Quality Council (EQC) to "[c]onduct hearings in any case contesting the grant, denial, suspension, revocation or renewal of any permit, license, certification or variance authorized or required by this act."

3. W.S. § 35-11-112(c)(ii) authorizes the EQC to "[o]rder that any permit, license, certification or variance be granted, denied, suspended, revoked or modified."

EXHIBIT
B

4. Protect Our Water Jackson Hole (POWJH) is a 501(c)(3) tax exempt, non-profit corporation registered in the State of Wyoming. Its mission is to serve as a powerful advocate for the protection of ground and surface waters in Teton County, Wyoming.

5. POWJH and its predecessor organization, Friends of Fish Creek, have invested heavily in efforts to restore and protect water quality in Fish Creek and its tributaries.

6. The operation of the onsite wastewater system contested herein will discharge pollutants —including E.coli— to Fish Creek and its tributaries, diminishing the use and enjoyment that Petitioners and its members and supporters enjoy and appreciate.

7. The WDEQ/WQD has determined that Fish Creek is impaired by concentrations of E.coli that exceed the quality standards for primary contact recreation contained in WQRR Chapter 1.

8. High concentrations of E.coli that exceed applicable water quality standards have diminished and negatively affected Petitioners' use and enjoyment of Fish Creek.

9. POWJH's members and supporters are adversely affected by the above-referenced permit and by the activities authorized thereunder, including but not limited to the construction and operation of a raised mound, pressure dosed commercial septic system in the headwaters of Fish Creek, a DEQ-designated Class 1 surface water that is heavily used year-round by Teton County residents and visitors alike for a variety of recreational, scenic, and aesthetic purposes.

The Temporary Use Permit

10. The Office of State Lands and Investments (OSLI) issued a Temporary Use Permit (TUP-03345) to Utah-based Mountain Ventures/Basecamp Hospitality, LLC ("Basecamp") on June 24, 2022, authorizing Basecamp to construct and operate "11 low-impact accommodations for single and multi-night vacation rental."

11. According to Basecamp's proposal to the OSLI, its development will include a "shower house trailers, a welcome center, retail/rental space, food offering, sauna, storage and maintenance shed, and small staff living quarters."

12. The TUP authorizes a number of other "improvements" on the site, including a septic system and leach field. Engineering drawings obtained by Petitioner show that a Public Water Supply well is planned on the property.

13. This complex of eleven geodesic domes and three prefabricated wood frame buildings is called Teton Village Resort, apparently a reference to the Jackson Hole Mountain Resort which lies a few miles to the north on Highway 390, the Teton Village Road.

14. Paragraph 8 of the TUP's General Conditions expressly requires Basecamp Hospitality, LLC, as the permittee, to "observe all state, federal and local laws and regulations."

15. The TUP issued by the OSLI granted the permittee the right to temporary occupancy and use of a small portion of land (OSLI Site 9) on a state trust section but expressly did not grant the permittee unfettered rights to construct and operate its geodesic dome hotel complex without permits required by federal, state and local regulations.

16. Basecamp began construction on the site soon after receiving the TUP, which included clearing and grading several acres and the partial installation of a raised-mound commercial wastewater system without first obtaining necessary permits and authorizations from the State of Wyoming and Teton County.

17. At some point following the commencement of construction activities on the parcel, the DEQ initiated conversations with Basecamp which ultimately led to the issuance of the contested permit in this dispute, Permit No. 2022-274.

18. In the process of reviewing Basecamp's September 16, 2022, application for a permit to construct an onsite wastewater system, the DEQ determined that the system is a commercial, i.e., non-residential, system, which is defined in the DEQ's rules as:

> (c) "Commercial/industrial waste and wastewater facilities" means any facility not defined as a municipal or single family residence facility." See WQRR Chapter 11, Section 4.

The General Permit relied on by DEQ has expired

19. The contested authorization, Permit No. 2022-274, was issued under the following general permit:

GENERAL PERMIT

AUTHORIZATION TO CONSTRUCT, INSTALL, MODIFY OR OPERATE A SMALL WASTEWATER FACILITY IN ACCORDANCE WITH WYOMING WATER QUALITY RULES AND REGULATIONS CHAPTER 3, CHAPTER 11, AND CHAPTER 25.

20. The general permit was signed by the Administrator of the Water Quality Division on June 17, 2017, and by the Director of the DEQ on June 19, 2017.

21. The signature page of the general permit states: "This permit becomes effective on the date of issuance and shall be reviewed every five years, modified as needed and **reissued** in accordance with the Wyoming Water Quality Rules and Regulations Chapter 3, Section 7(c)." (emphasis added).

22. Chapter 3, section 12(d) of the DEQ's Water Quality Rules and Regulations (WQRR) provides that: "The Director shall review each general permit at least every five (5) years from the date of issuance, make modifications as needed, **and reissue** the general permit." (emphasis added).

23. The general permit relied upon by the DEQ to support the issuance of Permit No. 2022-274 has not been reissued.

24. Permit No. 2022-274 was issued on October 6, 2022, several months after the June 19, 2022, expiration of the general permit.

25. The DEQ maintains a website where it provides important and useful information to the public. A page on the website maintained by the Water Quality Division's water and wastewater section states that: "DEQ develops and issues a new general permit every 5 years for each of the four types of facilities listed below. The general permits were last issued June 19, 2017, and are valid until June 19, 2022." See https://deq.wyoming.gov/water-quality/water-wastewater/permitting/general-permits/. (emphasis added).

26. A permit that is valid until June 19, 2022, is invalid thereafter, and may not be used to authorize the system approved in Permit No. 2022-274.

27. The general permit that purportedly provided the basis for the issuance of the NOTIFICATION OF COVERAGE, Permit No. 2022-274 has expired and is therefore invalid, and any authorization made under the expired general permit is also invalid.

28. Without proper authorization from the DEQ, the onsite commercial wastewater system constitutes an un-permitted discharge of pollutants into ground and surface waters of the state in violation of the Wyoming Environmental Quality Act, § 35-11-301(a).

Violations of the terms and conditions of the general permit

29. Even if, for purposes of argument only, the general permit somehow remains valid after its June 19, 2022, expiration, the DEQ violated multiple terms and conditions of the general permit in the course of authorizing Permit No. 2022-274.

30. The DEQ improperly and unlawfully determined that it could issue Permit No. 2022-274 under the general permit despite terms and conditions in the general permit that explicitly exclude from coverage the type of wastewater system approved in Permit No. 2022-274.

- Systems that do not meet the definition of a small wastewater facility;
- Class V injection wells and facilities regulated by the Underground Injection Control Program under DEQ's WQRR, Chapter 27;
- Small wastewater facilities regulated by local governments in accordance with W.S. § 35-11-304;
- Facilities that have or are required to obtain an individual permit in accordance with WQRR Chapter 3; and,
- Facilities that do not meet the minimum design and construction standards of WQRR Chapter 25; or
- Facilities that should be covered under an individual permit.

31. The onsite system approved by DEQ in Permit No. 2022-274 is not a small wastewater system and therefore requires an individual permit.

32. The Wyoming Environmental Quality Act defines a small wastewater system to mean: "(ix) any sewerage system, disposal system or treatment works having simple hydrologic and engineering needs which is intended for wastes originating from a single residential unit serving no more than four (4) families or which distributes two thousand (2,000) gallons or less of domestic sewage per day;" W.S. § 35-11-103(c).

33. The wastewater system approved by DEQ under the general permit, Permit No. 2022-274, is an unconventional, raised-mound, pressure dosed system requiring advanced engineering and a continuous electric power supply. The system is located in the headwaters of Fish Creek, an E.coli impaired Class 1 surface water, in an area with a shallow water table where groundwater flows on the surface at certain times of year. It is clearly not a system with "simple hydrologic and engineering needs." Reliance on the general permit to authorize an unconventional system utilizing a raised sand mound and pressure dosing that requires a continuous electricity supply is unlawful under the Act, its implementing regulations, and the general permit itself.

34. When design flows are properly calculated, the septic system approved by Permit No. 2022-274 exceeds 2,000 gallons per day, triggering a requirement for an individual UIC Class V permit under WQRR Chapter 27.

35. In reaching its conclusion that Basecamp's wastewater facility is a "small" wastewater facility, the DEQ relied on design flows contained in WQRR Chapter 25, Section 5, Table 2, which displays "Non-Residential Wastewater Design Flow Rates." Based on an incomplete and erroneous understanding of the nature of water use and effluent flows at the geodesic dome hotel complex, the DEQ determined that the appropriate analog was "campground." Using the design flows displayed in Table 2, the DEQ then calculated that total effluent flows would be less than 2,000 gallons per day (gpd). As specified in W.S. §35-11-103(c), flows below 2,000 gpd are by definition considered small wastewater facilities.

36. The geodesic dome hotel complex under construction on the site is by definition not a "campground" and the DEQ's classification as such for purposes of calculating wastewater design flow rates is incorrect, and unlawful. See WQRR Chapter 11, Section 4(b).

37. The proper analog for this geodome hotel complex is "Motel/Hotel/Resort." Chapter 25, Section 5, Table 2. The higher design flows for these types of establishments —140 gpd per bedroom— coupled with two employee housing units and the guest welcome center places the total in excess of 2,000 gpd.

38. Commercial wastewater systems that produce effluent exceeding 2,000 gpd are regulated as U.I.C. Class V injections under WQRR Chapter 27 and require an individual permit. Class V facilities, and facilities with design flow rates exceeding 2,000 gpd, may not be authorized under the GENERAL PERMIT, Part II.D.—Facilities Not Covered Under This Permit. The absence of a proper permit for the Basecamp wastewater system is unlawful, and constitutes a violation of W.S. § 35-11-301, and WQRR Chapters 3, 11, 25 and 27.

39. The Wyoming DEQ has granted to the Teton County Board of County Commissioners the authority to regulate small wastewater systems in Teton County pursuant to a delegation agreement under W.S. § 35-11-304. The plain terms of the general permit prohibit the DEQ from authorizing small wastewater systems in areas where small wastewater systems are regulated by a county government under a delegation agreement executed pursuant to W.S. § 35-11-304.

40. WQRR Chapter 11 contains design and construction standards for sewerage systems, treatment works, disposal systems and other facilities capable of causing or contributing to pollution, and standards for mobile home park and campground sewerage and public water supply distribution systems.

41. Part C of Chapter 11 contains additional specific requirements for commercial/industrial waste and wastewater facilities, including those specified in Section 25, quoted below:

> "This part contains the minimum standards for the design and construction of commercial/ industrial wastewater facilities. The applicant shall demonstrate to the Administrator that any discharge or seepage from the wastewater facility will not cause a violation of the Surface and/ or Groundwaters of the State in accordance with Chapter 1, "Quality Standards for Wyoming Surface Waters" and Chapter 8, "Quality Standards for Wyoming Groundwaters." Due to the wide variety of wastes, wastewater and site conditions, the latest available scientific information shall be used to demonstrate that violations will not occur."

42. The DEQ's October 6, 2022, authorization under the general permit fails to ensure that "any discharge or seepage from the wastewater facility will not cause a violation of the Surface and/ or Groundwaters of the State in accordance with Chapter 1, "Quality Standards for Wyoming Surface Waters" and Chapter 8, "Quality Standards for Wyoming Groundwaters." The DEQ's failure to require compliance with this rule is a violation of Chapter 11 and otherwise is arbitrary and capricious, unlawful, and an abuse of discretion within the meaning of W.S. § 16-3-114(c).

The system approved by DEQ fails to meet required setbacks

43. Mandatory setbacks for commercial facilities are specified in WQRR Chapter 25, Section 19. "Commercial and Industrial Wastes and/or Domestic Wastes Greater Than 2000 Gallons per Day." Section 19 provides that: "(e) The minimum horizontal setback distances (in feet) shown in Table 7 shall be maintained for commercial and industrial wastes and/or wastes greater than 2000 gallons per day but less than 10,000 gallons per day." See Table 7. Minimum Horizontal Setbacks for Commercial and Industrial Wastes in Feet. The setback prescribed by the rule from surface water is 100 feet; from a public water supply well, the minimum setback is 500 feet.

44. Engineering drawings completed for Basecamp show that the raised-mound absorption field is 50 feet or less from a pond, well within the 100 foot setback from surface water required for commercial septic systems, and potentially within the 50 foot setback required for residential wastewater systems under WQRR Chapter 25, Section 7, Table 4.

45. Field observations confirm that the raised mound septic system has been constructed within the mandatory setback from surface waters, in violation of Chapter 25, Section 19.

46. Engineering drawings completed for Basecamp show that the raised-mound pressure dosed absorption field is approximately 280 feet from a public water supply well planned for the site, considerably less than the 500 feet separation distance required by DEQ's rules, in violation of Chapter 25, Section 19.

Violations of ground and water quality standards

47. Basecamp's wastewater facility is under construction in the headwaters of Fish Creek, a WDEQ-designated Class 1 surface water. Pursuant to Chapter 1, Appendix A, the entire Fish Creek drainage is designated Class 1, along with all adjacent wetlands.

48. A number of studies and reports show a hydrologic connection between ground and surface water in the Fish Creek drainage.

49. The regulatory objective for Class 1 surface waters is to protect and maintain water quality that existed at the time of designation. Chapter 1, Section 4 and Section 7.

50. The DEQ's October 6, 2022, authorization to permit the construction of the commercial wastewater facility without proper safeguards and best management practices violates WQRR Chapter 1 by failing to protect Class 1 surface waters and adjacent wetlands in the Fish Creek drainage.

51. The commercial septic system authorized by DEQ in Permit No. 2022-274 will introduce a variety of pollutants into ground and surface water and adjacent wetlands in the headwaters of Fish Creek, including E.coli, further exacerbating an existing E.coli impairment documented in the DEQ's combined 305(b)/303(d) water quality assessment (2020). The WDEQ's decision

allowing a discharge of E.coli and other dangerous pathogens into a tributary of Fish Creek is a violation of the Wyoming Environmental Quality Act and is unlawful agency action within the meaning of W.S. § 16-3-114(c).

IV. Request for Hearing. Petitioner hereby requests a hearing before the Environmental Quality Council and requests that the Council reverse and vacate the DEQ's decision to issue Permit No. 2022-274, and grant the Petitioner such relief as they are entitled to by law or regulation.

Respectfully submitted this 21st day of November, 2022.

Daniel Heilig (WSB No. 5-2872)

____
9 Juniper Dr.
Lander, WY
Phone: (307) 206-4144
Email: <heiliglaw@gmail.com>

Attorney for Petitioner Protect Our Water Jackson Hole

CERTIFICATE OF SERVICE

I certify that on the _________ day of November, 2022, I served a true and correct copy of the foregoing by depositing the same in the U.S. Mail, Certified, Return Receipt Requested, postage prepaid and addressed to:

Todd Parfitt, Director
Department of Environmental Quality
200 West 17th St.
Cheyenne, WY 82002

Basecamp Hospitality, LLC
c/o Ryan Thomas
1616 Goosenest Drive
Payson, UT 84651

Cogency Global, Inc.
Registered Agent
1912 Capitol Ave., Suite 500
Cheyenne, WY 82001

____
Dan Heilig

Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

DEQ

Matthew H. Mead, Governor

Todd Parfitt, Director

GENERAL PERMIT

AUTHORIZATION TO CONSTRUCT, INSTALL, MODIFY OR OPERATE A SMALL WASTEWATER FACILITY IN ACCORDANCE WITH WYOMING WATER QUALITY RULES AND REGULATIONS CHAPTER 3, CHAPTER 11, AND CHAPTER 25

In compliance with the provisions of the Wyoming Environmental Quality Act and Wyoming Water Quality Rules and Regulations Chapters 3, 11, and 25, the owner may construct, install, modify or operate a small wastewater facility in accordance with the provisions of this permit. The owner of said facility shall submit the information required by Part IV of this permit in order to provide notice of intent to be covered under this permit. Owners are covered by this general permit when the department issues a written authorization of acceptance of coverage to the owner. Upon receipt of notice of coverage, the owner is authorized to construct, install or modify in accordance with this permit. This permit consists of this page, all pages of the Preamble, Table of Contents, and Parts I-V.

This permit becomes effective on the date of issuance and shall be reviewed every five years, modified as needed and reissued in accordance with Wyoming Water Quality Rules and Regulations Chapter 3, Section 7 (c).

Authorizations for coverage under this general permit are for the life of the facility unless suspended or revoked in accordance with Wyoming Water Quality Rules and Regulations Chapter 3, Section 16. Coverage under this general permit shall be transferred to a new owner in accordance with Wyoming Water Quality Rules and Regulations Chapter 3, Section 12.

Kevin Frederick
Administrator - Water Quality Division

June 17, 2017
Date

Todd Parfitt
Director - Department of Environmental Quality

June 19, 2017
Date

EXHIBIT
C

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PREAMBLE

The purpose of this preamble is to provide the owner with some helpful suggestions and practical advice for meeting the requirements of this general permit.

Written notification of acceptance of coverage under this general permit authorizes the owner to construct, modify or operate a facility in accordance with the terms and conditions of this general permit. Any modification to the terms and conditions of this general permit must be approved in accordance with Wyoming Water Quality Rules and Regulations Chapter 3, Section 11 (b). The owner-operator is required to operate the facility in accordance with the statements, representations, and procedures presented in the application, supporting documents and this permit.

This general permit should expedite the permitting process and allow responsible parties to construct, install or modify a small wastewater facility as soon as possible. In order to obtain approval of coverage under this general permit, the owner is responsible for completing the application and the Design Information Package. Coverage under this general permit is provided when the department issues a Notification of Coverage. The basic information that the owner is required to submit is outlined in Part IV. If you need assistance in completing the information required by Part IV, please contact the Water Quality Division at 307-777-7781 for the appropriate Water and Wastewater Program District Office contact information.

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Part I. DEFINITIONS

A. "Administrator" means the Administrator of the Water Quality Division, Wyoming Department of Environmental Quality or the administrator's authorized designee.

B. "Domestic sewage" means waste and wastewater that is primarily from human or household operations that is discharged to or otherwise enters a treatment works.

C. "General Permit" means a permit issued by the director to construct, install, or modify or operate all facilities of a specific type located within the State of Wyoming where coverage for each facility of that type can be permitted thereunder. The administrator or the administrator's designee has the authority to issue an acceptance of coverage under the permit.

D. "Groundwater" means subsurface water that fills available openings in rock or soil materials such that they may be considered water saturated under hydrostatic pressure.

E. "Individual Permit" means a permit issued by the director to construct, install, modify, or operate a specific facility at a certain location or site.

F. "Owner" means the permittee or the party, person, corporation or other entity that has control of the facility. The owner is responsible for ensuring compliance with all conditions of the permit.

G. "Small wastewater system" means any sewerage system, disposal system or treatment works having simple hydrologic and engineering needs that is intended for wastes originating from a single residential unit serving no more than four families or that distributes 2,000 gallons or less of domestic sewage per day.

H. "Source water protection program" means a program developed and adopted in accordance with the Wyoming's Source Water Assessment and Protection Program in order to protect designated areas from contaminants that may have any adverse effects on the health of persons under the Safe Drinking Water Act, Section 1428(b).

I. "Water quality management plan" means a plan to address water quality that is developed and adopted in accordance with the Wyoming Water Quality Management Planning Continuing Planning Process.

J. "Wellhead protection program" means a program developed and adopted in accordance with the Wyoming's Wellhead Protection Program in order to protect designated areas from contaminants that may have any adverse effects on the health of persons, Safe Drinking Water Act, Section 1428(b).

Part II. COVERAGE UNDER THIS PERMIT

A. Facilities Covered Under This Permit

In accordance with Water Quality Rules and Regulations, Chapter 3, Section 7 (a), the following may be provided coverage under this permit:

1. Small wastewater facilities located in areas not regulated by local governments in accordance with Wyoming Statute (W.S.) § 35-11-304.

2. Facilities that meet the minimum design and construction standards of Wyoming Water Quality Rules and Regulations Chapters 11 or 25 or a DEQ approved policy developed in accordance with Wyoming Water Quality Rules and Regulations Chapter 25.

3. The facility receives immediate coverage under this permit when the Administrator or a designee provides written notice to the owner that the materials submitted in accordance with Part IV of this general permit have been approved.

B. Construction and Operation in Compliance with Permit

In accordance with Water Quality Rules and Regulations Chapter 3, Section 11, the permittee shall conduct the construction and operation of any facility permitted under this general permit according to statements, representations, and procedures presented in the application and the terms and conditions of the permit.

C. Denial, Suspension or Revocation of Coverage Under a General Permit

1. Coverage under this general permit may be denied for any of the reasons listed in Water Quality Rules and Regulations of Chapter 3, Section 14. These reasons include, but are not limited to:

   a. The application is incomplete or does not meet applicable minimum design and construction standards as specified by Wyoming Water Quality Rules and Regulations.

   b. The project, if constructed, will cause a violation of applicable state surface or groundwater standards.

2. Coverage under this general permit may be suspended or revoked before construction is completed for any of the reasons listed in Water Quality Rules and Regulations Chapter 3, Section 16. These reasons include, but are not limited to:

   a. Noncompliance with the terms of the permit;

   b. Unapproved modifications in design or construction;

   c. False information submitted in the application.

D. Facilities Not Covered Under This Permit

The following are not provided coverage under this permit:

1. Systems that do not meet the definition of a small wastewater facility.

2. Class V injection wells and facilities regulated by the Underground Injection Control Program under Wyoming Water Quality Rules and Regulations Chapter 27.

3. Small wastewater facilities regulated by local governments in accordance with W.S. § 35-11-304.

4. Facilities that have or are required to obtain an individual permit in accordance with Wyoming Water Quality Rules and Regulations Chapter 3.

5. Facilities that do not meet the minimum design and construction standards of Wyoming Water Quality Rules and Regulations Chapter 25.

6. Facilities and systems not specifically covered by Wyoming Water Quality Rules and Regulations Chapter 11 or Chapter 25 or approved by a written policy and that are required to be evaluated and permitted in accordance with Wyoming Water Quality Rules and Regulations Chapter 25, Section 6.

7. Facilities that are in conflict with a DEQ approved water quality management plan, wellhead protection program or source water protection program.

8. Facilities that require an exemption from an approved water quality management plan, wellhead protection program or source water protection program.

E. Facilities that May Require an Individual Permit

The Administrator or his designee may require an owner applying for coverage under a general permit to obtain an individual permit if the information submitted in accordance with Part IV indicates that a general permit would not be protective of surface or groundwater standards and public health.

Part III. PERMITTING PROCEDURES

A. Application Process

1. Any person, corporation, or other entity that desires to be covered (permitted) under the conditions of this general permit shall submit three copies of the application package described in Part IV. The application package shall be submitted to the appropriate district office.

2. The application package will be processed in accordance with the procedures outlined in Wyoming Water Quality Rules and Regulations Chapter 3, Section 9 (b).

B. Change of Ownership

When the ownership of a facility is to change, the new owner shall submit permit transfer application forms to the Administrator in accordance with Wyoming Water Quality Rules and Regulations Chapter 3, Section 12 (c). The new owner must accept and agree to comply with all provisions of the general permit.

Part IV. MINIMUM APPLICATION PACKAGE CONTENT

The owner shall complete and submit the following when applying for coverage under this general permit:

A. Application for Permit To Construct, Install, Modify Or Operate Facilities , located on the Water Quality Division website, pursuant to W.S. § 35-11-301 (a) (iii) or (iv); and

B. General Instructions and Design Instructions and Worksheets located on the Water Quality Division website.

C. All plans, specifications, and reports shall be sealed, signed, and dated by a licensed professional engineer or licensed professional geologist in accordance with Wyoming Water Quality Rules and Regulations Chapter 3, Section 7(g).

Note: If the owner needs assistance in completing the application package, please contact the appropriate district office.

Part V. STANDARD PERMIT CONDITIONS

A. Property Rights

The issuance of this permit does not convey any property rights of any sort, nor any exclusive privileges, nor does it authorize any injury to neither private property nor any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.

B. Right to Access

The owner applicant shall allow DEQ personnel and their invitees to enter the premises where the facility is located, or where records are kept under the conditions of this permit, and collect resource data as defined by W.S. § 6-3-414, inspect and photograph the facility, collect samples for analysis, review records, and perform any other function authorized by law or regulation. The owner applicant shall secure and maintain such access for the duration of the permit.

If the facility is located on property not owned by the owner applicant, the owner-applicant shall also secure and maintain from the landowner upon whose property the facility is located permission for DEQ personnel and their invitees to enter the premises where a regulated facility is located, or where records are kept under the conditions of this permit, and collect resource data as defined by W.S. § 6-3-414, inspect and photograph the facility, collect samples for analysis, review records, and perform any other function authorized by law. The permittee shall secure and maintain such access for the duration of the permit.

If the facility cannot be directly accessed using public roads, the owner-applicant shall also secure and maintain permission for DEQ personnel and their invitees to enter and cross all properties necessary to access the facility. The permittee shall secure and maintain such access for the duration of the permit.

The owner applicant shall maintain in its records documentation that demonstrates that the permittee has secured permission for DEQ personnel and their invitees to access the permitted facility, including (i) permission to access the land where the facility is located, (ii) permission to collect resource data as defined by W.S. § 6-3-414, and (iii) permission to enter and cross all properties necessary to access the facility if the facility cannot be directly accessed from a public road. The owner applicant shall also maintain in its records a current map of the access route(s) to the facility and contact information for the owners or agents of all properties that must be crossed to access the facility. The owner applicant shall ensure that the documentation, map, and contact information are current at all times. The owner applicant shall provide the documentation, map, and contact information to DEQ personnel upon request. On closure of a facility, the owner-applicant shall maintain such records for a period of five years.

C. Signatory Requirements

All applications, reports, and other information submitted to the administrator shall be signed by the owner or a person who meets the following requirements:

1. For a corporation -- by a principal executive officer of at least the level of vice-president;

2. For a partnership or sole proprietorship -- by a general partner or the proprietor, respectively;

3. By a duly authorized representative for any of the above. A person is a duly authorized representative only if:

   a. the authorization is made in writing by one of the described principals;

   b. the authorization specifies either an individual or position having responsibility for the overall operation of the regulated site or activity; and,

   c. if an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility or site, a new authorization must be submitted to the administrator prior to or together with any reports or information, to be signed by an authorized representative.

D. Duty to Comply

The owner must comply with all conditions of this permit and is responsible for ensuring any subcontractors, employees or other persons associated with the construction installation, modification or operation of the facility comply with all conditions of this permit.

E. Penalties for Falsification of Reports and Monitoring Systems

Wyoming Environmental Quality Act Article 9 provides that any persons who knowingly makes any false statement, representation or certification in any application, report, plan or other document filed or required to be maintained under the act or who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method shall, upon conviction, be fined not more than $10,000 or imprisoned for not more than one year or both.

F. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for an owner in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

G. Duty to Provide Information

The owner shall furnish to the Administrator within a reasonable time, any required information to determine compliance with this permit.

H. Other Information

When the owner becomes aware that he or she failed to submit any relevant facts or submitted incorrect information in any report to the Administrator, he or she shall promptly submit such facts or information.

I. Transfers

This permit is not transferable to any person except after notice to the Administrator in accordance with Wyoming Water Quality Rules and Regulations Chapter 3, Section 12 (c) .

J. State Laws

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the owner from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by Clean Water Act Section 510.

K. Permit Actions

This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the owner operator for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

L. Severability

The provisions of this permit are severable, and if any provisions of this permit, or the application of any provision of this permit to any circumstance, are held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

M. Requirements by Other Agencies

Compliance with the conditions of this permit does not relieve the owner-operator of the necessity to comply with pollution control or other requirements of other state, local, or federal agencies.

N. Limit of DEQ Involvement

Nothing in this permit constitutes an endorsement by the DEQ of the construction or design of the facility. This permit verifies only that the submitted application meets the design and construction standards imposed by Wyoming Water Quality Rules and Regulations Chapter 25. The DEQ assumes no liability for, and does not in any way guarantee or warrant the performance or operation of the permitted facility. The owner and owner are solely responsible for any liability arising from the construction or operation of the permitted facility. By issuing this permit, the state does not waive its sovereign immunity.

O. Reporting Requirements

The owner will notify or provide the appropriate district office of the following:

1. The date construction will begin and the estimated completion date.

2. Any changes or modifications in accordance with Wyoming Water Quality Rules and Regulations Chapter 3, Section 11.

3. The Certification of Completion, located on the Water Quality Division website, shall be submitted within 60 days of construction of the authorized facility. The form shall include the following information:

   a. Date that construction of the facility was completed; and

   b. Date that the facility was placed in operation; and

   c. Certification the facility was constructed in accordance with the terms and conditions of the permit; or

   d. Certification the facility was completed with changes or modifications. Submittal of as-constructed plans and specifications for the system as it was constructed. All modifications or deviations from the authorized plans must be highlighted.

GJT/sg/17-0369

PROTECT OUR WATER
JACKSON HOLE

Transmitted by U.S. Priority Mail — Certified, Electronic Receipt

November 22, 2022

Keenan Hendon
Department of Environmental Quality
Water & Wastewater Program Manager
200 West 17th St.
Cheyenne, WY 82002

Re: POWJH Comments on the Wyoming DEQ's "NOTIFICATION OF COVERAGE" for the Teton Village Resort—Onsite Wastewater System Improvements Project, Permit No. 2022-274, Teton County.

Dear Mr. Hendon:

The following comments are submitted on behalf of Protect Our Water Jackson Hole (POWJH) in response to the DEQ's October 28, 2022, request for comments on the above-referenced NOTIFICATION OF COVERAGE published on the DEQ's Water & Wastewater webpage under "Recent General Permit Authorizations."

POWJH is a tax-exempt, nonprofit organization registered in the State of Wyoming. The mission of POWJH is to serve as a powerful advocate for the protection of ground and surface waters in Teton County, Wyoming. Our members and supporters are very concerned about potential adverse impacts to Fish Creek, its tributaries, and adjacent wetlands resulting from the construction and operation of Teton Village Resort's wastewater facility located in the headwaters of this Wyoming Game and Fish Department-designated "Red Ribbon" fishery.

Background

The Office of State Lands and Investments (OSLI) issued a temporary use permit (TUP-03345) to Mountain Ventures/Basecamp Hospitality, LLC ("Basecamp") on June 24, 2022, to develop a geodesic dome hotel complex on state trust lands in Teton County.[1] The TUP authorizes "11 low-impact accommodates for single and multi-night vacation rental." As described in the TUP, the project includes, and is authorized to develop, a "shower house trailers, a welcome center, retail/rental space, food offering, sauna, storage and maintenance shed, and

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[1] The site is located in the southeast portion of Section 36, T42N, R117W.

small staff living quarters." The TUP also authorized the construction of "a septic system and leach field" on the state land parcel. Paragraph 8 of the TUP's General Conditions expressly requires the permittee, to "observe all state, federal and local laws and regulations." However, in the short time this project has been in existence, the project has demonstrated a history of non-compliance.

The permittee completed excavation and clearing of the site in late summer, without obtaining a grading and erosion control permit from Teton County and in the absence of a Stormwater Pollution Prevention Plan (SWPPP) required by DEQ's water quality regulations. Subsequent efforts by POWJH ultimately led to the preparation of a SWPPP in late October, after the completion of major excavation activities.

In mid-September, the DEQ received an application from Basecamp for a commercial wastewater system. The application and associated materials indicated a significant deviation from the representations made to the State Land Board, which included promises to build a closed-loop wastewater system. Nevertheless, the DEQ authorized the construction and operation of a commercial wastewater system under a "NOTIFICATION OF COVERAGE" (NOC) Permit No. 2022-274, dated October 6, 2022.

The NOC was authorized under a general permit issued by the DEQ in June, 2017. The general permit provides that: "This permit becomes effective on the date of issuance and shall be reviewed every five years, modified as needed and reissued in accordance with the Wyoming Water Quality Rules and Regulations Chapter 3, Section 7(c)." [2]

On October 28, 2022, the DEQ published notice of the NOC on its Water & Wastewater webpage under "Recent General Permit Authorizations" and invited the public to submit comments during a 30-day period ending November 28, 2022.

The apparent futility of public comment

As an initial matter, we note the unusual circumstances in which the public is being invited to comment. The decision to authorize the Teton Village Resort wastewater system has been made, and the wastewater system has been constructed. Thus we question why the DEQ is inviting public comments now, weeks after the date of the NOC; it seems likely that comments submitted *after* the final decision will serve no useful purpose. Perhaps it is an attempt by DEQ to satisfy the requirements of W.S. § 35-11-801(d). If so, we cannot imagine the legislature creating a right for citizens to provide comments on one hand, while on the other intending that right, and any comments submitted thereunder, to be meaningless. Nevertheless, despite the apparent futility in writing, we believe it is important for POWJH to bring our concerns to DEQ, once again.

The October 6, 2022, NOC informs the permittee, Mountain Ventures/Basecamp Hospitality, LLC (Basecamp), that "DEQ authorizes you to construct, install, or modify the

[2] Note that Chapter 3, Section 7(c) referenced in the NOC has nothing to do with wastewater facilities; rather, it refers to sedimentation control structures. Moreover, the link contained in the NOC to the general permit is non-functional, "dead link."

facility in accordance with Chapter [sic] WQRR Chapter 25, the general permit, and the materials submitted in your application package." Based on the finality of this language, we assume that there are no additional authorizations required by DEQ, and that public comments submitted at this stage would serve no useful purpose. Nonetheless, we have elected to do so to outline our concerns, and to point out flaws in this process which we hope DEQ will correct.

As stated in our October 20, 2022, letter to Director Parfitt, our position is that wastewater from this operation should NOT be permitted to enter ground or surface water. That was the promise made to the State Land Board, OSLI, and to the public. But that promise was broken, and a septic system has been constructed on the site. We understand that occupancy of the site is weeks, if not months, away. In the meantime, and for the reasons stated below, we believe that the DEQ should order Basecamp to refrain from releasing any wastewater into the septic system's absorption field which, as noted in the attached materials, will inevitably enter nearby ground and surface waters thereby exacerbating existing *E.coli* impairment in Fish Creek and its tributaries.

Violations of the Wyoming Environmental Quality Act and the DEQ's Water Quality Rules and Regulations.

The reasons supporting an immediate cessation of wastewater discharges are stated below.

1) <u>The General Permit has expired; any authorization made thereunder is invalid.</u>

The DEQ's Water Quality Rules and Regulations (WQRR) provide that: "The Director shall review each general permit at least every five (5) years from the date of issuance, make modifications as needed, and **reissue** the general permit." See WQRR Chapter 3, section 12(d)(emphasis added). The General Permit relied on by the DEQ to support the issuance of the NOC was issued on June 19, 2017, for a five-year term which ended on June 19, 2022. The NOC, Permit No. 2022-274, was issued to Basecamp on October 6, 2022, several months <u>after</u> the June 17, 2022, expiration of the General Permit. As a result, the General Permit that purportedly provided the basis for the issuance of Permit No. 2022-274 is invalid, and any authorization made under it is also invalid.

Any question about the validity of an expired general permit is answered on the DEQ's website, which explains that: "DEQ develops and issues a new general permit every 5 years for each of the four types of facilities listed below. The general permits were last issued June 19, 2017, and are valid until June 19, 2022." See <u>https://deq.wyoming.gov/water-quality/water-wastewater/permitting/general-permits/</u>.

It goes without saying that if the general permit is "valid until June 19, 2022," it is <u>invalid</u> thereafter. Lacking proper authorization from DEQ, the commercial wastewater system constructed by Basecamp constitutes an un-permitted discharge of pollutants into ground and surface waters of the state in violation of the Wyoming Environmental Quality Act, § 35-11-301(a).

2) The General Permit cannot be used to authorize a small wastewater facility in Teton County.

Under the plain terms of the General Permit, the DEQ may not use a general permit to authorize a small wastewater facility in Teton County.

Teton County was delegated the authority by DEQ to regulate small wastewater systems. The Wyoming Environmental Quality Act states:

> (ix) "Small wastewater system" means any sewerage system, disposal system or treatment works having simple hydrologic and engineering needs which is intended for wastes originating from a single residential unit serving no more than four (4) families **or which distributes two thousand (2,000) gallons or less of domestic sewage per day;**

W.S. § 35-11-103(c) (emphasis added).

The DEQ asserts that Teton County lacks the authority under the delegation agreement to permit this wastewater system because it is a non-residential/commercial system, and therefore not a small wastewater system covered by the delegation agreement. The DEQ is mistaken. The definition provided in W.S. § 35-11-103(c) above is clear that a system that "distributes two thousand (2,000) gallons or less of domestic sewage per day" is also a small wastewater system, even if non-residential.[3]

The General Permit, Part II, A. Facilities Covered Under This Permit, plainly states that coverage is provided for "[s]mall wastewater facilities located in areas not regulated by local governments in accordance with Wyoming Statute (W.S.) § 35-11-304." (emphasis added). However, because Teton County is an area regulated by local government, the General Permit does not apply, and the authorization —Permit No. 2022-274—provided thereunder is invalid.

In addition, General Permit Part II.D. lists the types of "Facilities Not Covered Under This Permit, which include:

> 3. Small wastewater facilities regulated by local governments in accordance with W.S. § 35-11-304."

Because Teton County has been delegated the authority to regulate small wastewater facilities in accordance with W.S. § 35-11-304, the DEQ's reliance on the General Permit to authorize Basecamp's wastewater system is expressly prohibited, and the authorization under the general permit approving the septic system is unlawful and invalid. In this circumstance, the DEQ should take immediate action to halt the flow of any wastewater into the raised-mound system.

[3] The term, "domestic sewage" "means liquids or solid wastes obtained from humans and domestic activities including wastewater from activities such as showers, toilets, human wash basins, food preparation, clothes washing, and dishwashers." See DEQ WQRR Chapter 27, Section 2 (o).

3) The General Permit may not be used to authorize a small wastewater system having complex hydrologic and engineering needs.

The DEQ determined that the wastewater system proposed by Basecamp is a "small wastewater system," which is defined in the Wyoming Environmental Quality Act to mean: "any sewerage system, disposal system or treatment works having simple hydrologic and engineering needs which is intended for wastes originating from a single residential unit serving no more than four (4) families or which distributes two thousand (2,000) gallons or less of domestic sewage per day;" W.S. § 35-11-103(c)(ix).

Far from having "simple hydrologic and engineering needs," the wastewater system approved by DEQ under the General Permit is a complex, unconventional, raised-mound, pressure dosed system requiring advanced engineering and a continuous electric power supply. The system is located in an area where groundwater is often at, or above, the surface, which creates significant hydrologic concerns that conventional (i.e., standard) systems do not encounter. See the attached report from Alder Environmental describing the hydrology of this area and potential water quality impacts from Basecamp's onsite septic system.[4] A simple system is described in Chapter 25, Section 12, as a "Standard Soil Absorption System" which is a conventional, gravity fed, and entirely below the surface wastewater system. The septic system approved by DEQ and installed by Basecamp is clearly neither simple nor standard.

The DEQ abused its discretion and otherwise acted unlawfully by authorizing under the general permit a complex, raised mound, pressure dosed wastewater facility in the headwaters of Fish Creek, a system that—because of its hydrology and design flows— will undoubtedly add additional *E.coli* and other pollutants to surface waters previously deemed impaired by E.coli. See Teton County Septic System Effluent Monitoring Report, Teton Conservation District (August 2022) attached as Exhibit B.[5]

3) The wastewater system is located in prohibited setbacks.

In the process of reviewing Basecamp's application for a permit to construct a wastewater system, the DEQ determined that the system is a non-residential, i.e., commercial wastewater facility, which is defined in the DEQ's rules as:

> (c) "'Commercial/industrial waste and wastewater facilities' means any facility not defined as a municipal or single family residence facility." See WQRR Chapter 11, Section 4.

Mandatory setbacks for commercial wastewater facilities are specified in WQRR Chapter 25, Section 19. As shown in Table 7, the minimum setback from surface water is 100 feet; from a public water supply well, the minimum setback is 500 feet. Basecamp's engineering drawings show, however, that the raised-mound absorption field is 50 feet or less from a pond, well within

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[4] The assessment prepared by Alder Environmental is attached as Exhibit A, and is incorporated by reference in its entirety as if fully set forth herein.

[5] The report prepared by the Teton Conservation District, marked as Exhibit B, is incorporated by reference in its entirety as if fully set forth herein.

the 100-foot setback from surface water required for commercial septic systems, and likely within the 50-foot setback required for residential systems. Field observations confirm that the raised mound septic system has been constructed within the mandatory setback from surface waters, in violation of Chapter 25, Section 19. See Sean E. O'Malley, P.E., Review of Teton Village Resort Wastewater Treatment, November 22, 2022, attached as Exhibit C.[6]

In addition, the same engineering drawings show that the raised-mound pressure dosed absorption field is located 280 feet from a public water supply well, considerably less than the 500 feet separation distance required by DEQ's rules, in violation of Chapter 25, Section 19.

In addition, Chapter 11, Section 27 requires that "Commercial/ industrial facilities that generate waste that is entirely domestic waste shall be designed in compliance with Part B of Chapter 11 or Chapter 25." Basecamp's wastewater system is not in compliance with Chapter 11 or Chapter 25, and the DEQ's approval of wastewater facilities inside these critical setbacks is a violation of its own water quality rules and regulations.

Finally, the General Permit may not be used to authorize a wastewater facility "that [does] not meet the minimum design and construction standards of Wyoming Water Quality Rules and Regulations Chapter 25." See General Permit, Part II, D. Facilities Not Covered Under This Permit, No. 5. The wastewater system approved by DEQ does not meet the minimum design and construction standards required by DEQ's rules set forth in Chapter 11 and Chapter 25.

4) The NOC fails to protect ground and surface water resources.

The wastewater facility authorized by DEQ has been constructed in the headwaters of Fish Creek, a Class 1 surface water. Pursuant to WQRR Chapter 1, Appendix A, the entire Fish Creek drainage is designated Class 1, together with all adjacent wetlands. The regulatory objective for Class 1 surface waters is to protect and maintain water quality that existed at the time of designation. WQRR Chapter 1, Section 4 and Section 7.

A number of recent studies and reports show a hydrologic connection between ground and surface water in the Fish Creek drainage. See, e.g., Alder Environmental, attached as Exhibit A. Indeed, at certain times of the year, groundwater flows on the surface. The commercial septic system authorized by DEQ in Permit No. 2022-274 will introduce a variety of pollutants into ground and surface water and adjacent wetlands in the headwaters of Fish Creek, including *E.coli*, further exacerbating an existing E.coli impairment documented in the DEQ's combined 305(b)/303(d) water quality assessment (2020). The WDEQ's decision allowing a discharge of *E.coli*, nitrates and other pollutants into a tributary of Fish Creek is a violation of the Wyoming Environmental Quality Act, the federal Clean Water Act, and is unlawful agency action within the meaning of W.S. § 16-3-114(c).

Given the unique hydrology in this area, along with the inability of septic systems to remove all pollutants, contamination of ground and surface water from Basecamp's septic

[6] Mr. O'Malley's November 22, 2022, Review of Teton Village Resort Wastewater Treatment is incorporated by reference in its entirety as if fully set forth herein.

system is all but certain. See Verhougstraete, et al., *Linking fecal bacteria in rivers to landscape, geochemical, and hydrologic factors and sources at the basin scale*, National Academy of Sciences, August 18, 2015, Vol. 112, No. 33, 10419-10424.[7]

Despite the high risk of water quality contamination, the DEQ has failed to demonstrate, as required by its rules, that ground and surface water quality standards will be met. WQRR Chapter 11 provides:

> PART C: COMMERCIAL/INDUSTRIAL WASTE AND WASTEWATER FACILITIES
>
> Section 25. General.
>
> This part contains the minimum standards for the design and construction of commercial/ industrial wastewater facilities. The applicant shall demonstrate to the Administrator that any discharge or seepage from the wastewater facility will not cause a violation of the Surface and/ or Groundwaters of the State in accordance with Chapter 1, "Quality Standards for Wyoming Surface Waters" and Chapter 8, "Quality Standards for Wyoming Groundwaters." Due to the wide variety of wastes, wastewater and site conditions, the latest available scientific information shall be used to demonstrate that violations will not occur.

POWJH has been unable to locate any evidence in the application, drawings and related materials that such a demonstration has been made. Neither the expired general permit nor the one page NOTIFICATION OF COVERAGE provides this required demonstration or even references this requirement. In its haste to approve Basecamp's septic system, the DEQ missed —or perhaps ignored— this critical requirement.

5) <u>The DEQ acted unlawfully and abused its discretion by not requiring Basecamp to obtain an individual permit under Chapter 25, or alternatively, an individual permit required by Chapter 27, for a UIC Class V large capacity system.</u>

When properly calculated, design flows indicate that Basecamp's wastewater system may exceed 2,000 gallons per day, which would remove it from coverage under the General Permit. See Part II, D. <u>Facilities Not Covered Under This Permit</u>, #1, #2, and #4. In any event, and regardless of whether the system's design flows exceed 2,000 gallons per day or not, the complexity of the system, its location in the headwaters of Fish Creek, and potential to contaminate groundwater and Class 1 surface waters, design flows near (or in excess of) the 2,000 gpd threshold, necessitate the need for an individual permit.

In conclusion, for the reasons stated above, we request that you order Basecamp to refrain from and/or halt the placement of wastewater into the raised mound system until the issues raised above are resolved in a lawful and mutually satisfactory manner.

---

[7] This article is attached as Exhibit D and is incorporated by reference as if fully set forth herein.

Sincerely,

Dan Heilig
Board Member
Protect Our Water Jackson Hole

Cc (via email):

Mark Gordon, Governor of the State of Wyoming
Todd Parfitt, Wyoming DEQ Director
Jennifer Zygmunt, Water Quality Administrator
Wendy Cheung, EPA Region 8
Teton County Board of County Commissioners
Carlin Girard, Executive Director, Teton Conservation District

Enclosures: Exhibits

LIST OF EXHIBITS
(Incorporated by reference herein)

Alder Environmental, Aquatic Resources and Water Quality Impact Assessment of Wyoming State Land (Teton Village) OSLI Site 9, November 19, 2022.

Sean E. O'Malley, P.E. Review of Teton Village Resort Wastewater Treatment, November 22, 2022.

Teton Conservation District, Teton County Septic System Effluent Monitoring Study Report, August 2022, available online at: https://www.tetonconservation.org/septic-monitoring-study

Science News, "Septic tanks aren't keeping feces out of rivers, lakes." ScienceDaily. ScienceDaily, 3 August 2015. <www.sciencedaily.com/releases/2015/08/150803154850.htm>.

Verhougstraete, M. et al. (2015) Linking fecal bacteria in rivers to landscape, geochemical, and hydrologic factors and sources at the basin scale. Publication of the National Academy of Sciences, available online at: https://www.pnas.org/doi/full/10.1073/pnas.1415836112.

ALDERENVIRONMENTAL
water | wetlands | ecological consulting

November 19, 2022

To: Protect Our Water Jackson Hole, Wilson, WY

From: Brian Remlinger, *Professional Wetland Scientist*, Alder Environmental LLC

Re: WY State Land (Teton Village) Site 9 - Aquatic Resources and Water Quality Impact Assessment

Alder Environmental LLC has been retained by Protect Our Water Jackson Hole to assess the aquatic resources within the vicinity of Site 9 of the Teton Village State Land Parcel and to evaluate potential impacts to surface and groundwater quality from current Teton Village Resort (Resort) development on Site 9. This assessment and opinion are based off a review of historical aerial imagery, best available hydrologic feature data, a site visit on November 16, 2022, previous site visits to the parcel, and 23 years of professional experience and knowledge of wetlands and water resources in the area.

LOCATION

Site 9 of the "Teton Village" State Land Parcel is in the NE¼ SE¼ of Section 36, Township 42 North, Range 117 West of the 6th P.M., Teton County, Wyoming (Figure 1). The Teton Village Parcel is located centrally within the Fish Creek Watershed, a tributary of the Snake River. The watershed is underlain by the vast Snake River alluvial aquifer containing course gravels and significant groundwater reservoirs. There is a slight downward tilt in the valley to the west towards Wilson and Fish Creek where surface and groundwaters flow to.

Fish Creek and its tributaries, including wetlands, irrigation ditches, and return flows are designated as Class 1 Surface Waters by the State of Wyoming. Class 1 Surface Waters are defined by Wyoming's Chapter 1 Surface Water Quality Standards as:

> *(a)Class 1, Outstanding Waters. Class 1 waters are those surface waters in which no further water quality degradation by point source discharges other than from dams will be allowed. Non-point sources of pollution shall be controlled through implementation of appropriate best management practices. Pursuant to Section 7 of these regulations, the water quality and physical and biological integrity which existed on the water at the time of designation will be maintained and protected. In designating Class 1 waters, the Environmental Quality Council (council) shall consider water quality, aesthetic, scenic, recreational, ecological, agricultural, botanical, zoological, municipal, industrial, historical, geological, cultural, archaeological, fish and wildlife, the presence of significant quantities of developable water and other values of present and future benefit to the people.*

In addition, dredge and fill activities within Class 1 Surface Waters trigger specific Clean Water Act Sections 401 and 404 notifications to the State and US Army Corps of Engineers.

HYDROLOGIC CONDITIONS

The Fish Creek watershed gains surface water flows from Teton Mountain Range snowmelt runoff to the west and north, irrigation diversions from the Snake River to the east, and many springs seeping from the ground (Figure 1). Interactions between surface and groundwater are well documented in studies conducted by the US Geological Survey and others (Eddy-Miller 2009). Valley snowmelt and rainfall runoff contribute to surface flows and groundwater recharge at the Teton Village State Parcel. Groundwater flows within the gravel based alluvial aquifer at the Parcel respond quickly to seasonal conditions and surface water inputs or recharge. The seasonal rise in groundwater can result in the water table rising at or above the surface in certain locations.

The area within the vicinity of Site 9 Teton Village State Parcel contains surface waters that flow from northeast to southwest. These include irrigation supply ditches, remnant spring and river flood channels, and irrigation laterals (Figure 2). The ponds at the Site were historically excavated in course gravels and the water surface in the ponds fluctuate with the groundwater water table. The outlets of these ponds eventually surface flow into the Grosh and Palmer Ditches that return flows to Lake Creek, a tributary of Fish Creek. These ponds also recharge or interact with the groundwater in the vicinity. The groundwater within the vicinity of Site 9 has significant hydrologic connectivity with surface water and stormwater and snowmelt runoff due to being seasonally near the ground surface, having high infiltration rates, and as a result of high transmissivity or the porous nature of the gravel based alluvial aquifer.

AQUATIC RESOURCES

Aquatic resources include wetlands and surface waters that are regulated by the federal Clean Water Act. The area in the vicinity of Site 9 was observed to contain ponds, flowing channels, emergent and scrub-shrub wetlands, and groundwater inundating the ground surface. Figure 2 depicts the wetlands and surface waters identified and mapped using knowledge of the area, historical infrared and true color aerial imagery, site observations, and existing topographic contour data. Connectivity of these wetlands and surface water is continuous throughout the Study Area from Site 9 to the Grosh and Palmer ditches.

The US Army Corps of Engineers and WY Department of Environmental Quality (DEQ) determine federal and state jurisdiction over aquatic resources. Depending on their jurisdictional determination, any dredge or fill activities and other non-point source pollution resulting from construction and operation of Site 9 may require notification and/or permits from federal and state regulatory agencies.

WATER QUALITY

The surface and groundwater in the upper Snake River watershed in Jackson Hole is generally of excellent quality, however, has been affected by anthropogenic disturbances and uses in the Fish Creek watershed (Eddy-Miller 2013). Twenty-one different wastewater chemicals were detected in the Fish Creek and groundwater during the US Geological Survey studies from 2007-11 (Eddy-Miller 2013).

In the summer of 2021, Kelsey Ruehling, a University of Wyoming graduate student, collected and analyzed microbes in water, fecal, and wastewater samples to identify and quantify sources of fecal pollution in Fish Creek. Ms. Ruehling's research indicates that increasing land development in the Fish Creek watershed has a negative effect on microbial diversity and that human wastewater is the dominant fecal source contributor to the creek (Ruehling 2022). The high number of residential wastewater treatment leachfields in the Fish Creek watershed (~1,000) are assumed to be the primary contributor to this wastewater fecal contamination load.

A recent 2-year study of raised mound wastewater treatment leachfields and septic systems in the Fish Creek watershed indicates that nitrate contamination of groundwater due to these systems is highest during winter months when the effectiveness of these systems is limited by cold conditions (Nelson and Alder 2022). There was an increase in nitrate concentrations observed in the groundwater downgradient of the leachfields, most notably in the winter months. The study makes recommendations to improve winter treatment of wastewater in leachfields and septic systems through heat retention designs.

POTENTIAL & OBSERVED DEVELOPMENT IMPACTS

The proposed development plans at Site 9 (Teton Village Resort Construction Plans, 11/9/22) depicts a leachfield and mound near and likely within potential wetlands and surface waters. The existing contours on the plan set, a review of aerial imagery, and site observations indicate the mound from the leachfield extends into the wetland/pond complex. The leachfield infiltrators are less than 50 feet from estimated wetlands and possibly surface waters.

The potential fill in wetlands and surface waters resulting from development at Site 9 appears relatively minor and would likely comply with a federal Clean Water Act Section 401 and 404 Nationwide Permit Conditions, however the fact that the fill is associated with a leachfield system might negate that compliance. The US Army Corps of Engineers and WY DEQ are the regulatory authorities that would make determinations on this development fill and situation.

Negative water quality impacts to groundwater as a result of the wastewater from the proposed Site 9 Resort facilities would likely be highest during the winter unless the wastewater treatment system was designed to be insulated for heat retention, as recommended in the 2022 Nelson and Alder report. Regardless, there will likely be some level of wastewater pollutant contribution to groundwater from the Resort as indicated by the 2022 study. The level of wastewater pollution leaching into the groundwater at Site 9 will likely be low concentration, however, water quality impacts will be chronic and long term and will ultimately be determined by occupancy rates and flow rates to the system.

REFERENCES

Eddy-Miller, C.A., Wheeler, J.D., and Essaid, H.I., 2009, Characterization of interactions between surface water and near-stream groundwater along Fish Creek, Teton County, Wyoming, by using heat as a tracer: U.S. Geological Survey Scientific Investigations Report 2009–5160, 53 p.

Eddy-Miller, C.A., Peterson, D.A., Wheeler, J.D., Edmiston, C.S., Taylor, M.L., and Leemon, D.J., 2013, Characterization of water quality and biological communities, Fish Creek, Teton County, Wyoming, 2007–2011: U.S. Geological Survey Scientific Investigations Report 2013–5117, 76 p.

Nelson Engineering and Alder Environmental LLC. 2022. Teton County Septic System Effluent Monitoring Report. Jackson, WY. August 2022.

Ruehling, K. 2022. Microbial Source Tracking Presentation. May 26, 2022. Jackson, WY, https://www.youtube.com/watch?v=Yco-OoO8zMM&t=1535s

Enc. Figure 1 – Watershed and Location
Figure 2 – Aquatic Resources Connectivity in Vicinity of Site 9
Photo Log (Corresponds to Photo Points on Figure 2)

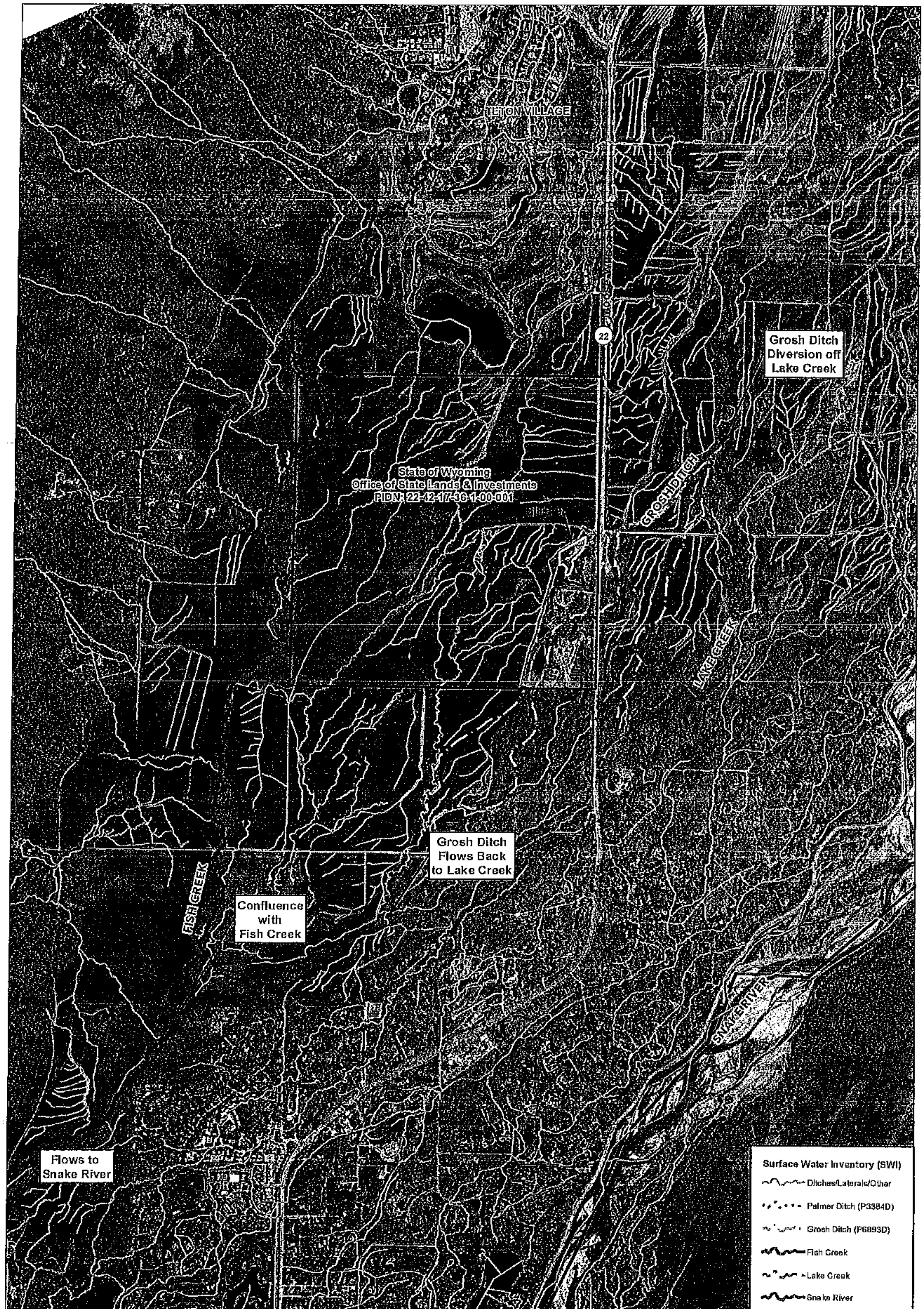


FIGURE 1	Protect Our Waters Jackson Hole	Legend	Sources	1 inch = 1,500 feet
Watershed & Location	Site 9 State Land Parcel	State Land Parcel	Teton County - Ownership Boundaries - Aerial Imagery, 2019 Teton Conservation District (TCD) - Surface Water Inventory (SWI) WY State Engineer's Office - Water Rights Alder Environmental LLC - Aquatic Resources (approximate)	Feet 0 500 1,000 1,500 N
November 19, 2022	Teton County, WY	Site 9 (approx.) Flowline (approx.)		ALDERENVIRONMENTAL water | wetlands | ecological consulting Jackson, WY alderenvironmental.com

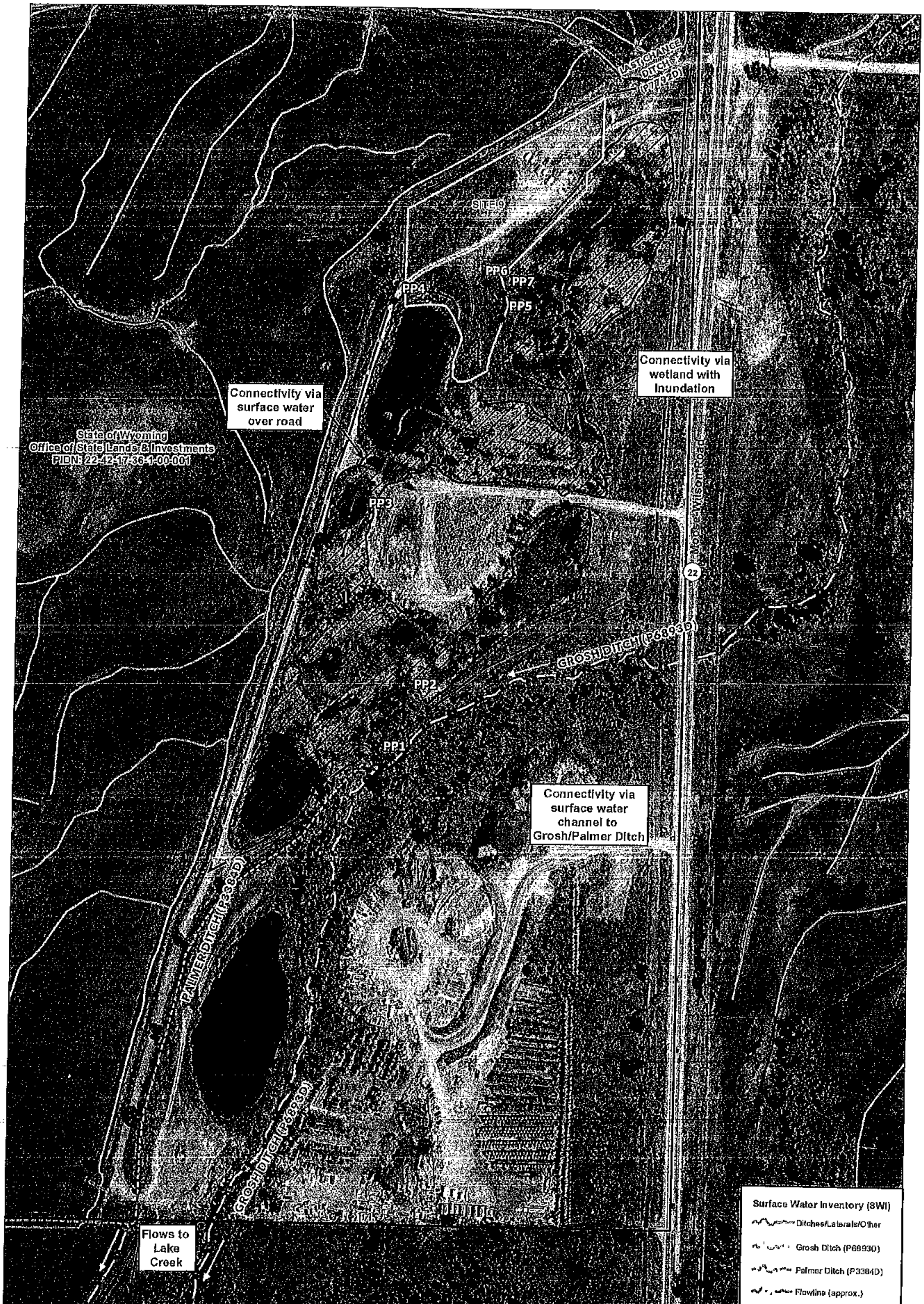


FIGURE 2 Aquatic Resources Connectivity in Vicinity of Site 9 November 19, 2022	**Protect Our Waters Jackson Hole** **Site 9 State Land Parcel** **Teton County, WY**	**Legend** State Land Parcel Study Area Site 9 (approx.) Wetland/Surface Water Complex (approx.) Flowline (approx.) Photo Point (11/16/22)	**Sources** Teton County - Ownership Boundaries - Aerial Imagery, 2019 Teton Conservation District (TCD) - Surface Water Inventory (SWI) WY State Engineer's Office - Water Rights Alder Environmental LLC - Aquatic Resources (approximate)	1 inch = 200 feet 0 50 100 150 200 Feet N ALDERENVIRONMENTAL water | wetlands | ecological consulting Jackson, WY alderenvironmental.com

Photo 1 – Photo Point 1. View south of Grosh Ditch/Palmer Ditch Diversion and the channel connecting from the Site 9 vicinity ponds (November 16, 2022).

Photo 2 – Photo Point 1. View northwest of surface water channel and wetland connectivity to Grosh/Palmer Ditch (November 16, 2022).

Photo 3 – Photo Point 2. View northwest of wetland and surface water complex that connects to Grosh/Palmer Ditch to Site 9 Vicinity (November 16, 2022).

Photo 4 – Photo Point 3. View northwest of surface water and wetland complex, with surface water connectivity over road to Site 9 Ponds (November 16, 2022).

Photo 5 – Photo Point 4. View northeast along surface water/wetland complex at Site 9 development (November 16, 2022).

Photo 6 – Photo Point 5. View southwest of location of future Geodome facilities, sewer line pipe risers on right (November 16, 2022).

Photo 7 – Photo Point 6. View northeast of leachfield mound fill adjacent to and likely into surface water/wetland complex (November 16, 2022).

Photo 8 – Photo Point 7. View north of surface water/wetland complex adjacent to Site 9 (November 16, 2022).

Sean E. O'Malley, P.E.
P.O. Box 1692
Jackson, Wyoming 83001

November 22, 2022

Brad Nielson, Board Chair
Meghan Quinn, Executive Director
Protect Our Water Jackson Hole
PO Box 1014
Wilson, WY 83014

Re: Review of Teton Village Resort Wastewater Treatment

Dear Brad and Meghan,

At the request of the Board of Directors of Protect Our Water Jackson Hole (POWJH), I have reviewed water quality elements of Basecamp Hospitality LLC's (Owner) Teton Village Resort "Glamping" project that is currently under construction on the Wyoming state land parcel located in Section 36, T42N, R117W.

After a career in the private sector as a consulting civil engineer, I served as the Teton County Engineer and Public Works Director from 2009 to 2019. While my experience in those roles has informed my understanding of water and wastewater issues, I do not presume to know the regulations and permitting requirements as well as Wyoming Department of Environmental Quality staff or the Teton County Sanitarian who, incidentally, reported directly to me. Nevertheless, my experiences have guided my questions and observations below.

Although I have concerns with traffic generation, wetland impacts, and stormwater, I will not address those issues in this document. Overall, and based on the information I have been able to access, it appears this project does not meet the groundwater and surface water standards of the Wyoming Department of Environmental Quality (WDEQ) and the US Environmental Protection Agency (EPA). This project has the potential to negatively impact the Fish Creek drainage and consequently harm citizens of, and visitors to, Teton County.

I understand that the WDEQ and the Office of State Lands and Investments (OSLI) have requested (or are allowing) public comment on this project. In my experience, the time to solicit comment is during draft plan review and not after permits have been issued and construction has started. <u>If it is determined that the work-to-date and the associated permits do not meet WDEQ or federal regulations, will the State put the brakes on this project until it is in compliance</u>?

Plan Revisions:

I have reviewed engineering plans stamped by Robert J. Rousselle of Ensign Engineering and dated November 9, 2022. There are several significant changes from the previous plans dated September 16, 2022.

- The wastewater disposal system was originally proposed to be a "greywater" system. Greywater systems typically dispose of wastewater from tubs, showers, and sinks to a conventional soil absorption field, while waters that have been contaminated by human waste (toilet discharge) are separated from the non-contaminated water and stored in a septic tank until trucked to a municipal wastewater treatment plant. It is my understanding the Owner no longer plans to separate the different waste flows and instead will dispose of both contaminated and non-contaminated waste in a raised-mound, pressure-dosed wastewater system on the site. This system includes a septic tank, filter, dosing tank and pressurized, small-diameter distribution system. It is not a "Small Wastewater System" per Wyoming Statute W.S. 35-11-103(c):
    - *(ix) "Small wastewater system" means any sewerage system, disposal system or treatment works having simple hydrologic and engineering needs which is intended for wastes originating from a single residential unit serving no more than four (4) families or which distributes two thousand (2,000) gallons or less of domestic sewage per day;*

Per the Delegation Agreement between WDEQ and Teton County, effective January 25, 2018, Article IV, (6) states:

- WQD (Water Quality Division) *"delegates and the Entity accepts the authority and responsibility to enforce and administer the provisions of W.S. 35-11-301(a)(i) for small wastewater facilities, as defined in W.S. 35-11-103(c)(ix). This delegation includes the authority to develop necessary rules, regulations, standards, and permit systems, to review and approve construction plans, conduct inspections, issue permits, to enforce against violations, and to develop rules governing the review and appeal of any decision made by the Entity. This Agreement does not include authority or responsibility to enforce and administer any other provisions of W.S. 35-11-302(a)(in), including wastewater systems with design flows greater than two thousand (2,000) gallons of domestic sewage per day or any system that discharges non-domestic wastewater."*

Because WDEQ is regulating and permitting the wastewater system for this resort, it appears they are acknowledging that Teton County does not have the authority to regulate the wastewater system because it is not a small wastewater system. This system serves far more than four families and, due to the pressure-dosed system, does not have "simple hydrologic and engineering need." It is more complex than a simple, gravity-flow soil absorption field (leach field) system. Further, and as noted in the *Teton County Septic System Effluent Monitoring Report* prepared by Nelson Engineering and

Alder Environmental LLC, even when properly designed, constructed, and maintained, these systems can introduce a variety of contaminates and pathogens into the surrounding surface and groundwater - including nitrates, phosphates, fecal material, and E. coli bacteria.

- The sewer flow calculations (Sheet C-102 of Teton Village Resort plans dated 11/9/22) are now based on a rate of 2.6 occupants per glamping unit and 2.5 occupants per staff (employee) unit, for a daily occupancy average of 33.6. See additional discussion of wastewater calculation elsewhere in this report.
- According to the engineering plans, water connections (hookups) have decreased from 15 to 14 and guest and employee housing units have decreased from 15 to 13 (11 guest units and 2 employee units). However, it is unclear if the "Welcome" center building will also include a sink, toilet, as well as food preparation and cleaning facilities. If so, these uses should be added to the wastewater flow calculations. Despite these changes, the water system is guided by the EPA Safe Drinking Water Standards because the resort serves an average of more than 25 people.
- On October 6, 2022, James Brough. P.E., Northwest District Engineer for the WDEQ, issued a Notice of Coverage to Teton Village Resort.
    - *The Department of Environmental Quality (DEQ) has reviewed and approved the above application for coverage under the small wastewater facility general permit at NE 1/4 SE 1/4, Section 36, T42N, R117W* ***(43.560 Lat / -110.823 Long)*** *in accordance with Chapter 3, Section 7 of the Wyoming Water Quality Rules and Regulations (WQRR) and hereby issues this Notice of Coverage (NOC).*

Chapter 3, Section 7, covers "Sedimentation" and is not the appropriate section. Presumably he meant to reference Section 5, which covers general permits for small wastewater systems. As outlined above, it appears this system should be evaluated under Chapter 25, Section 19: Commercial and Industrial Wastes and/or Domestic Wastes Greater Than 2000 Gallons per Day. As well, perhaps this permit was issued for the originally-proposed Greywater system. <u>Has the DEQ issued a permit for the revised system</u>?

- After a visit to the site on October 13, 2022, Brad Ellis, P.E., WDEQ Northeast District Engineer, directed the Owner to elevate the newly constructed leach field in order to provide 4 feet of vertical separation from groundwater and meet Teton County requirements. This change has been field-verified by Nelson Engineering on November 1, 2022.

Underground Injection Control and Class V Wells:
As mandated by the Safe Drinking Water Act of 1974, the United States Environmental Protection Agency (EPA) has promulgated regulations establishing minimum requirements,

technical criteria, and standards for State Underground Injection Control (UIC) programs to protect underground sources of drinking water (USDW). The State of Wyoming received UIC program primacy from the EPA in 1983 and has since operated under an EPA approved UIC program. The Wyoming Department of Environmental Quality (WDEQ) Water Quality Division (WQD) currently has regulatory authority for Class V injection wells. The EPA classifies a wastewater system that serves 20 or more people per day as a Large Capacity Septic System (LCSS). From the EPA Office of Ground Water and Drinking Water:

- A septic system is required to meet UIC Program requirements and is considered a Class V well if either one of the following conditions is met:
  - The septic system, regardless of size, receives any amount of industrial or commercial wastewater (also known as industrial waste disposal wells or motor vehicle waste disposal wells); or
  - The septic system receives solely sanitary waste from multiple family residences or a non-residential establishment and has the capacity to serve 20 or more persons per day (also known as large-capacity septic systems).

<u>It appears Teton Village Resort should meet UIC requirements</u>. At this time, it is unclear to me whether they have met the requirements for Underground Injection Control and Class V wells.

Drinking Water Setbacks:
Based on WDEQ, Chapter 25, Section 19, Table 7, it appears that Public Water Systems has a required minimum separation between the drinking water well and the soil absorption field of 500 feet. <u>The separation shown on the plans, at approximately 288 feet, does not meet this setback requirement</u>.

- From the EPA's Information about Public Water Systems: *A public water system provides water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serves an average of at least <u>25 people</u> for at least 60 days a year. A public water system may be publicly or privately owned.*
- In particular, the system appears to meet the EPA's definition for a Transient Non-Community Water System: *A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods of time.*

Wastewater Definitions and Related Issues:
Based on the Sewer Flow calculation on sheet C-102, the engineer has utilized a flow rate of 45 gallons per day (gpd) for the Teton Village Resort. This design flow rate is from WDEQ, Water Quality, Chapter 25, Section 4, Table 2 (Non-Residential Wastewater Design Flow Rates) for a "Campground with shower facility" designation. In WDEQ, Water Quality, Chapter 11, Section 4, Definitions:

- *"Campground" means a parcel or tract of land under the control of a person at which sites are offered for the use of the public or members of an organization* *either free of charge or for a fee, for the establishment of temporary living quarters for two or more recreational units."*

The only similarity between this development and a campground is that the glamping units are tent-like, soft-sided structures. This resort does not meet the Wyoming Department of Environmental Quality's definition for campground. Because the glamping units are connected to a Public Water System and utilize a raised-mound, pressure-dosed wastewater system; and because the units are permanent, stand-alone structures with beds, sinks, and showers; a more appropriate designation of the use is "Motel, Hotel, Resort", with a flow rate of 140 gpd per unit (per Table 2).

At 140 gpd, the 13 units are estimated to generate slightly less than 2,000 gpd in total. Additional connections at the Welcome Center will likely push the total over 2,000 gpd. Either way, the system meets the definition of a Commercial/industrial wastewater disposal system per the definitions in Chapter 11:

- *"Commercial/industrial waste and wastewater facilities" means any facility not defined as a municipal or single family residence facility."*

Based on site observations and review of the plans, it appears the soil absorption field does <u>not</u> meet the minimum horizontal setback of 100 feet from surface water, as outlined in Chapter 25, Section 19, Table 7. If it is argued that this is a small, domestic wastewater system and subject to a 50 feet setback rather than 100 feet (see **Plan Revisions** discussion above), the wastewater system still does not meet this lesser standard. From site observations, the separation from toe of constructed slope to surface water appears to be significantly less than 50 feet.

The engineering plans show a proposed 1,500-gallon septic tank and a 1,000-gallon dosing tank. In conflict with the engineering plans, Part 9.2.2.1 of the Storm Water Pollution Prevention Plan (SWPPP), submitted by the owner and dated October 20, 2022, states: *The wastewater system will include three 3,000-gallon sewage holding tanks which will meet all County and State requirements.* In my review of the plans and submittals, I have been unable to determine what has been, or will be, installed for the wastewater system. <u>Do the engineering plans accurately describe the system or should the SWPPP description be relied upon</u>? Whether it is a single, 1,500-gallon tank or three 3,000-gallon tanks, there is potential that the system has not been optimally-sized for the ultimate wastewater flows. Improper sizing can result in poor separation of scum, water, and sludge which, in turn, results in partial digestion of retained organic materials and excessive contamination in the effluent. <u>The Owner, their engineer, and/or the WDEQ should provide information on what has been built and what assumptions have been used to size the system.</u>

Surface and Ground Water Impacts:
The proximity of the soil absorption field to surface water poses a health threat to the public. There are a series of ponds and wetlands adjacent to the Teton Village Resort site on the east and south. Although these ponds shrink in the winter, they are filled by groundwater during spring and summer. The high groundwater is a result of snowmelt and seasonally high runoff

from the Snake River as well as irrigation of Snake River Ranch lands to the north. During irrigation season, the Grosh/Palmer irrigation ditch flows seasonally out of Lake Creek, at a point approximately one-half mile northeast of the State Land parcel, then southerly through the State Land ponds, and eventually re-enters Lake Creek approximately one mile southwest of the State Lands. Lake Creek then enters Fish Creek, significantly increasing the volume of that stream. Due to the inadequate separation between the soil absorption field and the adjacent surface water, the irrigation ditch could potentially convey effluent containing nitrates, E. coli, and other pathogens from the soil absorption field to Fish Creek, a Class 1 stream.

From WDEQ, Water Quality, Chapter 1, Section 4(a), a Class 1 stream is defined as follows:

> *(a) Class 1, Outstanding Waters. Class 1 waters are those surface waters in which no further water quality degradation by point source discharges other than from dams will be allowed. Nonpoint sources of pollution shall be controlled through implementation of appropriate best management practices. Pursuant to Section 7 of these regulations, the water quality and physical and biological integrity which existed on the water at the time of designation will be maintained and protected. In designating Class 1 waters, the Environmental Quality Council (council) shall consider water quality, aesthetic, scenic, recreational, ecological, agricultural, botanical, zoological, municipal, industrial, historical, geological, cultural, archaeological, fish and wildlife, the presence of significant quantities of developable water and other values of present and future benefit to the people.*

In January 2020, Fish Creek was listed as an impaired waterway due to elevated E. coli bacteria levels. The addition of 2,000 gallons per day of fecal-contaminated wastewater has the potential to degrade Fish Creek and its tributaries further and generate additional risks to swimmers, boaters and other waterway users. Closer to the Teton Village Resort, these potentially contaminated ponds may be an attraction to guests, especially children. <u>How will the Owner mitigate the risk of exposure to pathogens</u>?

Other Commercial/Industrial Waste Concerns:
WDEQ, Water Quality, Chapter 11, Part C, Section 25 outlines requirements for the Commercial/Industrial designation:

> *"This part contains the minimum standards for the design and construction of commercial/ industrial wastewater facilities. The owner shall demonstrate to the Administrator that any discharge or seepage from the wastewater facility will not cause a violation of the Surface and/ or Groundwaters of the State in accordance with Chapter 1, "Quality Standards for Wyoming Surface Waters" and Chapter 8, "Quality Standards for Wyoming Groundwaters." Due to the wide variety of wastes, wastewater and site conditions, the latest available scientific information shall be used to demonstrate that violations will not occur."*

I have not seen evidence that the Owner and their engineer have demonstrated compliance with Chapter 11, Part C and Chapter 8 requirements.

Conclusion:
The Teton Village Resort, under development by Basecamp Hospitality LLC, continues to evolve and no longer resembles their original proposal. Some of these changes include: the average daily occupancy is now estimated to be 33.6 people, the number of dwelling units and water hookups has changed, the original greywater wastewater disposal system is now an onsite septic disposal that should be permitted as a commercial rather than a small system, and the improper designation of the resort as a "Campground" facility understates the likely wastewater flows. It appears the Wyoming Department of Environmental Quality's oversight has not kept pace with these changes – and the permits that have been issued do not match the work on the ground. Consequently, this project does not meet the EPA Safe Drinking Water Standards nor the Wyoming Department of Environmental Quality regulations for commercial/industrial wastewater systems. Specifically, the drinking water well is less than 500 feet from the wastewater system and the open surface water is less than 50 feet (where 100 feet is required) from the toe of the soil absorption field. Conflicts between the plans and permits for the wastewater system raise doubt that it is properly sized to treat the wastewater flows.

This project, as currently designed and constructed, has the potential to further degrade water quality in the Fish Creek drainage. The Office of State Lands and Investments and the Wyoming Department of Environmental Quality should consider revoking the existing permits and issue new permits if, and when, the Owner is in compliance with the appropriate regulations.

Respectfully,

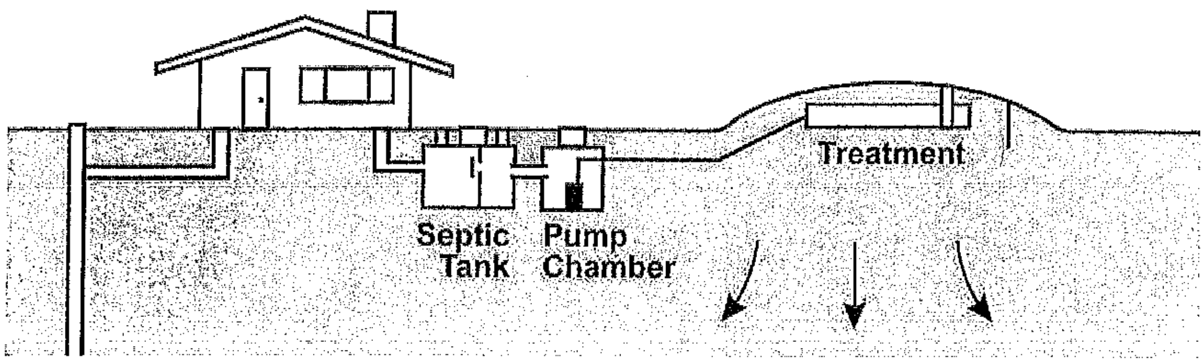
Sean E. O'Malley
Wyoming Professional Engineer No. 6520

Teton Conservation District Est. 1946

TETON COUNTY SEPTIC SYSTEM EFFLUENT MONITORING REPORT

Prepared for:

TETON CONSERVATION DISTRICT



Prepared by:

NELSON ENGINEERING since 1964
Professional Engineers & Land Surveyors
JACKSON, WY · BUFFALO, WY

and

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AUGUST 2022

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Appendices

1. Introduction

The Teton County Septic System Effluent Monitoring Project is an investigation into septic system impact on groundwater given the relative uncertainty surrounding the treatment potential of commonly used residential leachfield designs. Septic tanks remove most settleable and floatable material and function as an anaerobic bioreactor that promotes partial digestion of retained organic matter. Septic tank effluent, which contains significant concentrations of pathogens, Ammonia, and other nutrients, has traditionally been discharged to soil media absorption fields (leachfields) for further treatment through biological processes (nitrification and denitrification), adsorption, filtration, and infiltration into underlying soils. These systems work well if they are installed in areas with appropriate soils and hydraulic capacities, are designed to treat the incoming waste load to meet public health, groundwater, and surface water performance standards, are installed properly, and are maintained to ensure long-term performance.

In Teton County many systems are located close to groundwater, four feet regulatory minimum, in coarse alluvial soils. These conditions, in combination with the cold climate, create a condition where onsite system installations might not be adequate for minimizing Nitrate contamination of groundwater, removing Phosphorus compounds, and attenuating pathogenic organisms (e.g., bacteria, viruses) in this four-foot vadose zone. Nitrates that leach into groundwater used as a drinking water source can cause methemoglobinemia, also known as "blue baby syndrome". Nitrates and Phosphorus discharged into surface waters directly or through subsurface flows can spur algal growth and lead to eutrophication and low Dissolved Oxygen in creeks and rivers. In addition, pathogens reaching groundwater or surface waters can cause human disease through direct consumption or recreational contact.

The intent of the Septic System Effluent Monitoring Project is to determine the impact of typical septic tank soil absorption systems on groundwater in Teton County, WY. With this stated purpose in mind and the fact that residents have expressed concern about nutrient and pathogen contamination of drinking water supplies and the overall nutrient contribution to the groundwater and the subsequent impact on surface water, the Teton Conservation District and Teton County jointly funded this effort, the result of which is contained herein.

Project Timeline

In June of 2019, the Teton Conservation District issued a Request for Proposals (RFP) for the work. The Nelson Engineering Team, consisting of Nelson Engineering and Alder Environmental LLC, responded to the request in July of 2019, and after consideration was awarded the work in August of 2019 with an amended scope of service (described in detail later in this section). A kick off meeting was held in November of 2019 to discuss the scope of services, the sampling plan, and the selection of probable properties for installation of monitoring wells.

A solicitation for volunteers was drafted and released to the public in December of 2019. Only a handful of responses were received, so additional research and more pointed and direct requests were required in order to obtain a list of suitable candidates.

Four primary or preferred sites and four secondary sites were then chosen for site visits and detailed evaluation. The criteria for the selection of a site included the following:

- the system should have documented design records, installation inspections and regular maintenance to reduce the number of variables that could invalidate the statistical analysis of the monitoring program;
- the leachfield should be situated above relatively shallow groundwater (10 feet deep or less) to facilitate easier installation and sampling of the groundwater;
- the system should serve two or more full-time residents;
- the age of the system should be between 5 and 30 years, rather than brand new construction, ensuring a healthy and functioning biomat is in place; and
- ideal sites would have relatively open space downgradient from the leachfield for placement of monitoring wells.

Site visits were conducted from May through August of 2020, four sites with raised mound distribution systems in place were chosen, and temporary well and access easement and agreement documents were executed. Installation of the monitoring wells occurred in August and September of 2020. Sampling began in October of 2020. Five additional months of sampling were added by contract amendment, extending the sampling through March of 2022. Reclamation of the sites took place in late spring of 2022.

Amended Scope of Services

PARAMETERS TO BE SAMPLED

The initial project scope required that the parameters to be sampled would be as follows:

- Field parameters (Specific Conductivity, pH, temperature, and Dissolved Oxygen)
- Laboratory analysis (Nitrate, Nitrite, Ammonia, Orthophosphate, Phosphorus, Chloride, and E.coli)

The Team agreed with the listed field parameters but was of the opinion that the laboratory analysis included parameters that would not apply to all sampling points given the constituents of the typical wastewater and the biological process that occur in a septic system. The following is a table showing the typical composition of untreated domestic wastewater for the parameters listed in the RFP.

TABLE 1-1 Typical Composition of Untreated Domestic Wastewater

Parameter	Unit	Low [1] Strength	Medium [1] Strength	High [1] Strength	Typical Teton Village
Nitrogen, Total	mg/l	20	40	70	30-40
Ammonia	mg/l	12	25	45	25-30
Nitrates	mg/l	0	0	0	0-2
Nitrites	mg/l	0	0	0	0
Total Phosphorus	mg/l	4	7	12	7-12
Chlorides	mg/l	30	50	90	77

(1) Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Fourth Edition, Table 3-15

The Ammonia concentration in effluent from a septic tank is typically higher than raw wastewater, because the organic Nitrogen is broken down anaerobically to Ammonia resulting in average Ammonia levels of 40 mg/l. Some of the Phosphate will precipitate out in a septic tank thus reducing the Total Phosphorus concentration in the septic tank effluent. Literature and experience indicate that there would not be any measurable Nitrates or Nitrites in the septic tank effluent. The Team understood that the purpose of requesting sampling and testing for total coliform and E. coli was to determine if pathogens could be transmitted to groundwater from the wastewater but proposed to test only for E. coli in the groundwater, anticipating that there would be total coliform in the shallow groundwater from other natural sources regardless of the septic systems. The Team also anticipated that E. coli in a septic tank would be "too numerous to count", and therefore the test results would not provide useful data.

PROPOSED SAMPLING

- Septic Tank Effluent- The Team proposed to sample and test the field parameter, with the exception of Dissolved Oxygen, which should not be present, and proposed to test for Ammonia, Total Phosphate, and Chlorides. The purpose of the lab tests was primarily to determine the concentration of the constituents being applied to the leachfield. The Team did not propose to sample and test for E. coli or total coliform, again, believing the colonies to be too numerous to count.
- Leachfield- The leachfield monitoring points were proposed as two lysimeters and one monitoring well. The lysimeters would be set at 1'± and 3'± below the bottom of the leachfield; the parameters tested would be all the field parameters plus Ammonia, Nitrate, Total Phosphate, Chlorides, and E. coli. The purpose of the lysimeter testing was to determine if the nitrification process in the upper section of the leachfield was converting the Ammonia to Nitrate and if the anoxic zone below was effectively converting Nitrates to Nitrogen gas during all seasons. The monitoring well in the leachfield allowed for sampling of groundwater directly below the leachfield prior to substantial dilution. Parameters tested in the leachfield monitoring well included all of the field parameters plus Ammonia, Nitrate, Orthophosphate, Total Phosphate, Chlorides, and E. coli.
- Monitoring Wells- The Team proposed one upgradient monitoring well to determine the background water quality prior to the septic system, three monitoring wells downgradient and about 10 feet from the leachfield, and two monitoring wells downgradient and about 50 feet from the leachfield. The Team initially did not believe that it would be necessary to sample each of the wells 10 feet downgradient of the leachfield every month of the year, and based on the gradient, proposed sampling just two of the three wells to reduce the overall number of samples. The Team anticipated that irrigation ditches and surface water ponds could affect the groundwater gradient and that the gradient would shift seasonally; once the direction of groundwater movement was determined, it was thought that it could be possible to strategically eliminate the sampling of one or more of the downgradient wells thus reducing field time and laboratory costs. Ultimately, all downgradient wells were sampled monthly. Parameters tested in the groundwater monitoring wells included all of the field parameters plus Ammonia, Nitrate, Orthophosphate, Total Phosphate, Chlorides, and E. coli.

TABLE 1-2 Summary of Proposed (Amended) Sampling Sites and Laboratory Analysis

Sampling Location	No. of Sampling Points	LABORATORY ANALYSIS PARAMETERS				
		Nitrogen, Ammonia as N	Phosphorus, Total	Chloride	Nitrogen, Nitrate as N	E. coli
SEPTIC TANK						
Effluent	1	1	1	1		
LEACHFIELD						
Lysimeters (-1' and -3')	2	2	2	2	2	2
Groundwater	1	1	1	1	1	1
GROUNDWATER						
Upgradient	1	1	1	1	1	1
Downgradient (10')	3	3	3	3	3	3
Downgradient (50')	2	2	2	2	2	2
TOTAL PER SITE	**10**	**10**	**10**	**10**	**9**	**9**
MAX PER FOUR SITES	**40**	**40**	**40**	**40**	**36**	**36**

SEPTIC SYSTEM SITES

The initial project scope required that six sites be sampled – three pressurized or raised systems and three traditional, gravity systems in locations with relatively shallow groundwater for a one-year period.

The Team was of the opinion that the number of septic systems to be monitored could be reduced, but the minimum number should be four to ensure statistically accurate results. From there the plan was to select two septic systems that were conventional gravity systems with a good distribution system, and two raised mound pressure distribution systems; however, since the focus was shallow groundwater applications (10 feet deep or less) to facilitate easier installation and sampling of the groundwater, a decision was made to choose raised mound systems instead. (Two systems consisted of leachfields constructed of pipe and gravel and two were constructed using drain tiles or standard infiltrator units to distribute the effluent.) All four systems would be required to have documented design records, installation inspections, and regular maintenance, as previously mentioned, to ensure that the systems to be monitored were properly designed and constructed and maintained on a regular basis. Monitoring a system that was not properly designed, installed or maintained, would insert additional variables that could invalidate the statistical analysis of the monitoring program.

2. Onsite Wastewater Treatment System

A conventional onsite wastewater treatment system consists of a septic tank and subsurface infiltration system, which discharges to groundwater and usually relies on the unsaturated or vadose zone for final polishing of the wastewater before it enters the saturated zone.

A septic system is a highly efficient, self-contained, underground wastewater treatment system. Because septic systems treat and dispose of household wastewater onsite, they are often more economical than centralized sewer systems in rural areas where lot sizes are larger and houses are spaced widely apart. Septic systems are also simple in design, which make them generally less expensive to install and maintain. And by using natural processes to treat the wastewater onsite, usually in a homeowner's backyard, septic systems don't require the installation of miles of sewer lines, making them less disruptive to the environment.

A septic system consists of two main parts: a septic tank and a drainfield. The septic tank is a watertight box, usually made of concrete, with an inlet and outlet pipe. Wastewater flows from the home to the septic tank through the sewer pipe. The septic tank treats the wastewater naturally by holding it in the tank long enough for solids and liquids to separate. The wastewater forms three layers inside the tank. Solids lighter than water (such as greases and oils) float to the top forming a layer of scum. Solids heavier than water settle at the bottom of the tank forming a layer of sludge. This leaves a middle layer of partially clarified wastewater.

The layers of sludge and scum remain in the septic tank where anaerobic bacteria found naturally in the wastewater work to break the solids down. The sludge and scum that cannot be broken down are retained in the tank until the tank is pumped. The layer of clarified liquid flows from the septic tank to the drainfield or to a distribution device, which helps to uniformly distribute the wastewater in the drainfield. A standard drainfield (also known as a leachfield, disposal field, or a soil absorption system) is a series of trenches or a bed lined with gravel or coarse sand and buried one to three feet below the ground surface. Perforated pipes or drain tiles run through the trenches to distribute the wastewater. The drainfield treats the wastewater by allowing it to slowly trickle from the pipes out into the gravel and down through the soil. The gravel and soil act as biological filters.

INFLUENT WASTEWATER CHARACTERISTICS

Potential groundwater pollutants from septic tank systems are primarily those associated with domestic wastewater. Contaminants originating from sewer system cleaning can also contribute to groundwater pollution potential of septic tank systems. Based on numerous studies, the volume of wastewater introduced to a septic tank system for a residential household may range from 26 to 85 gallons/person/day (gpcd). A study published in the "USEPA Onsite Wastewater Treatment Systems Manual"[(2)] of 1188 residential houses showed a mean per capita daily indoor use of 69.3 gpcd, a median of 60.5 gpcd, with a standard deviation of 39.6 gpcd. Leaks in household water fixtures discharging to the sewer system and infiltration/inflow in the sewer system may contribute to the influent flow to the septic tank.

Maximum and minimum flows and instantaneous peak flow variations are necessary factors in properly sizing and designing septic systems. The system should be capable of accepting and treating normal peak events without compromising performance. Peak flows for sizing sewer systems are typically determined by summation of fixture units in accordance with the International Plumbing Code. Septic tanks in Wyoming are sized to provide 40+ hours of detention time based on 150 gpd per bedroom with a minimum septic tank size of 1000 gallons. While this capacity may seem like much more than is necessary, given the average gallons per capita per day, the volume is calculated to provide room for solids build up on the bottom and scum accumulation on the surface, leaving sufficient capacity for anaerobic digestion of the wastewater without frequent pumping or cleaning of the tank.

The quality characteristics of wastewater entering septic tank systems are summarized in the following table taken from the USEPA Onsite Wastewater Treatment Systems Manual[(2)].

TABLE 2-1 Constituent Mass Loadings and Concentrations in Typical Residential Wastewater [a]

Constituent		**Mass Loading (grams/person/day)**	**Concentration [b] (mg/L)**
Total Solids (TS)		115-200	500-800
Volatile Solids (VS)		65-85	280-375
Total Suspended Solids (TSS)		35-75	155-330
Volatile Suspended Solids (VSS)		25-60	110-265
5-day Biochemical Oxygen Demand (BOD_5)		35-65	155-286
Chemical Oxygen Demand (COD)		115-150	500-660
Total Nitrogen (TN)		6-17	26-75
Ammonia (NH_4)		1-3	4-13
Nitrites and Nitrates (NO_2-N; NO_3-N)		<1	<1
Total Phosphorus (TP)[c]		1-2	6-12
Fats, Oils and Grease (FOG)		12-18	70-105
Volatile Organic Compounds (VOC)		0.02-0.07	0.1-0.3
Surfactants		2-4	9-18
Total Coliforms (TC)[d]		-	10^8-10^{10}
Fecal Coliforms (FC)[d]		-	10^6-10^8

[a] For typical residential dwellings equipped with standard water using fixtures and appliances

[b] Milligrams per liter; assumed water use of 60 gpcd

[c] The detergent industry has lowered the TP concentrations since early studies therefore Sedlak (1991) was used for TP data

[d] Concentrations presented in Most Probable Number of organisms per 100 milliliters (MPN)

Source: Adapted from Bauer et al., 1979; Bennett and Linstet, 1975; Laak, 1975, 1986; Sedlak, 1991; Tchobanoglous and Burton, 1991.

The physical and chemical constituents in septic tank influents are reasonably comparable in their concentrations to medium strength community domestic wastewater. Bacteria counts in household wastewater tend to be lower than in community wastewater, with a possible cause being a shorter incubation time from the source to the septic tank in comparison with time from the source to the community treatment plant.

SEPTIC TANK TREATMENT EFFICIENCY

Numerous studies have been made of the treatment efficiencies and effluent qualities from septic tanks, with fewer reported studies related to soil absorption systems efficiencies.

The septic tank serves several important functions such as solid-liquid separation, storage of solids and floatable materials, and anaerobic treatment of both stored solids as well as non-settleable organic materials. Previous studies have shown that the treatment efficiency of the septic tanks is variable, probably due to the fact that most of the residential wastewater is discharged to the septic tank in a short period of time, four to eight hours, thus reducing the effective detention time in a tank sized for daily flow.

The treatment processes that contribute to the septic tank treatment efficiency is settling of the solids and anaerobic digestion of the settled biosolids. These processes remove up to 50% of the BOD_5 resulting in an effluent that is primarily soluble BOD_5.

The Total Nitrogen (organic plus Ammonia) in the septic tank influent averages 40 mg/l with 32% in the Ammonium form. Anaerobic digestion of the organic Nitrogen converts most of the Nitrogen to the Ammonium form. Therefore, the septic tank is ineffective in Nitrogen removal, but it does cause conversion of organic Nitrogen to Ammonium. The Nitrates concentration in septic tank effluents is low due to the lack of Oxygen in that environment.

The anaerobic digestion process occurring in the septic tank converts most of the influent phosphorous, both organic and condensed Phosphate forms, to soluble Orthophosphate. Septic tanks are not highly efficient in Phosphorus removal.

Based on the composite information from 41 tank systems the following table represents typical physical and chemical parameter effluent concentrations from septic tanks.

TABLE 2-2 Summary of Effluent Quality from Various Septic Tank Studies [a]

Parameter		Sample-Weighted Average [b]
Suspended Solids		77 mg/l
BOD_5		142 mg/l
COD		296 mg/l
Total Nitrogen		42 mg/l
Total Phosphorous		15 mg/l

[a] Septic Tank System Effects on Ground Water Quality, Canter and Knox, 1985[3]
[b] Calculated from 5 studies of 41 septic tanks

As temperature decreases, so does microbial activity. It has been found that microbes in wastewater become dormant from 35 to 39°F. Temperature also affect the flow and mixing characteristics in the septic tank. Very little research evaluating septic tank treatment at varying temperatures is available. However, on study of the anaerobic digestion of septic tanks and temperature effects at 41°F, 50°F, and 68°F found organic removal efficiency impact are minimal at higher hydraulic retention times. This is a positive outcome for cold climates with larger septic tank capacities. The septic tank at 68°F consistently achieves higher levels of performance compared to tanks a 41°F and 50°F. The septic tank operating at 41°F was the most affected by hydraulic retention time changes (Viraraghavan and Dickenson, 1991)[4].

SOIL ABSORPTION SYSTEM EFFICIENCY

Pretreated wastewater from the septic tank enters the subsurface infiltration system at the surface of the infiltration zone. A biological layer (biomat) forms in this zone, which usually is only a few centimeters thick. Most of the physical, chemical and biological treatment of the pretreated effluent occurs in this zone and in the vadose zone below the biomat. Particulate matter in the septic tank effluent accumulates on the infiltrative surface and within the pores of the soil matrix, providing a source of carbon and nutrients to the active biomass. New biomass and its metabolic by-products accumulate in this zone. The accumulated biomass, particulate matter, and metabolic by-products reduce the porosity and the infiltration rate through them. Thus, the infiltration zone is a transitional zone where fluid flow changes from saturated to unsaturated flow. The biomat controls the rate at which the pretreated wastewater moves through the infiltration zone in coarse to medium textured soils, but it is less likely to control the flow through fine textured silt and clay soils because they may be more restrictive to flow than the biomat.

Nitrogen

The transport and fate of Ammonium ions may involve adsorption, cation exchange, incorporation in microbial biomass, or release to the atmosphere in the gaseous form. The effluent from the septic tank is spread over a sand layer at the upper level of the drainfield. The suspended solids, organic material, and bacteria accumulate on the sand creating a thin layer (2-3 mm) of biomass. The aerobic bacteria in the biomass digest the organic material and convert the Ammonia to Nitrate.

Anaerobic conditions will normally prevail below the upper layers of soil beneath the soil absorption system but above the groundwater. Under these conditions, positively charged Ammonium ions (NH_4^+) are readily adsorbed onto negatively charged particles.

Nitrates can be formed by nitrification, the conversion of Ammonium ion to Nitrites and to Nitrates. Nitrification (NH_4^+ to NO_2^- to NO_3^-) is an aerobic reaction performed primarily by autotrophic organisms, and Nitrate is the predominant end product. Nitrification is dependent on the aeration of the soil which in turn is dependent on the soil characteristics, percolation rate, loading rate, and distance to groundwater. Effluent from septic systems located in sandy soils can be expected to undergo predominately aerobic reactions.

Denitrification is another important Nitrogen transformation in the subsurface environment underlying septic tank systems. It is the only mechanism by which the NO_3^- concentration in the percolating (and oxidized) effluent can be decreased. Denitrification, or the reduction of NO_3 to NO_2 or N_2, is a biological process performed primarily by ubiquitous facultative heterotrophs. In the absence of O_2, NO_3^- acts as an acceptor of electrons generated in the microbial decomposition of an energy source. However, in order for the denitrification to occur in soils beneath a home waste disposal system, the Nitrogen must usually be in the NO_3^- form and an energy source (organic carbon) must be available. Therefore nitrification, an aerobic reaction, must occur before denitrification. (Septic Tank System Effects on Ground Water Quality, Canter and Knox, 1985)[3].

Like other biochemical reactions, microbial nitrification and denitrification activity is affected by temperature. The activity increases with reaction temperature, and nitrification/denitrification is limited when wastewater temperature and soil temperature is below 10°C (Water Environment Federation, 1998)[(5)].

Nitrogen in the form of Nitrate will become very mobile if it reaches the groundwater because of its solubility and anionic form. Nitrates can move with groundwater with minimal transformation. They can migrate long distances from input areas if there are highly permeable subsurface materials which contain Dissolved Oxygen. (Septic Tank System Effects on Ground Water Quality, Canter and Knox, 1985)[(3)].

Chlorides
Chlorides are natural constituents in groundwater and household wastewater. Septic systems are ineffective for Chloride removal. Due to their anionic form (Cl^-) and mobility with the water, Chlorides can be useful as a tracer or indicator of septic tank system pollution.

Phosphorus
The anaerobic digestion process occurring in the septic tank converts most of the influent Phosphorus, both organic and condensed Phosphate forms, to soluble Orthophosphate. Septic tank portion of septic tank systems are not highly efficient in Phosphorus removals. (Septic Tank System Effects on Ground Water Quality, Canter and Knox, 1985)[(3)].

While Phosphorus can move through soils underlying soil absorption systems and reach groundwater, this has not been a major concern since Phosphorus can easily be retained in the underlying soils due to chemical changes and adsorption.

Biological Contaminants
The potential for biological contamination of groundwater by percolation from septic tank systems is high. Biological contaminates (pathogens) have a wide variety of physical and biological characteristics, including wide ranges in sizes, shape, surface properties, and die-away rates. There have been numerous studies of the transport and fate of bacteria and viruses in soils and groundwater associated with septic tank systems.

Several mechanisms combine to remove bacteria and viruses in soil. The physical process of straining (chance contact) and the chemical process of adsorption (bonding and chemical interaction) appear to be the most significant. The most important factors that may influence removal efficiency of bacteria and viruses is flow rate and soil type. Low flow rates (adsorption field loading rates) result in very efficient removal of bacteria and viruses. Sandy soils with low water holding capacity have a lower survival rate.

Trace Organic Constituents
Trace organic compounds can be present in septic tank effluent from oil and grease residues introduced during dish washing, clothes laundering, and other cleaning tasks. However, typically these compounds are not detected in the underlying groundwater plume, indicating relatively complete volatile organic compound (VOC) transformation in a sandy unsaturated zone.[(6)]

Overall, properly-functioning septic systems provide a high degree of removal of trace organic constituents, particularly in the drainfield unsaturated zones, although some recalcitrant compounds can persist. However, these same compounds also persist through conventional sewage treatment as well.[(6)]

FAILING SEPTIC SYSTEMS

The previous sections discuss the relatively high degree of treatment that a properly (designed, constructed and maintained) functioning septic system will provide for many wastewater constituents. However, studies have documented impacts from septic systems on surface water courses, and the data suggests that the surface water impacts are the result of seepage of untreated wastewater from 'failing' septic systems. Septic system failure is a term commonly used when wastewater discharged to a drainfield does not percolate into the subsurface, but breaks out onto the surface and drains into a nearby surface water course. This can result from inadequate percolation through the drainfield, from soil clogging, high groundwater, or mechanical failure.[6]

3. Site Selection and Characteristics

As previously mentioned, four monitoring sites were chosen for sampling, two of the pipe and gravel construction and two of the infiltrator construction. To protect the privacy of the volunteers, the sites will be referred to by number only. Study Site Location Maps can be found in Appendix A. The record Teton County Small Wastewater Facility permits for all four sites are included in Appendix B.

Sites were chosen based on design/installation records and proper maintenance, groundwater depth, the number of full-time residents, the age of the system, and the available land for placement of downgradient monitoring wells.

Site 1

The system located at Site 1 was built on or around 9/15/1994 and sized at 600gpd to accept wastewater from a 3-bedroom, 3-bathroom house and a 1-bedroom, 1-bathroom apartment above the garage. The septic tank is a dual chamber 1500-gallon capacity vault, and the lift station is a single compartment 1000-gallon capacity vault. The type of leachfield construction is a gravel bed mound system, with a site percolation rate of 3 min/inch, but fill was used with a percolation rate of 10 min/inch. The leachfield area is 1000sf (25' wide by 40' long) and consists of a 2-inch diameter manifold to 1-inch diameter perforated pipe, 5-feet on center, with pressure discharge, 12 inches of one to two-inch washed rock, and 24 inches of pit run. Estimated depth to seasonal groundwater, as given in the permit documentation, is 3.33 feet. Occupancy is typically two adults in the main home.

Design and calculated flow rate data is given in the table below.

TABLE 3-1 Site 1 Flows

Design Application Rate	0.6	gpd/sf
Average Application Rate	0.09	gpd/sf
Peak Month Rate	0.32	gpd/sf
Pump	18.46	gpm
Vol Cycle	143	gal

Monitoring wells for Site 1 were installed on 7/23/20, 8/6/20, and 9/25/20.

Site 2

The system located at Site 2 was built on or around 7/2/1993 and sized at 600gpd to accept wastewater from a 3-bedroom, 2-bathroom house and a 1-bedroom, 1-bathroom apartment above the garage. The septic tank is a dual chamber 1000-gallon capacity vault, and the lift station is a single compartment 1000-gallon capacity vault. The type of leachfield construction is a gravel bed mound system, with a site percolation rate of 15 min/inch. The leachfield area is 1152sf (24' wide by 48' long) and consists of a 2-inch diameter manifold to 4-inch diameter perforated pipe, 6-feet on center, with gravity discharge from perforated pipe, and 12 inches of gravel. Measured depth to seasonal groundwater, as given in the permit documentation, is 4.5 feet. Occupancy is typically two adults, one in the main home and one in the garage apartment.

Design and calculated flow rate data is given in the table below.

TABLE 3-2 Site 2 Flows

Design Application Rate	0.52	gpd/sf
Average Application Rate	0.13	gpd/sf
Peak Month Rate	0.16	gpd/sf
Pump	97.54	gpm
Vol Cycle	178.8	gal

Monitoring wells for Site 2 were installed on 7/22/20 and 9/16/20.

Site 3

The system located at Site 3 was built on or around 10/18/2013 and sized at 900gpd (the equivalent of six bedrooms) to accept wastewater from a 4-bedroom, 3-full-bathroom and 3-half-bathroom house, barn, and greenhouse/workshop/garage. The septic tank is a dual chamber 1500-gallon capacity vault, and the lift station is a single compartment 1000-gallon capacity vault. The type of leachfield construction is an infiltrator chamber bed (64 chambers) mound system, with a percolation rate of 10 min/inch (lower soil) and an average of 54 min/inch (upper soil). The leachfield area is 864sf (12' wide by 72' long) and consists of a 2-inch diameter line from the pump to a 1.5-inch diameter manifold to eight 1-inch diameter laterals strung through the infiltrator units. Each lateral is perforated with eight 3/16-inch diameter holes facing upward at 4-feet on center. The mound itself is composed of five feet of pit run fill over silty loam. Measured depth to seasonal groundwater as given in the permit documentation is 3.43 feet. Occupancy is typically two adults and two children in the main home.

Design and calculated flow rate data is given in the table below.

TABLE 3-3 Site 3 Flows

Design Application Rate	1.04	gpd/sf
Average Application Rate	0.56	gpd/sf
Peak Month Rate	0.66	gpd/sf
Pump	85.83	gpm
Vol cycle	178.8	gal

Monitoring wells for Site 3 were installed on 7/21/20, 8/6/20, and 9/16/20.

Site 4

The system located at Site 4 was built on or around 8/19/1999 and sized at 750gpd to accept wastewater from a 3-bedroom, 3-bathroom main house and a 2-bedroom, 2-bathroom guest house. The septic tank is a dual chamber 1500-gallon capacity vault, and the lift station is a single compartment 1000-gallon capacity vault. The type of leachfield construction is an infiltrator chamber bed (42 chambers) mound system, with a percolation rate of 10 min/inch. The leachfield area is 788sf (18' wide by 43.75' long) and consists of pressure discharge through a 2-inch diameter line from the pump to a 3-inch diameter manifold to six 1.5-inch diameter laterals strung through the infiltrator units. Each lateral is perforated with seven 1/4-inch diameter holes facing upward at 6.25-feet on center. The mound itself is composed of six inches of pea rock and 24 to 30 inches of 3-inch minus pit run. Estimated depth to seasonal groundwater as given in the permit documentation is 2 feet. Occupancy is typically two adults and two children in the main home and an assumed average of two adults in the guest house.

Design and calculated flow rate data is given in the table below.

TABLE 3-4 Site 4 Flows

Design Application Rate	0.952	gpd/sf
Average Application Rate	0.481	gpd/sf
Peak Month Rate	0.702	gpd/sf
Pump	59.98	gpm
Vol Cycle	107.96	gal

Monitoring wells for Site 4 were installed on 9/9/20.

4. Sampling Procedures

A Septic System Effluent Monitoring Sampling and Analysis Plan (SAP), prepared by Alder Environmental LLC can be found in Appendix C. Following are excerpts from the SAP that summarize the sampling procedures that were utilized during the project. The SAP describes the methodology that was chosen to provide reliable and repeatable monitoring of the typical septic systems found in Teton County. Sites were selected based on the criteria identified in the previous section. Raw Field Data Forms can be found in Appendix D, and Laboratory Data can be found in Appendix E.

Sampling Frequency and Timeframe

The septic tank effluent and each well and lysimeter were sampled at all locations monthly, for a period of 17 months. The sampling regime included sampling over a duration of one year at minimum in order to capture seasonal fluctuations in the groundwater table, as well as to capture seasonal climatic changes.

Well Array Design and Purpose

A well array design was prepared and installed to successfully and accurately assess impacts to groundwater while being cost effective and minimally invasive and damaging to landowners' properties and leachfield. The well array included one upgradient well, one well within the leachfield, and five downgradient monitoring wells. Additionally, two lysimeters were installed directly below the adsorption field at a depth of one and three feet below the infiltrators. The effluent from the septic tank was sampled directly from the lift stations.

Seven groundwater monitoring points were installed. The monitoring points included one upgradient monitoring well installed to determine the background water quality prior to the septic system, one monitoring well installed in the leachfield, three monitoring wells installed downgradient and about 10 feet from the leachfield, and two monitoring wells installed downgradient and about 50 feet from the leachfield.

The purpose of the monitoring well upgradient of the adsorption field was to obtain a background water sample to adequately quantify the dilution of Nitrates discharged from the adsorption field. The purpose of the monitoring well in the leachfield was to allow for groundwater sampling directly below the leachfield prior to substantial dilution. The purpose of installing and collecting samples from the two lysimeters at different depths was to determine if the nitrification process in the upper section of the leachfield is converting the Ammonia to Nitrate and if the anoxic zone below is effectively converting Nitrates to Nitrogen gas during all seasons. The lysimeter testing was intended to determine the amount of nitrification and denitrification that occurs prior to the wastewater comingling with the groundwater, and to determine the bacterial (E. coli coliform) removal in this zone. The lysimeters allowed for moisture to be pulled from the vadose zone into a ceramic pot through the use of a vacuum pump, to retrieve the sample for laboratory analysis.

WASTEWATER METHODS

Pump run time meters were installed in the pump controllers. The purpose was to quantify the amount of wastewater that is applied to the adsorption field on a monthly basis between sampling.

The method used depended on the septic tank/adsorption field configuration, but each method allowed for the determination of monthly flows. Since all sampling sites were pumped, a counter was installed to monitor pump starts, and draw down was measured between the pump ON and OFF, to determine how much effluent was pumped.

LYSIMETER DESIGN AND INSTALLATION METHODS

At each site, two lysimeters were installed directly below the adsorption field at depths of 1'+/- and 3'+/- below the bottom of the leachfield. Lysimeters installed were Soilmoisture's Model 1920F1 Pressure-Vacuum Soil Water Samplers, which came fully assembled. The operating instructions state that "the unit is constructed of a 1.9-inch O.D. PVC tube (made of FDA-approved material) with a 2-bar porous ceramic cup bonded to one end. The serviceable end of the Sampler was completely sealed, and two 1/4-inch tube connectors protrude from the top. The white tube connector indicates the "Pressure/Vacuum" side and is used exclusively for pressurizing and evacuating the Sampler. The green tube connector is used to recover the collected sample. Two 1/4-inch O.D. polyethylene access tubes were used for pressurizing and recovering samples which terminated in neoprene tubing. Clamping rings were used to clamp the neoprene to keep the Sampler under negative pressure." An extraction kit was required for sample retrieval and a vacuum pump is required to evacuate the sampler. A Model 2006G2 Pressure-Vacuum Hand Pump and Model 1900K3 1,000 ml Extraction Kit was used. A 2-1/2" well bore pipe with a drive point was used for lysimeter installation and bedded with sand and a silica slurry. Lysimeters were covered with an irrigation valve box (labeled with site identification) to contain all tubing.

WELL DESIGN AND INSTALLATION METHODS

At each site, monitoring wells were installed at the seven locations identified above in an array that takes into account the site's localized groundwater gradient. As previously stated, an upgradient monitoring well was installed, along with a monitoring well within the adsorption field and five monitoring wells downgradient of the adsorption field. Three of the downgradient monitoring wells were approximately 10 feet downgradient of the adsorption field and two were approximately 50 feet downgradient of the adsorption field. It was anticipated that at some sites, because of seasonal surface flow, the groundwater gradient may shift thus requiring that the monitoring wells be located to allow accurate sampling during all seasons.

Shallow (about 8-10 feet below ground surface), small diameter 1.0-inch PVC monitoring wells were installed at each site. The monitoring wells were installed at a depth where groundwater sampling could occur through the full range of seasonal groundwater depths. Typically, the seasonal groundwater elevation on the west bank of the Snake River varies 2-3 feet; however, there are locations where the variation is 6-7 feet.

1. The PVC well casings were perforated by the manufacturer. Therefore, monitoring wells had perforations approximately 2 feet below and 2 feet above the average groundwater level. Anticipated depth below ground level was 6 to 10 feet.
2. Two 5-foot perforated sections were put together, and the top portion (approximately 2 feet) of the perforation was duct taped.
3. The wells were installed using a vibratory hammer to drive a 2.5" steel pipe with steel well point to the desired depth. The perforated PVC pipe was then installed, installing silica sand in the annulus between the steel pipe and PVC pipe and withdrawing the steel pipe. The well casing

and ground surface interface was plugged with bentonite clay. A cap was placed on the top of the PVC well pipe. (In some instances, if requested by the landowner, an irrigation valve box was installed to cover the well at the ground surface and no bentonite clay was added).

4. At the completion of the monitoring and sampling, all equipment (including the monitoring wells) was removed, and the tubing to the buried lysimeters was cut.

Following installation of monitoring wells, a survey of well locations and well elevations was completed in order to be able to calculate groundwater elevations at each well, once future groundwater depth readings were measured during sampling events.

Sampling Parameters, Collection Methods and Laboratory Analysis

The following section describes the chemical and physical parameters that were collected in the field and analyzed in the laboratory.

SAMPLING PARAMETERS OVERVIEW

The methods presented below for sampling and measuring chemical water quality parameters generally followed the techniques described in the USGS' *National Field Manual for the Collection of Water-Quality Data* (Book 9), various dates[7]. Table 4-1 describes the lab parameters that were sampled for, as well as other information about the laboratory requirements and analyses. For the lab analyses, Energy Laboratories performed the nutrient parameter analysis; however, any similar USEPA-certified labs would be acceptable when attempting to reproduce this study.

TABLE 4-1 Laboratory Analytical Method Details

Parameter	Lab Method	Container/ Volume	Preservative	Storage	Holding Time	Reporting Units	Practical Quantitation Limit
Chloride	EPA 300.0	250mL Plastic	n/a	2°C to 6°C	28 days	mg/L	1
Bacteria, E. coli Coliform	A9223 B	100mL plastic sterile	n/a	2°C to 6°C	6 hours	MPN/100 mL	1
Nitrogen, Ammonia	EPA 350.1	250mL plastic	Sulfuric acid	2°C to 6°C	28 days	mg/L	0.05
Nitrogen, Nitrate + Nitrite	EPA 353.2	250mL plastic	Sulfuric acid	2°C to 6°C	28 days	mg/L	0.01
Phosphorus, Total	EPA 365.1	250mL plastic	Sulfuric acid	2°C to 6°C	28 days	mg/L	0.005
Phosphate, Total	Calculation	n/a	n/a	n/a	n/a	mg/L	0.03

Laboratory analysis parameters included nutrients (Ammonia, Nitrate plus Nitrite, Total Phosphorus, and Total Phosphate), major ions (Chloride), and biological (E. coli coliform bacteria).

Field parameters (Dissolved Oxygen, pH, Specific Conductance, and water temperature) were measured during all sampling events at all sites, except Dissolved Oxygen was not measured at the septic tank effluent monitoring site or from the lysimeters. The physical parameter of depth of water for groundwater monitoring wells was measured during all sampling events at all sites. Table 4-2 indicates which parameters were sampled and analyzed for, at which sites and at what frequency.

TABLE 4-2 Summary of Sampling Sites and Laboratory Analysis

Sampling Location		SEPTIC TANK	LEACHFIELD		GROUNDWATER		
Sampling Sites		Effluent	Lysimeters (-1' & -3')	Groundwater	Upgradient	Downgradient (10' distance)	Downgradient (50' distance)
# of Sampling Points		1	2	1	1	3	2
FIELD PARAMETERS	Dissolved Oxygen			1	1	3	2
	pH	1	2	1	1	3	2
	Specific Conductance	1	2	1	1	3	2
	Temperature	1	2	1	1	3	2
LABORATORY ANALYSIS PARAMETERS	Nitrogen, Ammonia as N	1	2	1	1	3	2
	Nitrogen, Nitrate + Nitrate as N		2	1	1	3	2
	Chloride	1	2	1	1	3	2
	Phosphorus, Total	1	2	1	1	3	2
	Phosphate, Total	1	2	1	1	3	2
	E. coli		2	1	1	3	2

At the septic tank effluent monitoring point, field parameters, except for Dissolved Oxygen which should not be present, was sampled and tested. Ammonia, Total Phosphorus, Total Phosphate, and Chlorides were also tested. The purpose of these lab tests is primarily to determine the concentration of the constituents being applied to the leachfield. E. coli was not tested for, as the colonies would likely be too numerous to count.

The parameters to be tested in the leachfield lysimeters include all the field parameters plus Ammonia, Nitrate plus Nitrite, Total Phosphorus, Total Phosphate, Chlorides, and E. coli. The parameters to be tested in the leachfield monitoring well and the groundwater monitoring wells include all the field parameters plus Ammonia, Nitrate plus Nitrite, Total Phosphorus, Total Phosphate, Chlorides, and E. coli.

INSTRUMENTATION AND CALIBRATION

Field water quality parameters were measured using a handheld multiparameter instrument, the YSI 556 Multiprobe System, or equivalent device. This multiprobe provides high resolution, accuracy, appropriate range, and field calibrations. Field instrumentation information for sampling can be found in Table 4-3.

Calibrations of the water quality field parameter probes were performed as recommended by the manufacturer. Calibration of the probes was done twice annually for temperature and at the beginning of each monthly sampling event for pH, Specific Conductance, and Dissolved Oxygen. The following calibration solutions were recommended for this project since their values cover the general range found in groundwater in the Fish Creek and Snake River watersheds:

- pH – a two-point calibration using 7.00 and 10.00 pH buffer solutions
- Specific Conductance – a solution concentration of 447 µS/cm
- Dissolved Oxygen – 100% air saturation method

TABLE 4-3 Field Instrumentation

Make	Meter Name	Parameters Measured	Model #	Serial #	Manual Link
Eutech Instruments/ Oakton	PCSTestr35	pH, conductivity, TDS, Salinity, Temperature	NA	1607981	http://www.4oakton.com/SellSheets/35425-00,-05,-10.pdf
YSI	Pro Plus Multiparameter Meter	pH, DO, conductivity ORP, Temperature	605596	16M101916	https://www.ysi.com/File%20Library/Documents/Manuals/605596-YSI-ProPlus-User-Manual-RevD.pdf
Geotech	Geopump peristaltic pump-Series 1	Water Samples	51350031	3328	http://www.geotechenv.com/Manuals/Geotech_Geopump_Peristaltic_Pump.pdf
Geotech	Geopump easy load II pump head	Water Samples	900-1280	L14004504	http://www.geotechenv.com/Manuals/Geotech_Geopump_Peristaltic_Pump.pdf
Soilmoisture	Pressure Vacuum Hand Pump	Soil Water Samples	2006G2		https://www.soilmoisture.com/pdfs/Resource_Instructions_0898-2006_2006G%20Pressure%20Vacuum%20Hand%20Pump.pdf

SEPTIC TANK SAMPLING

At each of the four septic pump vaults, unfiltered samples of effluent were collected directly from the vault. Samples were analyzed at the laboratory for Ammonia, Total Phosphorus, Total Phosphate, and Chlorides. Field parameters, except for Dissolved Oxygen which should not be present, (Specific Conductivity, pH, and temperature) were measured in the field.

Pre-Sampling Preparation

Pre-sampling preparation included:

- preparing appropriate data sheets
- checking and gathering of field and processing supplies and equipment
- ordering the proper bottle sets from the laboratory 2-3 weeks in advance of sampling date
- inventorying and ordering (if necessary) processing supplies

Energy Laboratories (Casper, WY) was employed for analysis of nutrients. Energy Labs bottles arrived with labels on and preservatives separate to be added to samples in the field.

The laboratory's instructions for preparing the bottles were followed and preservatives were added when needed. Protective nitrile gloves were worn when handling bottles to protect against contamination and protect samplers against acids and other preservatives. Safety goggles were used for sampling from the septic tanks.

Sample Collection

The septic tank effluent was collected using a low-flow peristaltic sampling pump.

The Septic Tank and Lysimeter Field Data Form was used to record sampling data.

Sampling Technique:

1. The port at the pump vault was inspected for signs of damage.
2. Water quality probes were rinsed with distilled water before and after use at each site.
3. Effluent water was extracted from the vault using a low-flow peristaltic pump and dedicated, site specific tubing. The intake end of the tubing was inserted into the septic tank. The outlet end of the tubing was placed into a dedicated flask or bottle. Effluent was sufficiently purged to ensure that the tubing was cleaned prior to sample collection. The purged effluent was collected into a flask or bottle, and field parameters (Specific Conductivity, pH, and temperature) were measured once with the Multi-Parameter Tester 35 (PCSTestr 35) from the flask or bottle. Field parameters were recorded on the Field Data Form. A Nitrate/Nitrite test strip was dipped into this purged water, read, and recorded. Purged water was disposed of back into the vault after sampling was complete.
4. Samples were collected. Preservatives were added to any bottles requiring them.
5. Sample bottles were labelled in the field with permanent/ waterproof markers. Site name, date and times were double-checked in the field.
6. After samples were collected, deionized water was flushed through the tubing and tubing was dried. The dry tubing was stored in a plastic bag for the next sampling event at each site. [Note: Some sites had dedicated tubing installed at the septic tank vault.]
7. The pump run time meter was checked and recorded on the Field Data Form.

Sample Preparation

Sample bottle caps were firmly placed on bottles and immediately placed in a plastic bag in a cooler containing ice. Samples were cooled to between 2-6° C until arrival at the laboratories. If different laboratories had been used, the laboratory's procedures would have been followed for storing samples until shipment. Table 4-1 provides the holding times and preservatives required for each parameter.

LYSIMETER SAMPLE COLLECTION

At the four leachfield sites, unfiltered samples were collected from the two lysimeters at each site. Samples were analyzed at the laboratory for Ammonia, Nitrate plus Nitrite, Total Phosphorus, Total Phosphate, Chlorides, and E. coli. Field parameters, except for Dissolved Oxygen which would not have been accurate as read from the lysimeters, (Specific Conductivity, pH, and temperature) were measured in the field.

Pre-Sampling Preparation

Pre-sampling preparation included:

- preparing appropriate data sheets
- checking and gathering of field and processing supplies and equipment
- ordering the proper bottle sets from the laboratory 2-3 weeks in advance of sampling date
- inventorying and ordering (if necessary) processing supplies

Energy Laboratories (Casper, WY) was employed for analysis of nutrients. Energy Labs bottles arrived with labels on and preservatives separate to be added to samples in the field.

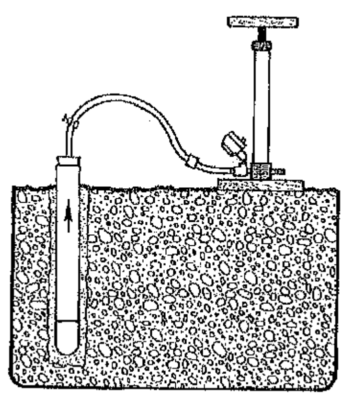
The laboratory's instructions for preparing the bottles were followed and preservatives were added when needed. Protective nitrile gloves were worn when handling bottles to protect against contamination and protect samplers against acids and other preservatives.

Sample Collection

The Septic Tank and Lysimeter Field Data Form was used to record sampling data.

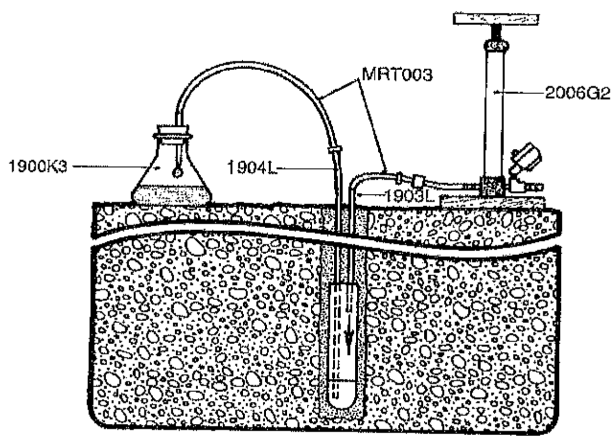
Sampling Technique (according to Soilmoisture's Operation Manual for 1920F1 Pressure-Vacuum Soil Water Samplers):

1. The area around the lysimeter was inspected for signs of damage.
2. To collect a sample, the discharge access tube was closed using a clamping ring, and the vacuum port of the hand pump was connected to the Pressure-Vacuum access tube. Using the pump, a vacuum of about 60 cb was created inside the Sampler, as indicated on the gauge connected to the pump and shown below.



NOTE: The vacuum within the sampler causes the moisture to move from the soil, through the porous ceramic cup, and into the sampler. The rate at which the soil solution collects within the sampler depends on the hydraulic conductivity of the soil, the soil suction value within the soil (as measured in tensiometers), and the amount of vacuum that has been created within the sampler. In moist soils of good conductivity, at field capacity (10 to 30 centibars of soil suction as read on a tensiometer), substantial soil water samples can be collected within a few hours. Under more difficult conditions, it may require several days to collect an adequate sample. In general, a vacuum of 50 to 85 cb is normally applied to the Soil Water Sampler. In very sandy soils, however, it has been noted that very high vacuums applied to the Soil Water Sampler seem to result in a lower rate of collection of the sample than a lower vacuum. In these coarse, sandy soils, the high vacuum within the Sampler may deplete the moisture in the immediate vicinity of the porous ceramic cup reducing the hydraulic conductivity, which creates a barrier to the flow of water to the cup. In loams and gravelly clay loams, users have reported collection of 300 to 500 ml of solution over a period of a day with an applied vacuum of 50 cb, when soils are at field capacity. At wastewater disposal sites, users have obtained 1500 ml of sample solution in 24 hours following cessation of irrigation with 1 to 2 inches of wastewater on sandy or clay loam soil.

3. To recover a soil water sample, the Pressure-Vacuum tube was removed from the vacuum port of the pump, and the tube was attached to the pressure port. The discharge access tube was placed in a small collection bottle and both clamping rings were removed. A few strokes were applied to the hand pump to develop enough pressure within the Sampler to force the collected water out of the Sampler and into the collection bottle, as shown below.



4. Subsequent samples were collected by again creating a vacuum within the sampler and following the steps as outlined above.
5. The soil water was collected from the lysimeter in a flask and poured into sample bottles. Preservatives were added to any bottles requiring them.
6. Sample bottles were labelled in the field with permanent/ waterproof markers. Site name, date and times were double-checked in the field.
7. Field parameters were measured from the remaining collected water in the flask using the Multi-Parameter Tester 35 (PCSTestr 35) instrument. Field parameters were recorded on the Field Data Form.
8. The multiprobe instrument was rinsed with distilled water prior to and after each use.
9. After sampling completion, the tube ends were covered or plugged to prevent debris from entering the tubes and later contaminating the Sampler.
10. All water was removed from the sample line before clamping it for the next sample.

Sample Preparation

Sample bottle caps were firmly placed on bottles and immediately placed in a plastic bag in a cooler containing ice. Samples were cooled to between 2-6° C until arrival at the laboratories. If different laboratories would have been used, the laboratory's procedures would have been followed for storing samples until shipment. Table 4-1 provides the holding times and preservatives required for each parameter.

WELL SAMPLE COLLECTION

At each of the four sites, unfiltered samples were collected from the seven groundwater monitoring wells at each site. These seven monitoring wells include the following: one upgradient monitoring well, one monitoring well in the leachfield, three monitoring wells downgradient and about 10 feet from the leachfield, and two monitoring wells downgradient and about 50 feet from the leachfield.

For all monitoring wells, samples were analyzed at the laboratory for Ammonia, Nitrate plus Nitrite, Total Phosphorus, Total Phosphate, Chlorides, and E. coli. Field parameters (Dissolved Oxygen, Specific Conductivity, pH, and temperature) were measured in the field.

Pre-Sampling Preparation

Pre-sampling preparation included:

- preparing appropriate data sheets
- checking and gathering of field and processing supplies and equipment
- ordering the proper bottle sets from the laboratory 2-3 weeks in advance of sampling date
- inventorying and ordering (if necessary) processing supplies

Energy Laboratories (Casper, WY) was employed for analysis of nutrients. Energy Labs bottles arrived with labels on and preservatives separate to be added to samples in the field.

The laboratory's instructions for preparing the bottles were followed and preservatives were added when needed. Protective nitrile gloves were worn when handling bottles to protect against contamination and protect samplers against acids and other preservatives.

Sample Collection

The monitoring wells were purged using a low-flow peristaltic sampling pump, and all field parameters were measured continuously in a flow cell during the purging process until the water characteristics were consistent of groundwater. The key constituents for this determination were temperature and Dissolved Oxygen (DO) concentration in the purged water. Water sample collection began once field parameters stabilized, and samples were collected from the monitoring wells at the top six inches of the groundwater.

The Groundwater Well Field Data Form was used to record sampling data.

Sampling Technique:

1. The area around the wellhead and casing was inspected for signs of damage.
2. Water quality probes were rinsed with distilled water before and after use at each site.

3. The groundwater level was measured using a clean water level meter. Both the depth to water below the top of casing and the depth to the bottom of the well were measured to the hundredths of a foot.
4. The water volume was calculated using the formula provided in the Field Data Sheet.
5. Water was purged from the well using a low-flow peristaltic pump and dedicated, site-specific tubing (one dedicated tube was used for all groundwater wells at each site – starting at the upgradient well, distilled water was flushed through the tubing between leachfield well and all downgradient wells). The intake end of the tubing was inserted into the well to a depth of approximately 6" below the water's surface. The outlet end of the tubing was connected to the flow cell containing the multiprobe instrument. The purge volume for each well was at least 3 well volumes or when field water quality parameters stabilized, in order to assure that fresh formation groundwater was sampled. Purged water was discharged into a bucket and disposed of downgradient of the well and far enough away to prevent recharging the well.
6. Final, stabilized temperature, pH, Specific Conductance, and Dissolved Oxygen were recorded on the Field Data Form.
7. Samples were not collected until field parameter measurements had stabilized. The flow cell was disconnected before samples were collected.
8. Sampling followed low flow sampling techniques, requiring a flow rate between 100-500 mL/minute.
9. Samples were collected. Preservatives were added to any bottles requiring them.
10. Sample bottles were labelled in the field with permanent/ waterproof markers. Site name, date and times were double-checked in the field.
11. After samples were collected, distilled water was flushed through the tubing and tubing was dried. The dry tubing was stored in a plastic bag for the next sampling event at each site.

Sample Preparation

Sample bottle caps were firmly placed on bottles and immediately placed in a plastic bag in a cooler containing ice. Samples were cooled to between 2-6° C until arrival at the laboratories. If different laboratories would have been used, the laboratory's procedures would have been followed for storing samples until shipment. Table 4-1 provides the holding times and preservatives required for each parameter.

DEPTH TO GROUNDWATER

Methods for measuring water levels in wells are described in Garber and Koopman (1978)[8].

The groundwater level was measured using a clean water level meter. Both the depth to water below the top of casing and the depth to the bottom of the well were measured to the hundredths of a foot.

Pre-Sampling Preparation

Pre-sampling preparation included:

- preparing appropriate data sheets
- checking and gathering of field equipment
    - a vice grip for removing the well caps
    - a Solinst model 102 or equivalent water level meter

Depth Measurements

Methods from USGS' *National Field Manual for the Collection of Water-Quality Data* (Book 9) were used.

1. The well was checked for any damage and potential for contamination.
2. The diameter of the well was measured and well construction material was recorded.
3. The water level meter probe and line were cleaned with nonphosphate laboratory soap, like Liquinox, and rinsed with distilled water prior to depth measurements.
4. The depth to groundwater surface was measured from the top of the pipe (north side) and recorded on the Field Data Form.
5. The probe was then lowered until reaching the bottom of the well. This distance was recorded as the depth to the well bottom from the top of the pipe.
6. The well cap was replaced securely after measurements were completed.

Quality Assurance/Quality Control (QA/QC)

Quality Assurance (QA) may be defined as an integrated system of management procedures designed to evaluate the quality of data and to verify that the quality control system is operating within acceptable limits (Friedman and Erdmann, 1982; Eaton et al., 1995)[9,10]. Quality Control (QC) may be defined as the system of technical procedures designed to ensure the integrity of data by adhering to proper field sample collection methods, operation and maintenance of equipment and instruments. Together, QA/QC functions to ensure that all data generated is consistent, valid, and of known quality (U.S. Environmental Protection Agency, 1983; 1990)[11]. QA/QC should not be viewed as an obscure notion to be tolerated by monitoring and assessment personnel, but as a critical, deeply integrated concept within each step of the monitoring process.

Standardized field procedures were followed to prevent contamination of the samples, and these guidelines are stated below. QC included both internal and external measures. It is the duty of the sampler to ensure internal QA/QC in all stages of the monitoring. External QC involved the contract laboratories.

EQUIPMENT MAINTENANCE

All equipment and instrumentation were properly maintained according to the manufacturer's instructions, as previously described.

FIELD QUALITY CONTROL SAMPLES

Quality Control sampling sites were selected using random numbers generated by www.random.org or another random table generator. Sampling sites were numbered 1-4 and groundwater wells were numbered 1-7 at each site. Therefore, a random number between 1-28 was selected for each sampling event, corresponding to one well at a particular site (i.e., MW1 at Site 2 would be used for the QA/QC site if 8 was the random number generated).

Field Duplicates

Duplicate samples are defined as: two or more samples taken consecutively at the same site or two or more measurements made consecutively with a field instrument. Procedures for each duplicate sample were documented on field data sheets. Sites that had duplicate samples were randomly determined prior to sampling. If samples are representative and the sampling methods are consistent, differences between samples and duplicates should be within acceptable ranges for the selected parameter (within 20%).

Sample duplication was completed at least once per sampling event for all chemistry parameters. Duplicate samples of laboratory analyzed parameters consisted of two sample bottles filled sequentially at the same site by the same person.

Field Blanks

As part of Quality Control, field blanks for water chemistry samples were required for each water quality laboratory sampling activity. Field blanks are sterilized laboratory bottles filled with de-ionized or distilled water while in the field and treated as a sample. Blanks are used to identify errors or contamination in sample collection while in the field. If samplers have any reason to suspect that sampling bottles may contribute contamination, they should be discarded. Sterilized and empty chemistry field blank bottles were provided by the contract laboratory. Field blanks were delivered to the contract laboratory for analysis with the water quality samples. After the field blank was filled with de-ionized or distilled water, it remained closed and with the samples until delivery to the laboratory. The parameter(s) to be analyzed for each type of blank were rotated among sample events.

SAMPLE PRESERVATION AND HOLDING TIME

Field samplers were responsible for adding the appropriate preservative, immediately placing samples which require cooling in an insulated container with wet ice (or blue ice packs if preferred by the laboratory) and ensuring that the samples were kept at the required temperature when the sampler gave up custody. Table 4-1 provides a list of parameters, preservatives and holding times.

For nutrient samples sent to Energy Labs, the cooler included one sample bottle containing a minimum of 200 mL de-ionized or distilled water. This bottle was labeled "Temperature Check". In the absence of a temperature check, a regular sample may be used. The temperature of this water was measured and recorded when the samples arrived at the office or commercial laboratory before the samples were tested. This temperature was an audit to verify that the samples arrived at the laboratory at the required temperature and indicated that the samples were maintained at that temperature after collection.

Water chemistry samples requiring laboratory analysis were immediately preserved (preservatives supplied by Energy Laboratories), placed on ice and kept at 2-6° C throughout the next business day shipping delivery to the laboratory. Samples with 48 hour holding times were shipped no later in the week than Thursday for a Friday delivery.

DOCUMENTATION AND RECORDS

Field Sampling Documentation

Equipment Checklists were reviewed prior to leaving the office for a sampling event to ensure all necessary supplies were available. Samplers carried field data forms, and complete entries for each site during each sampling event. Hard copies of the data forms used in the field and COC forms from the laboratories were maintained, but data forms and other information were scanned and maintained digitally.

Sample Labeling

Water quality samples were labeled with a permanent, waterproof marking pen on plastic or synthetic type labels. Labels are provided on the bottles from both Energy Labs and were filled out accordingly. Sample identification information was recorded on the sample, on the chain of custody forms, on the laboratory's analytical reports, and on the field data forms.

Chain of Custody Forms

Chain of custody documents how and when samples were collected, preserved (if required), stored, transported to the laboratory, treated, and tracked during the analytical processes. Chain of Custody (COC) forms were completed by samplers prior to delivery to the laboratory or shipment center. Copies of completed original forms were maintained with the data forms.

The COC form was prepared and signed by the sampler before samples were shipped, and a carbon copy or scan of the COC form was retained. The COC form was sealed in a zip lock bag inside a cooler with the samples and shipped to the contract analytical laboratory. After samples changed custody, laboratory internal COC procedures were implemented according to their Quality Assurance Plan. The completed original COC form was returned by the analytical laboratory after completion of analyses.

Data Review and Validation

Data generated by the contract laboratories is subject to the internal contract laboratory QA/QC process before it is released. This data is assumed valid because the laboratory should adhere to internal QA/QC procedures. Field data generated by samplers is considered valid and usable only after the QA/QC procedures and process have been applied, evaluated, and deemed acceptable. Data determined to be invalid was rejected and not used in any reports.

Sampling Plan Modifications

Some suggestions for sampling plan modifications are as follows:

1. For the leachfield wells (MW2), possibly make those wells deeper than 10 foot, if installation allows for this. (The study was originally designed for sites with very shallow groundwater. Due to difficulties finding appropriate sites, some of the sites ended up having slightly deeper groundwater. If sites with deeper groundwater (like Sites 3 and 4) are to be used in the future, deeper (15-20 foot) wells, including the upgradient and downgradient wells, should be used. However, this may require a different method of installation.)

2. For the leachfield wells (MW2), it could be helpful to have only the lower two-foot section of the PVC well within groundwater be perforated and the top portion solid PVC, to help reduce the likelihood of leachate getting in the well. Also, it would be advantageous to place bentonite in the annular space between the steel well pipe and the PVC monitoring pipe for at least 4 feet below the bottom of the leachfield to provide a monitoring well surface seal.
3. Take onsite air temperature readings during sampling events.
4. Re-evaluate vacuum lysimeters, due to difficulties collecting samples. Pulling samples from gravel leachfield versus fine soils presented issues collecting enough sample volume.

5. Summary of Primary Findings

The following section contains a summary of primary findings.

In general, the data supports the fact that the septic systems—in specific the leachfields—work well during the summer months; the onsite treatment systems are removing nitrogen, phosphorus, phosphate and E.coli from the wastewater effluent. It seems that leachfield sites are achieving a good level of dilution as well, based on the sample results at the 10-foot monitoring wells and the 50-foot monitoring wells. The winter data set indicates that nitrification and denitrification are, however, reduced in the colder months. We observed that the last two winters were particularly cold and dry. We were able to add "blue board" to insulate the sample ports at the center of the leachfield and warm them enough to keep the lysimeters from freezing but were not always able to get enough sample volume to perform a laboratory test.

Site 1

The data set for Site 1 was fairly complete. There were times when a complete set of samples was not possible to obtain.

SITE 1 NITRATE, TEMPERATURE AND DISSOLVED OXYGEN OBSERVATIONS

The Nitrate, temperature and Dissolved Oxygen (DO) data from all of the collective sampling points at Site 1 demonstrates that the groundwater Nitrate levels decrease with an increase in temperature, and the Dissolved Oxygen levels decrease with an increase in temperature in sync with the DO saturation, but there is still DO available for biological activity, Chart 5-1. This indicates that aerobic biological activity, including denitrification, decreases as temperature decreases and increases as temperature increases. We surmise that as groundwater temperature decreases, aerobic biological activity decreases, thus bacteria are not utilizing Oxygen from O_2 or NO_3, and therefore, Nitrate levels will increase at lower temperatures.

CHART 5-1 Site 1

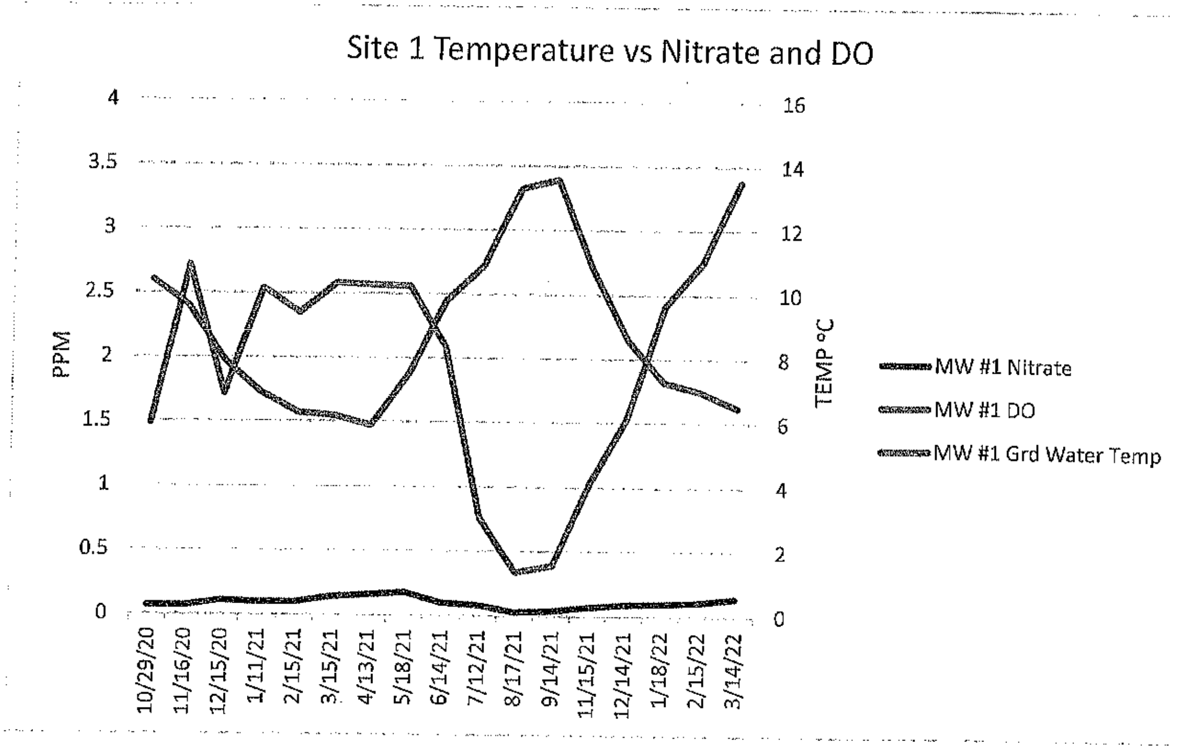


CHART 5-2 Site 1

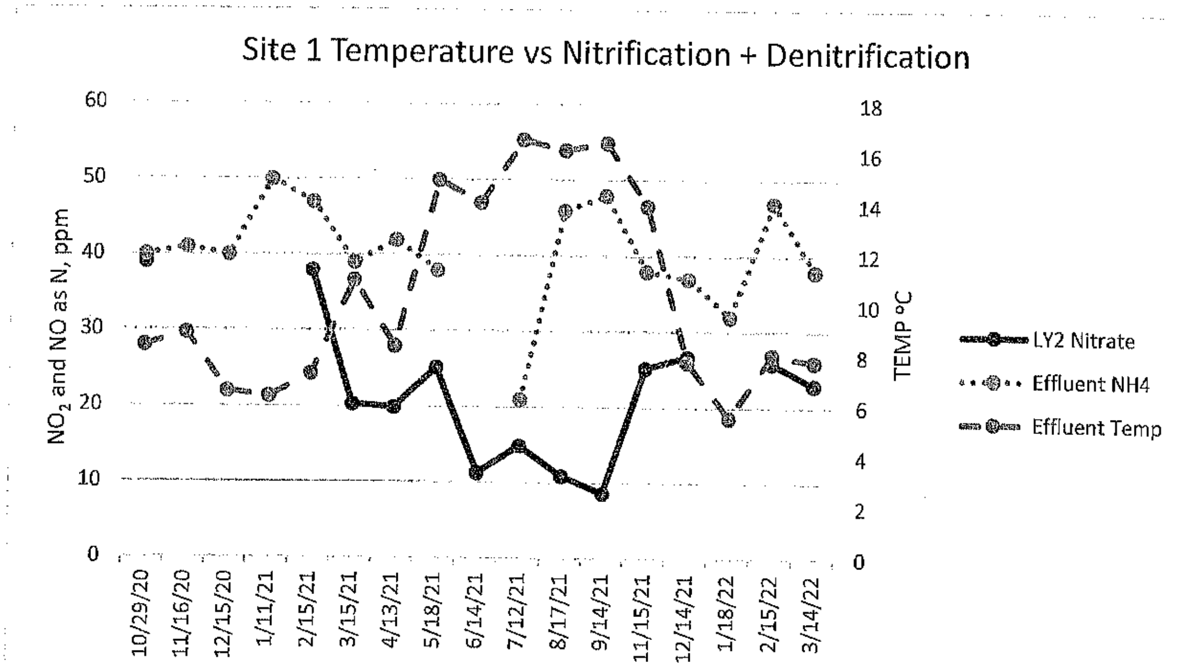
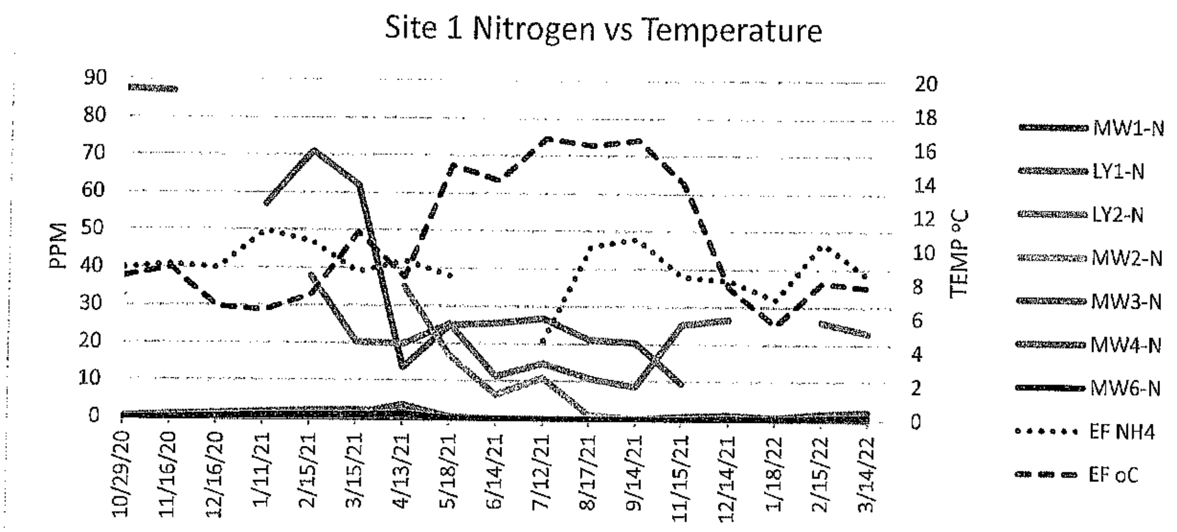


CHART 5-3 Site 1

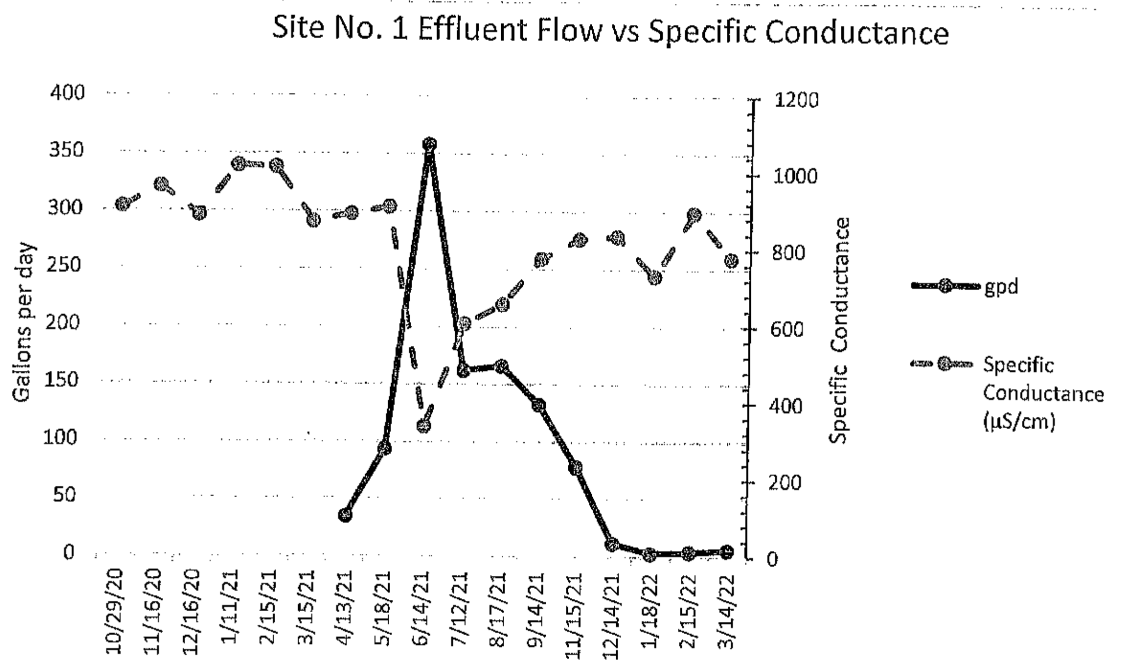


SITE 1 PUMP CHAMBER EFFLUENT OBSERVATIONS

Following are some observations from studying the data from the effluent samples taken from the pump chamber prior to discharge to the leachfield.

1. The effluent temperature varies based on the time of year, and more specifically, the climatic temperatures. A low of 5.8°C was observed in January, and a high of 16.6°C was observed in July. Effluent temperatures have a direct effect on the temperature of the leachfield. There could be a benefit to insulating the septic and pump tanks from the frost in the ground.
2. The effluent pH is fairly constant throughout the year, averaging 7.65, with a standard deviation of 0.2.
3. The effluent Ammonia, NH_4, is fairly consistent, averaging 40.3 mg/l, with a standard deviation of 7.1.
4. The effluent Nitrate is essentially nonexistent due to anaerobic digestion of organic Nitrate to Ammonia.
5. The effluent Chloride averages 34.6 mg/l, with a standard deviation of 9.8, resulting from one low test of 10 mg/l on 6/14/21, which could indicate possible infiltration, and one high test of 56 mg/l, principally due to grab samples.
6. The effluent Phosphorus and Phosphate are variable, probably due to laundry cycles and timing of grab samples.
7. Specific Conductance decreases when average daily flow increases indicating possible inflow or infiltration. The Specific Conductance was at its lowest in June. This could be due to infiltration of groundwater into the pump chamber diluting the septic tank effluent.

CHART 5-4 Site 1



SITE 1 LYSIMETER SAMPLE OBSERVATIONS

Following are some observations from studying the data from the lysimeter samples taken from the leachfield. Lysimeter 1 (LY1) pulled samples from approximately 8 inches below the top of the gravel bed. Lysimeter 2 (LY2) pulled samples from approximately 36 inches below the top of the gravel bed.

1. The lysimeter water temperatures vary with time of year, and more specifically, the ground temperature. Lysimeter temperatures are affected by the temperature of the applied effluent and ground temperature/frost. LY1 temperatures are slightly higher than the LY2 temperatures.
2. LY1 pH is generally similar to the effluent pH. LY2 pH was lower due to nitrification that occurs in the aerobic zone of the leachfield. Nitrification reduces the alkalinity (pH buffer) 7 ppm for each NH_4 ppm that is reduced to Nitrate.
3. LY1 Ammonia was not measurable, probably due to the time that it takes the vacuum pump to collect a sample and the continuing nitrification during that time. LY2 sample tests showed that the Ammonia was reduced to Nitrate by nitrification. Nitrification is affected by available Oxygen, temperature, and pH. The reduction in nitrification efficiency in the winter months (2.8 to 6.5 ppm) versus the summer months (0.07 to 0.18 ppm) is due to the lower temperatures.
4. LY1 and LY2 Nitrogen (NO_2 plus NO_3) levels were highest in the winter and lowest in the summer months. Denitrification, the conversion of NO_3 to Nitrite and Nitrogen gas, occurs in an anoxic condition where there is insufficient Dissolved Oxygen for the biological activity, resulting in the bacteria using the Oxygen in the NO_3 for metabolism. Denitrification is dependent upon Dissolved Oxygen, temperature, and a carbon source for the biological degradation. The lower denitrification levels observed in the winter are probably due to temperature.
5. Chloride concentration in the samples from the lysimeters is variable but generally similar to the Chloride levels in the effluent.

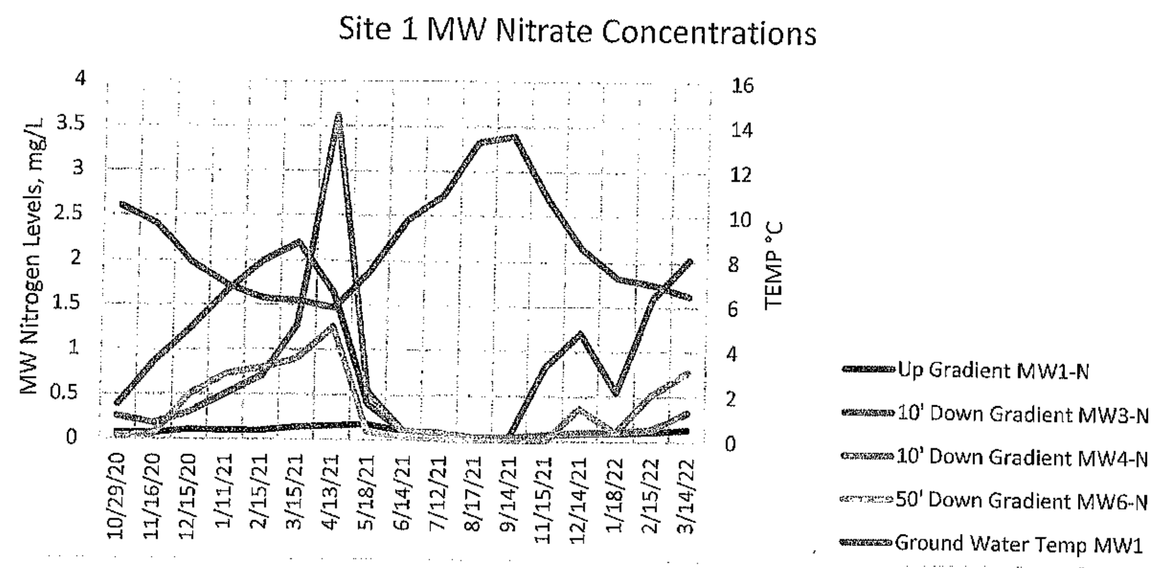
6. Phosphorus and Phosphate concentration in the lysimeters is variable and slightly lower than the effluent concentrations, probably due to adsorption to the soil particles.

SITE 1 MONITORING WELL SAMPLE OBSERVATIONS

Following are some observations from studying the data from the monitoring well samples taken from Site 1. Monitoring Well 1 (MW1) is the upgradient monitoring well. Monitoring Well 2 (MW2) is located in the center of the leachfield. Monitoring Wells 3 through 5 (MW3, MW4 and MW5) are located approximately 10 feet downgradient of the leachfield. Monitoring Wells 6 and 7 (MW6 and MW7) are approximately 50 feet downgradient of the leachfield.

1. Monitoring well sample temperatures are indicative of the groundwater temperature. Monitoring well water temperatures vary seasonally and are generally the same for MW1 and MW3 through MW7. Temperature of water in MW2 is generally a few tenths of a degree higher than the other monitoring wells, probably due to the influence of the leachfield.
2. Monitoring well water pH was very consistent and generally the same for MW1 and MW3 through MW7. The water in MW2 had a lower pH than the other monitoring wells, probably due to the nitrification process that was occurring in the leachfield.
3. Monitoring well Dissolved Oxygen (DO) varied seasonally probably due to temperature. The saturation level of Dissolved Oxygen is highest at low temperatures and lowest at high temperatures. The DO in MW1 was on average 7 mg/l below the DO saturation level for the measured temperature, with a standard deviation of 0.5 mg/l.
4. Ammonia concentrations in the monitoring wells were not measurable.
5. Nitrate nitrogen concentrations in MW1 (upgradient) and MW5 and MW7 (downgradient) ranged from 0.02 to 0.18 ppm. The Nitrogen concentrations in MW2 were highest in the winter (35 ppm) indicating reduced denitrification and possible short circuiting of effluent into MW2. The Nitrate concentrations in MW3, MW4, and MW6 were considerably lower than MW2 due to additional Nitrate removal and dilution with groundwater. The higher concentrations of Nitrate in MW1, MW6, and MW7 in April (generally March-May) could be due to snow melt and the atmospheric Nitrate captured in the snow.
6. Chloride concentrations in the monitoring wells show the effect of the groundwater diluting the Chloride from the effluent.
7. The reduced Phosphorus and Phosphate concentrations in the monitoring wells show the effect of the groundwater diluting the effluent leachate and the adsorption in the soil. MW2 did show some measurable Phosphorus and Phosphate concentration, but the concentration was at background levels in the downgradient monitoring wells.
8. Monitoring well MW1 and MW3 through MW7 water samples did not have any total coliform or E. coli bacteria. MW2 did show high concentrations of bacteria in July; this could be due to short circuiting of leachate into MW2 or sampling contamination.

CHART 5-5 Site 1



Site 2

The data set for Site 2 was the most comprehensive of the sites. There were times when a complete set of samples was not possible to obtain.

SITE 2 NITRATE, TEMPERATURE AND DISSOLVED OXYGEN OBSERVATIONS

The Nitrate, temperature and Dissolved Oxygen (DO) data from all of the collective sampling points at Site 2 demonstrates that the groundwater Nitrate levels decrease with an increase in temperature, and the Dissolved Oxygen levels decrease with an increase in temperature in sync with the DO saturation, but there is still DO available for biological activity, Chart 5-6. This indicates that aerobic biological activity, including denitrification, decreases as temperature decreases and increases at temperature increases. We surmise that as groundwater temperature decreases, aerobic biological activity decreases, thus bacteria are not utilizing Oxygen from O_2 or NO_3, and therefore, Nitrate levels will increase at lower temperatures.

CHART 5-6 Site 2

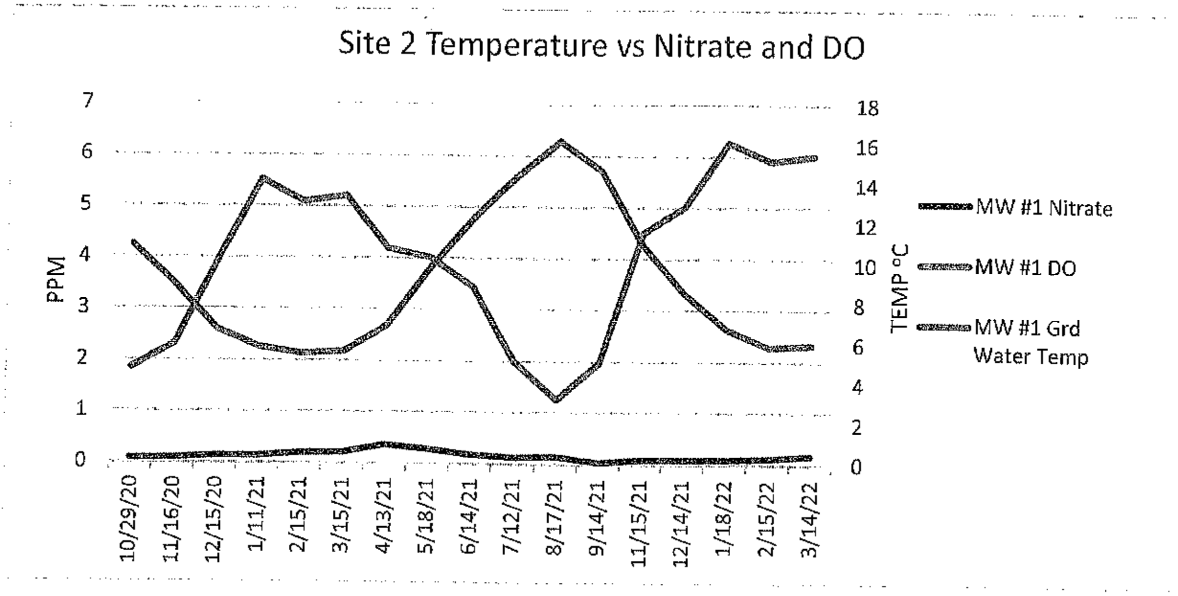


CHART 5-7 Site 2

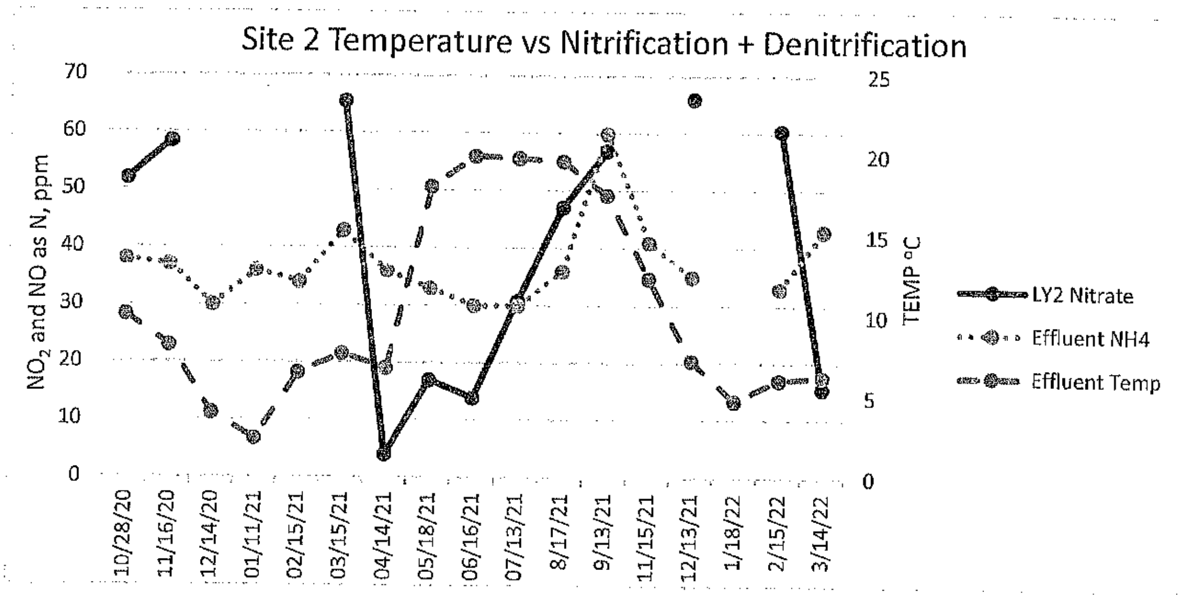


CHART 5-8 Site 2

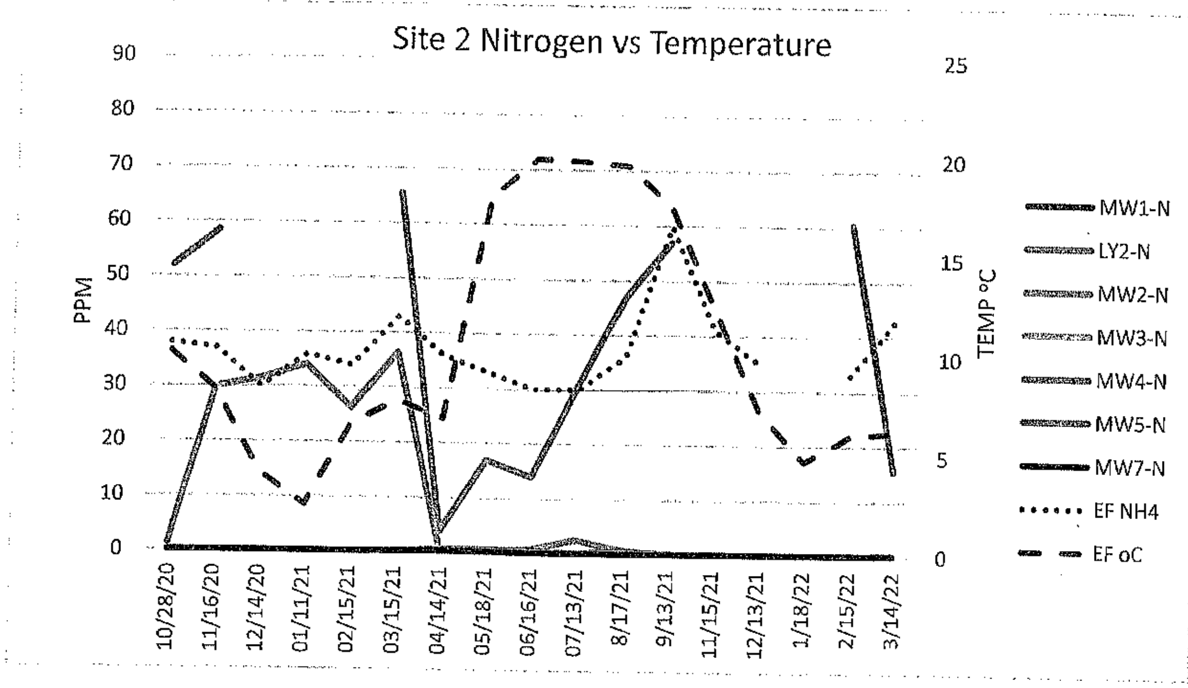
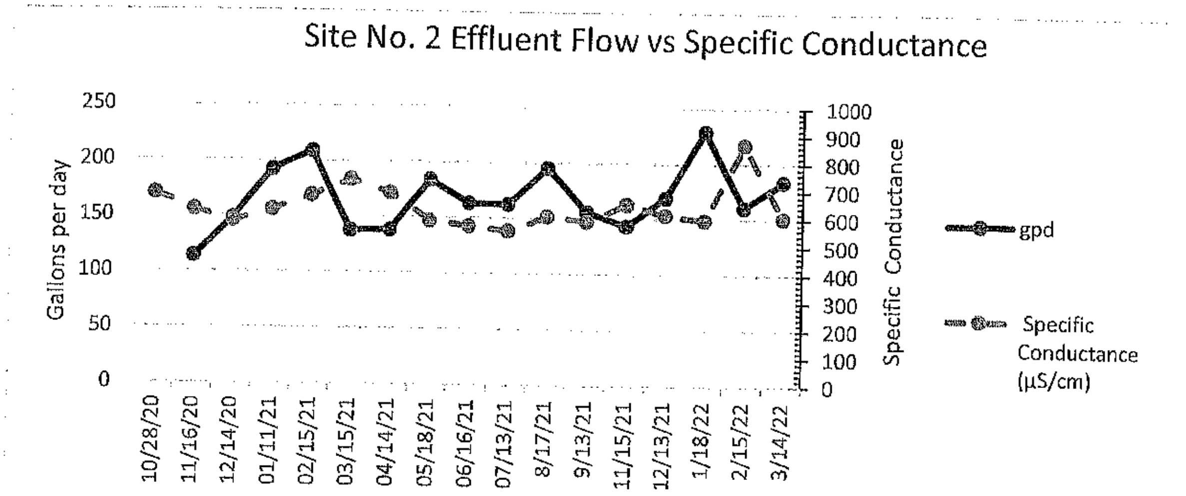


CHART 5-9 Site 2



SITE 2 PUMP CHAMBER EFFLUENT OBSERVATIONS

Following are some observations from studying the data from the effluent samples taken from the pump chamber prior to discharge to the leachfield.

1. The effluent temperature varies based on the time of year, and more specifically, the climatic temperatures. A low of 2.4°C was observed in January, and a high of 20°C was observed in June and July. Effluent temperatures have a direct effect on the temperature of the leachfield. There could be a benefit to insulating the septic and pump tanks from the frost in the ground.
2. The effluent pH is fairly constant throughout the year, averaging 7.52, with a standard deviation of 0.3.
3. The effluent Ammonia, NH_4, is fairly consistent, averaging 37.2 mg/l, with a standard deviation of 7.4.
4. The effluent Nitrate is essentially nonexistent due to anaerobic digestion of organic Nitrate to Ammonia.
5. The effluent Chloride averages 25.4 mg/l, with a standard deviation of 2.6.
6. The effluent Phosphorus averages 4.18 mg/l, with a standard deviation of 1.2, and Phosphate averages 12.61 mg/l, with a standard deviation of 4.1.

SITE 2 LYSIMETER SAMPLE OBSERVATIONS

Following are some observations from studying the data from the lysimeter samples taken from the leachfield. Lysimeter 1 (LY1) was intended to pull samples from approximately 12 inches below the top of the gravel bed, however no water was found in LY1. It is possible that because the leachfield is a gravel bed type that LY1 was not installed below the perforated pipe distributing the effluent. Lysimeter 2 (LY2) was intended to pull samples from approximately 36 inches below the top of the gravel bed, however it is possible that LY2 was not as deep as anticipated.

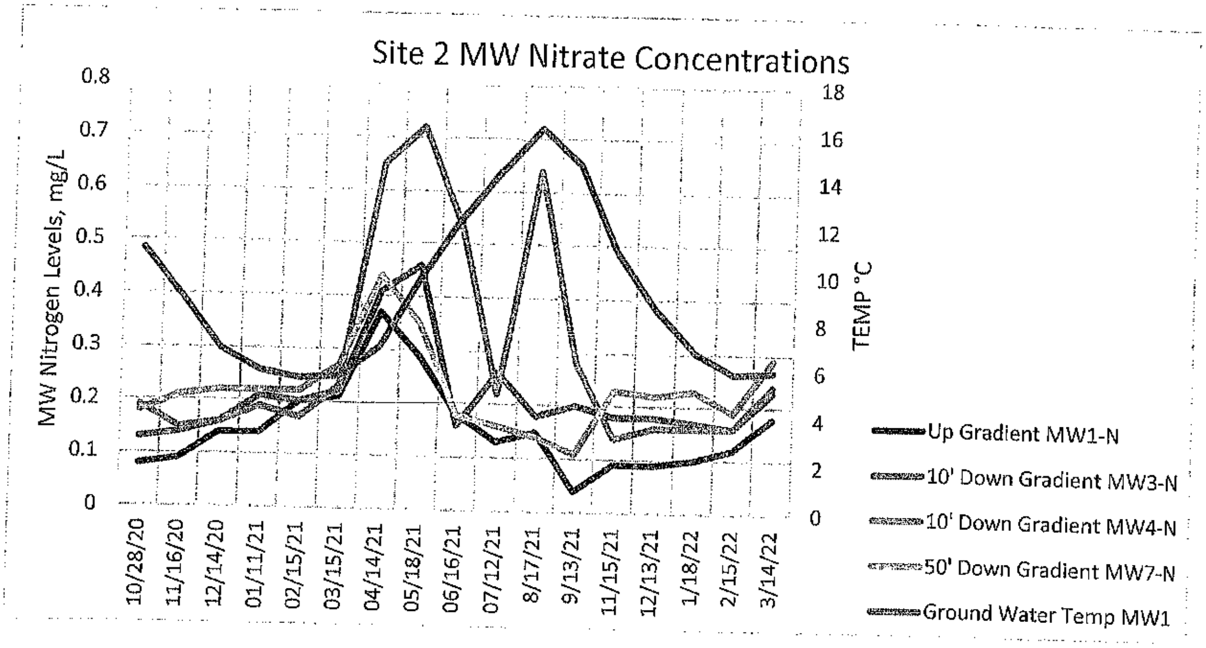
1. The lysimeter water temperatures vary with time of year, and more specifically, the ground temperature/frost. Lysimeter temperatures are affected by the temperature of the applied effluent and ground temperature/frost. LY1 temperatures were not measured.
2. LY1 pH was not measured. LY2 pH was generally higher than the effluent pH, indicating that nitrification in the aerobic zone of the leachfield was not lowering the pH. Nitrification reduces the alkalinity (pH buffer) 7 ppm for each NH_4 ppm that is reduced to Nitrate.
3. LY1 Ammonia was not measured. LY2 sample tests showed that the Ammonia was reduced to Nitrate by nitrification. Nitrification is affected by available Oxygen, temperature, and pH. The reduction in nitrification efficiency in the winter months was not substantially different than in the summer months.
4. LY1 Nitrogen levels were not measured. LY2 Nitrogen levels were variable but generally highest in the winter and lowest in the summer months. Denitrification, the conversion of NO_3 to Nitrite and Nitrogen gas, occurs in an anoxic condition where there is insufficient Dissolved Oxygen for the biological activity, resulting in the bacteria using the Oxygen in the NO_3 for metabolism. Denitrification is dependent upon Dissolved Oxygen, temperature, and a carbon source for the biological degradation. The low denitrification rates could be due to temperature and shallow installation of LY2 not giving sufficient time for complete denitrification.
5. Chloride concentration in the samples from the lysimeters is variable but lower than the Chloride levels in the effluent.
6. Phosphorus and Phosphate concentration in the lysimeters is variable and lower than the effluent concentrations, probably due to adsorption to the soil particles.

SITE 2 MONITORING WELL SAMPLE OBSERVATIONS

Following are some observations from studying the data from the monitoring well samples taken from Site 2. Monitoring Well 1 (MW1) is the upgradient monitoring well. Monitoring Well 2 (MW2) is located in the center of the leachfield. Monitoring Wells 3 through 5 (MW3, MW4 and MW5) are located approximately 10 feet downgradient of the leachfield. Monitoring Wells 6 and 7 (MW6 and MW7) are approximately 50 feet downgradient of the leachfield.

1. Monitoring well sample temperatures are indicative of the groundwater temperature. Monitoring well water temperatures vary seasonally and are generally the same for MW1 and MW3 through MW7. Temperature of water in MW2 is generally a few tenths of a degree lower than the other monitoring wells, probably due to the influence of the leachfield.
2. Monitoring well water pH was very consistent and generally the same for MW1 and MW3 through MW7. The water in MW2 had a lower pH than the other monitoring wells, probably due to the nitrification process that was occurring in the leachfield.
3. Monitoring well Dissolved Oxygen (DO) showed a general pattern of reduction from MW1 to MW3 through MW7, indicating that there could be some Oxygen demand imposed on the groundwater by the effluent from the leachfield. The DO varied seasonally, probably due to temperature. The saturation level of DO is highest at low temperatures and lowest at high temperatures.
4. Ammonia concentrations in the monitoring wells were not measurable.
5. Nitrate nitrogen concentrations in MW1 (upgradient) and MW5, MW6 and MW7 (downgradient) ranged from 0.14 to 0.46 ppm, being the highest in April. The Nitrogen concentrations in MW2 were highest in the winter (36.4 ppm) indicating reduced denitrification. The Nitrate concentrations in MW3 through MW7 were considerably lower than MW2 due to additional denitrification and dilution with groundwater.
6. Chloride concentrations in the monitoring wells show the effect of the groundwater diluting the Chloride from the effluent. MW2 had high Chloride concentrations November through March indicating less groundwater dilution during this period.
7. The reduced Phosphorus and Phosphate concentrations in the monitoring wells show the effect of the groundwater diluting the effluent leachate and the adsorption in the soil. MW2 did show some measurable Phosphorus and Phosphate concentration, but the concentration was at background levels in the downgradient monitoring wells.
8. The monitoring wells did occasionally show some coliform bacteria, however there did not seem to be a pattern.

CHART 5-10 Site 2



Site 3

The monitoring wells constructed 10 feet below the surface were not deep enough to sample groundwater except in June, July, August, and September. As a result, samples were not obtainable in the fall, winter, and spring months, and therefore no data was available to draw conclusions regarding the treatment efficiency of the Site 3 leachfield.

No further study was done for Site 3.

Site 4

The data set for Site 4 was fairly complete. There were times when a complete set of samples was not possible to obtain. Due to low groundwater elevation, samples were not taken in January, February, and March of 2022.

SITE 4 NITRATE, TEMPERATURE AND DISSOLVED OXYGEN OBSERVATIONS

The Nitrate, temperature, and Dissolved Oxygen (DO) data from all of the collective sampling points at Site 4 demonstrates that the groundwater Nitrate levels decrease with an increase in temperature, and the Dissolved Oxygen levels decrease with an increase in temperature in sync with the DO saturation, but there is still DO available for biological activity, Chart 5-11. This indicates that aerobic biological activity, including denitrification, decreases as temperature decreases and increases at temperature increase. We surmise that as groundwater temperature decreases aerobic biological activity decreases thus bacteria are not utilizing Oxygen from O_2 or NO_3, and therefore Nitrate levels will increase at lower temperatures.

CHART 5-11 Site 4

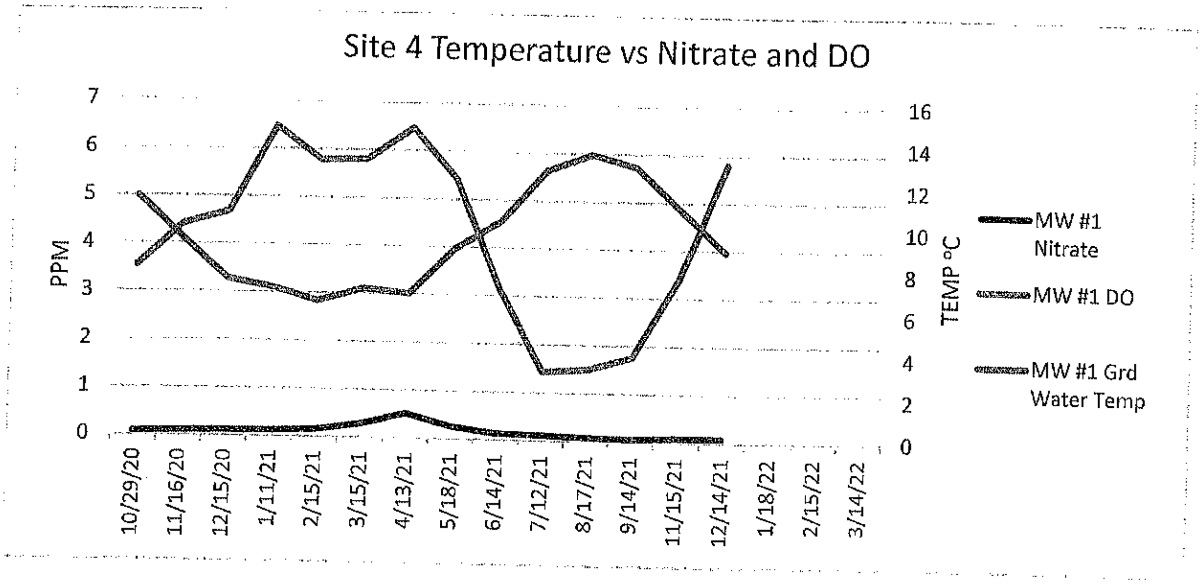


CHART 5-12 Site 4

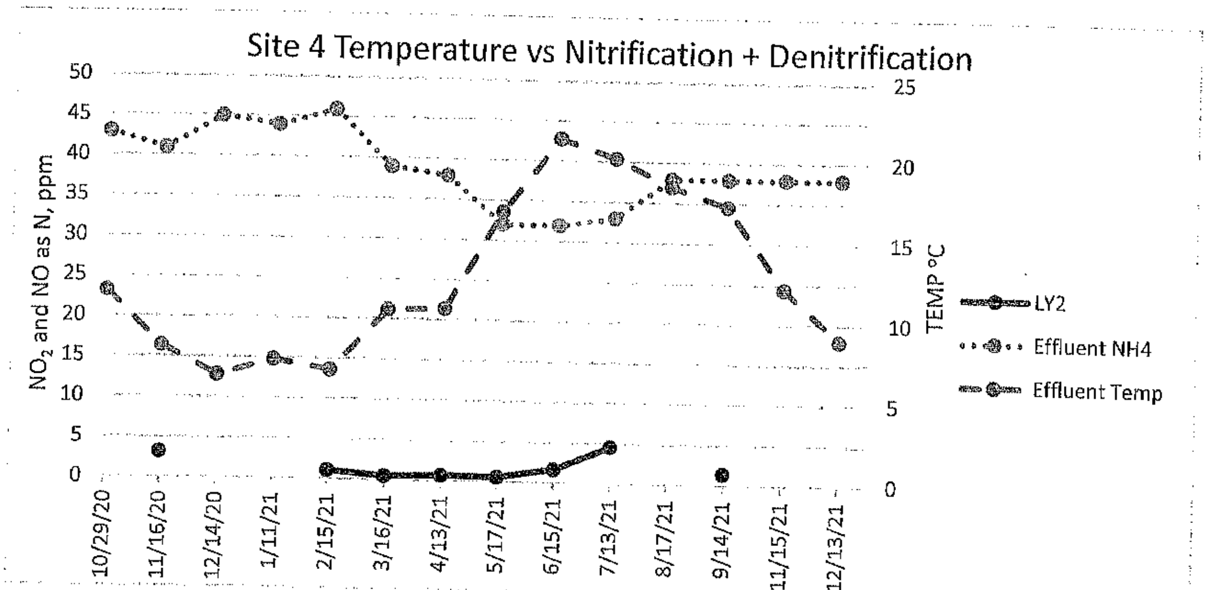


CHART 5-13 Site 4

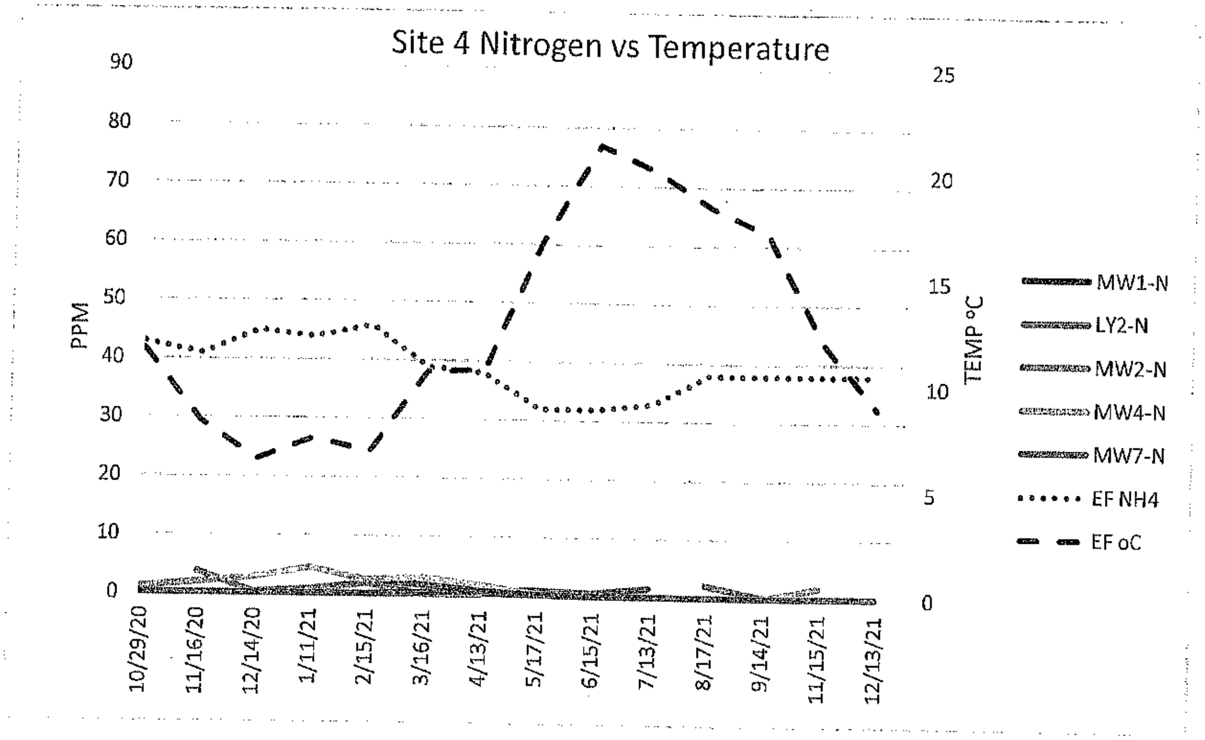
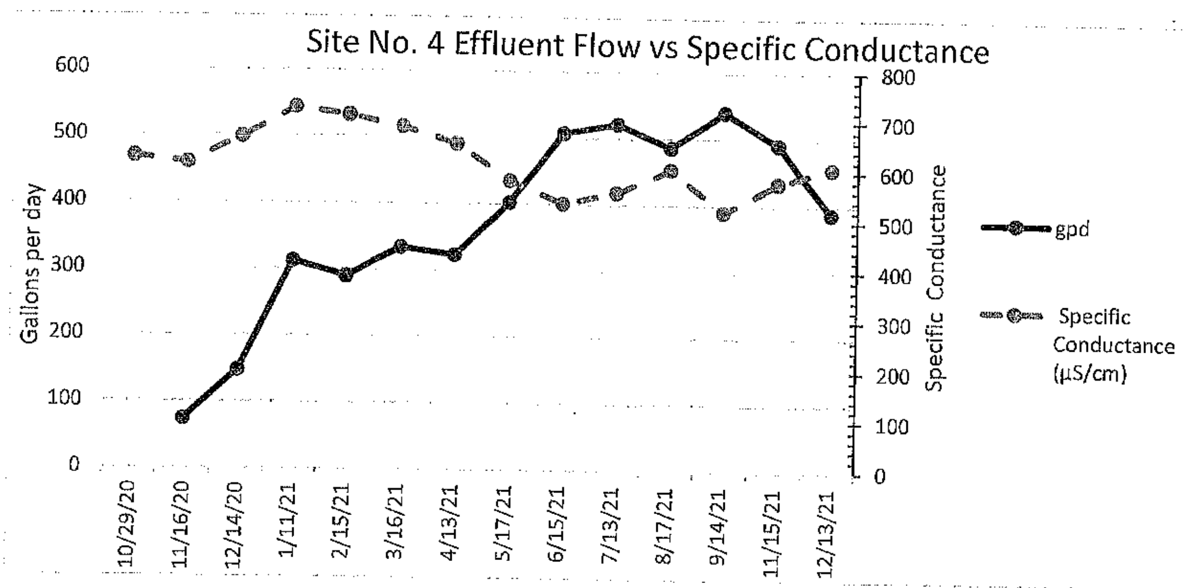


CHART 5-14 Site 4



SITE 4 PUMP CHAMBER EFFLUENT OBSERVATIONS

Following are some observations from studying the data from the effluent samples taken from the pump chamber prior to discharge to the leachfield.

1. The effluent temperature varies with the time of year, and more specifically, the climatic temperatures. A low of 6.4 °C was observed in January, and a high of 21.4 °C was observed in June. Effluent temperatures have a direct effect on the temperature of the leachfield. There could be a benefit to insulating the septic and pump tanks from the frost in the ground.
2. The effluent pH is fairly constant throughout the year, averaging 7.43, with a standard deviation of 0.2.
3. The effluent Ammonia, NH_4, is fairly consistent averaging 39.1 mg/l, with a standard deviation of 4.9.
4. The effluent Nitrate is essentially nonexistent due to anaerobic digestion of organic Nitrate to Ammonia.
5. The effluent Chloride averages 20.7 mg/l, with a standard deviation of 3.4.
6. The effluent Phosphorus averages 4.87 mg/l, with a standard deviation of 1.7, and Phosphate averages 14.9 mg/l, with a standard deviation of 5.1.

SITE 4 LYSIMETER SAMPLE OBSERVATIONS

Following are some observations from studying the data from the lysimeter samples taken from the leachfield. Lysimeter 1 (LY1) was intended to pull samples from approximately 12 inches below the bottom of the infiltrators. Lysimeter 2 (LY2) was intended to pull samples from approximately 36 inches below the bottom of the infiltrators.

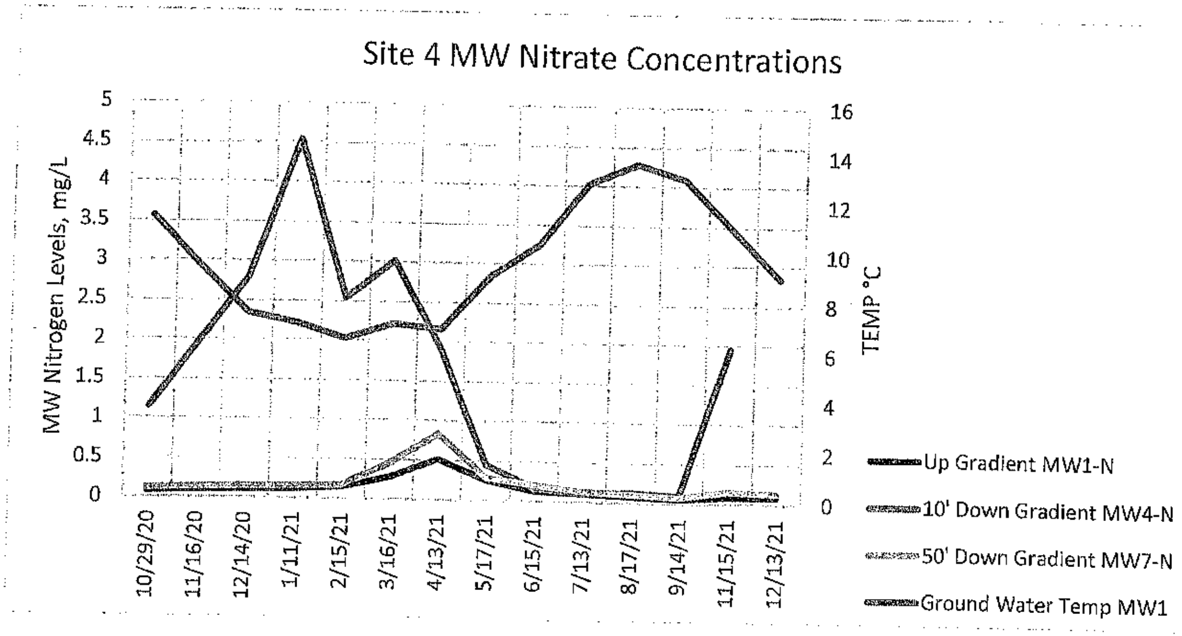
1. The lysimeter water temperatures vary with time of year, and more specifically, the ground temperature. Lysimeter temperatures are affected by the temperature of the applied effluent and ground temperature/frost. LY1 temperatures were not measured.
2. LY1 pH was not measured. LY2 pH was generally similar to the effluent pH in the winter, indicating that nitrification in the aerobic zone of the leachfield was not lowering the pH. LY2 pH in the summer was lower than the effluent pH, indicating that nitrification was taking place in the warmer months. Nitrification reduces the alkalinity (pH buffer) 7 ppm for each NH_4 ppm that is reduced to Nitrate.
3. LY1 Ammonia was variable. LY2 Ammonia was lower than the effluent Ammonia indicating nitrification. Nitrification is affected by available Oxygen, temperature, and pH. The nitrification efficiency in the winter months was not substantially different than in the summer months.
4. LY1 Nitrogen levels were variable. LY2 Nitrogen levels were variable but generally highest in the winter and lowest in the summer months. Denitrification, the conversion of NO_3 to Nitrite and Nitrogen gas, occurs in an anoxic condition where there is insufficient Dissolved Oxygen for the biological activity, resulting in the bacteria using the Oxygen in the NO_3 for metabolism. Denitrification is dependent upon Dissolved Oxygen, temperature, and a carbon source for the biological degradation.
5. Chloride concentration in the samples from the lysimeters is variable but generally about the same as the Chloride levels in the effluent.
6. Phosphorus and Phosphate concentration in the lysimeters were very low and much lower than the effluent concentrations, probably due to adsorption to the soil particles.

SITE 4 MONITORING WELL SAMPLE OBSERVATIONS

Following are some observations from studying the data from the monitoring well samples taken from Site 4. Monitoring Well 1 (MW1) is the upgradient monitoring well. Monitoring Well 2 (MW2) is located in the center of the leachfield. Monitoring Wells 3 through 5 (MW3, MW4 and MW5) are located approximately 10 feet downgradient of the leachfield. Monitoring Wells 6 and 7 (MW6 and MW7) are approximately 50 feet downgradient of the leachfield. Based on field reports of septic tank effluent odor in samples from MW2 and test results, it is probable that there was a cross connection between the leachfield distribution system and MW2.

9. Monitoring well sample temperatures are indicative of the groundwater temperature. Monitoring well water temperatures vary seasonally and are generally the same for MW1 and MW3 through MW7.
10. Monitoring well water pH was very consistent and generally the same for MW1 and MW3 through MW7. The water in MW2 had a lower pH than the other monitoring wells, probably due to the nitrification process that was occurring in the leachfield.
11. Monitoring well Dissolved Oxygen (DO) did not show a consistent pattern of reduction from MW1 to MW3 through MW7. Some monthly samples (August and September) did show a downgradient decrease in DO, indicating that there could be some Oxygen demand imposed on the groundwater by the effluent from the leachfield. Overall, DO levels increased with the decrease in groundwater temperature in sync with the DO saturation, but there was still DO available for biological activity.
12. Specific Conductance measurements in the monitoring wells shows the effect of the groundwater diluting the dissolved solids in the effluent. High Specific Conductance in MW2 indicates probable cross connection.
13. Ammonia concentrations in the monitoring wells, with the exception of MW2, were not measurable. Ammonia in MW2 was probably due to cross connection.
14. Nitrate nitrogen concentrations in MW1 (upgradient) and MW5, MW6 and MW7 (downgradient) ranged from 0.08 to 0.84 ppm, being the highest in April. The Nitrogen concentrations in MW2 and MW4 were highest in the winter indicating reduced denitrification. The Nitrate concentrations in MW6 and MW7 were considerably lower than MW2 through MW4 due to additional denitrification and dilution with groundwater.
15. Chloride concentrations in the monitoring wells show the effect of the groundwater diluting the Chloride from the effluent. Chloride in MW2 indicates cross connection.
16. The reduced Phosphorus and Phosphate concentrations in the monitoring wells show the effect of the groundwater diluting the effluent leachate and the adsorption in the soil. MW2 did show high Phosphorus and Phosphate concentration, probably due to cross connection.

CHART 5-15 Site 4



6. Comparison of Empirical Data to Published Studies

The results of the analysis of the septic tank effluent from the three sites was similar to published data:

TABLE 6-1 Study Results vs Published Data

	3 Site Ave.	Published			
Septic Tank Effluent		Mean	Std Dev.	# Sites	
Temperature (°C)	11.2				
pH	7.54	7.4	0.2	17	Geary and Lucas, 2019[12]
Specific Conductance (µS/cm)	693	1480	131	17	Geary and Lucas, 2019[12]
Ammonia, NH4 (mg/l)	39	72	37	111	Robertson et al., 2019[6]
Nitrogen, N as NO_2 and NO_3 (mg/l)	0.04	0.2	0.2	10	Geary and Lucas, 2019[12]
Chloride (mg/l)	27.0	64		106	Robertson et al., 2019[6]
Phosphorus (mg/l)	4.4	4.6	4.2	37	Withers et al., 2011[13]
Phosphate (mg/l)	13.8				

Leachfields analyzed in this study in general perform better than published data, however there is very little published data on leachfield performance, only lab columns and short-term testing before the biomat is formed on the surface of the drainfield.

The location and installation of the lysimeters in an existing leachfield is problematic; installation of lysimeters during construction of the leachfield would provide better sampling capability. However, the development of the biomat on the surface of the leachfield takes time, and therefore early sampling, within the first year of lysimeters constructed with the leachfield, may not be indicative of the leachfield treatment efficiency.

Much of the published data on groundwater contamination from leachfields is based on monitoring wells with the results showing the contaminate plume and reduction of the contaminates as the groundwater flows away from the leachfield. This study did not have a sufficient number of monitoring wells at each site to clearly establish the plume and develop a groundwater flow model.

Utilizing Chloride and Specific Conductance as a tracer to indicate dilution with groundwater is common with other studies and was effective in this study. Some published studies used NO_3, Na, minor and trace constituents such as Boron, or artificial sweeteners (Acesulfame and Sucralose), however the concentrations of these constituents in domestic wastewater are very low compared to background values in groundwater and are therefore difficult to monitor.

Ammonia was almost completely oxidized in the unsaturated zone at all three sites, an average of 97.1% reduction. Published data indicates that this level of oxidation is typical of properly-constructed leachfields with sufficient unsaturated zone for oxidation of the septic tank effluent prior to mixing with the groundwater.

Nitrate was removed by denitrification in the leachfield, 50.2% at Site 1 and 96.3% at Site 4. Site 2 did not exhibit any denitrification in the leachfield, possibly due to the location of the lysimeters. All three sites did show effective denitrification prior to the first monitoring wells 10 feet downgradient of the leachfield. These results are consistent with the variability in published data as the treatment efficiency of the leachfield is dependent on the leachfield design, soil types, and effluent application.

The average Nitrogen removal from all three sites, based on the samples from the lysimeters, was 46.2%. Site 1 removed 48.2% of the Nitrogen, Site 2 did not remove Nitrogen, Site 4 removed 92.1% of the Nitrogen. This variability in Nitrogen removal is similar to published data because of the variability in design, climate, and soil types.

Based on results from the lysimeters, the average Total Phosphorus removal was 71.4%. Site 1 removed 35.5% of the Phosphorus, Site 2 removed 92.1% of the Phosphorus, and Site 4 removed 90.7% of the Phosphorus. These results are better than most published studies, however again it is difficult to compare these results to published studies because of the difference in soil types, pH, and leachfield construction.

Overall Phosphate removal in the leachfield was 72.2%. Site 1 removed 33.2% of the Phosphate, Site 2 removed 91.9% of the Phosphate, and Site 4 removed 92.2% of the Phosphate. This variation could be due to differences in laundry detergents and the leachfield loading rates at the individual sites.

7. Conclusions

It appears that Site 1 has a leaking septic tank or pump chamber based on the low pumping rate in winter and high pump rate in June. The leak could be at the opening in the chamber where the pipe enters or exits.

Site 4 septic tank effluent and leachfield had the highest temperature in winter; this could be because it had more earth cover over the infiltrators than the other sites.

Site 2 had the lowest Nitrogen removal, had nitrification but no denitrification as measured by the lysimeters. Site 2 was a gravel bed, not infiltrators. However, Site 2 did have Nitrogen removal below the lysimeters as evidenced by the Nitrogen concentration in the downgradient monitoring wells.

Overall, the three sites showed an average Ammonia (nitrification) removal of 97.1%. The majority of the nitrification occurred in the first 12 inches of the leachfield.

Based on the samples from the lysimeters, the three sites showed an average Total Nitrogen removal of 46.2%; Site 1 Nitrogen removal was 48.2%, Site 2 was 0, and Site 4 Total Nitrogen removal was 92.1%. Average Chloride removal for all three sites was 7.4%.

Average Phosphorus removal for all three sites was 71.4%. Site 1 was lowest at 35.5% while Site 2 and Site 4 had Phosphorus removal of 92.1% and 90.7%, respectively.

Average Phosphate removal for all three sites was 72.2%. Site 1 was the lowest at 33.4%, while Site 2 and Site 3 had Phosphate removal of 91.9% and 92.2%, respectively.

Based on tracer constituents, Chloride and Specific Conductance, there is significant dilution of Nitrogen and Phosphorus when they reach the groundwater.

The Nitrogen concentration in the immediate downgradient monitoring well 10 feet from the leachfield increased, over upgradient MW1, an average of 0.89 mg/l at Site 1, 0.14 mg/l at Site 2, and 1.44 mg/l at Site 4.

The Nitrogen concentration in the immediate downgradient monitoring well 50 feet from the leachfield increased, over upgradient MW1, an average of 0.27 mg/l at Site 1, 0.07 mg/l at Site 2, and 0.07 mg/l at Site 4.

The largest increase in the monitoring well Nitrogen concentration occurred during the winter months.

The Total Phosphorus concentration in the immediate downgradient monitoring well 10 feet from the leachfield increased, over upgradient MW1, an average of 0.020 mg/l at Site 1, 0.015 mg/l at Site 2, and 0.34 mg/l at Site 4.

The Total Phosphorus concentration in the immediate downgradient monitoring well 50 feet from the leachfield increased, over upgradient MW1, an average of 0.001 mg/l at Site 1, 0.001 mg/l at Site 2, and 0.037 mg/l at Site 4.

If future studies are conducted it would be helpful, if budget allows, to track the Total Organic Carbon (TOC) from the septic tank effluent through the lysimeters and monitoring wells. TOC has become an important parameter used to monitor overall levels of organic compounds present. TOC does not provide direct quantitative correlation between Total Organic Carbon and the Biochemical Oxygen Demand (BOD) but is an easy-to-measure, general indicator of the approximate level of organic contamination in the water. Tracking the reduction in TOC would provide an indication of the aerobic reduction of organic matter through the leachfield and groundwater aquifer.

For the leachfield wells (MW2), it could be helpful to have only the lower section of the PVC well within groundwater be perforated and the top portion solid PVC, to help reduce the likelihood of leachate short circuiting into the well. Also, it would be advantageous to place bentonite in the annular space between the steel well pipe and the PVC monitoring pipe for at least four feet below the bottom of the leachfield prior to pulling the steel pipe to provide a monitoring well surface seal.

8. Recommendations

Septic System Design Modifications

1. Require that septic tank and pump chamber be insulated to retain heat from household wastewater and reduce cooling effect of frozen ground. Do not allow tank and pump chamber to be placed under plowed surfaces without additional insulation.
2. Encourage the use of infiltrators and require a minimum of 1.5 to 2 feet of cover to provide more insulation above the drainfield.
3. Leak test septic tank and pump chamber after construction.

Septic System Operational Suggestions

1. Assure that septic tanks are pumped at least every 5 years.
2. Assure an inspection of the septic system, at least, each time the septic tank is pumped.
3. Close leachfield vents in winter.

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Septic tanks aren't keeping feces out of rivers, lakes

Date: August 3, 2015

Source: Michigan State University

Summary: The notion that septic tanks prevent fecal bacteria from seeping into rivers and lakes simply doesn't hold water, says a new study. A team of water detectives has discovered freshwater contamination stemming from septic systems.

FULL STORY

The notion that septic tanks prevent fecal bacteria from seeping into rivers and lakes simply doesn't hold water, says a new Michigan State University study.

Water expert Joan Rose and her team of water detectives have discovered freshwater contamination stemming from septic systems. Appearing in the *Proceedings of the National Academy of Sciences*, the study is the largest watershed study of its kind to date, and provides a basis for evaluating water quality and health implications and the impact of septic systems on watersheds.

"All along, we have presumed that on-site wastewater disposal systems, such as septic tanks, were working," said Rose, Homer Nowlin Chair in water research. "But in this study, sample after sample, bacterial concentrations were highest where there were higher numbers of septic systems in the watershed area."

Until now, it was assumed that the soil could filter human sewage, and that it works as a natural treatment system. Discharge-to-soil methods, a simple hole dug in the ground under an outhouse, for example, have been used for many years. Unfortunately, these systems do not keep *E. coli* and other pathogens from water supplies, Rose said.

"For years we have been seeing the effects of fecal pollution, but we haven't known where it is coming from," she said. "Pollution sources scattered in an area -- called non-point -- have historically been a significant challenge in managing water quality."

The researchers used source-tracking markers, a novel method Rose calls "CSI (Crime Scene Investigation) for water," to sample 64 river systems in Michigan for *E. coli* and the human fecal bacteria B-theta. Advances in source-tracking allow water scientists to track down the origin of non-point pollution more accurately than ever before.

Michigan, Florida and South Carolina, as well as resort areas near lakes all across the United States, rely heavily on septic tanks for human sewage. Though each state regulates septic tanks differently, more needs to be done in order to ensure humans are not contaminating surface waters by using septic tanks.

Continuing to use long-trusted methods of waste disposal systems may come at a hefty price, added Rose. The Environmental Protection Agency's latest survey for capitol improvement identifies the need to invest $298 billion over the next 20 years on wastewater and stormwater infrastructure to meet the Clean Water Act public safety goals of swimmable and fishable waters.

"This study has important implications on the understanding of relationships between land use, water quality and human health as we go forward," she said. "Better methods will improve management decisions for locating, constructing and maintaining on-site wastewater treatment systems. It's financially imperative that we get it right."

Story Source:

Materials provided by **Michigan State University**. *Note: Content may be edited for style and length.*

Journal Reference:

1. Marc P. Verhougstraete, Sherry L. Martin, Anthony D. Kendall, David W. Hyndman, Joan B. Rose. **Linking fecal bacteria in rivers to landscape, geochemical, and hydrologic factors and sources at the basin scale**. *Proceedings of the National Academy of Sciences*, 2015; 201415836 DOI: 10.1073/pnas.1415836112

Cite This Page:

MLA APA Chicago

Michigan State University. "Septic tanks aren't keeping feces out of rivers, lakes." ScienceDaily. ScienceDaily, 3 August 2015. <www.sciencedaily.com/releases/2015/08/150803154850.htm>.

Linking fecal bacteria in rivers to landscape, geochemical, and hydrologic factors and sources at the basin scale

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Edited* by Rita R. Colwell, University of Maryland, College Park, MD, and approved June 29, 2015 (received for review August 15, 2014)

Linking fecal indicator bacteria concentrations in large mixed-use watersheds back to diffuse human sources, such as septic systems, has met limited success. In this study, 64 rivers that drain 84% of Michigan's Lower Peninsula were sampled under baseflow conditions for *Escherichia coli*, *Bacteroides thetaiotaomicron* (a human source-tracking marker), landscape characteristics, and geochemical and hydrologic variables. *E. coli* and *B. thetaiotaomicron* were routinely detected in sampled rivers and an *E. coli* reference level was defined (1.4 $\log_{10}$ most probable number·100 mL^{-1}). Using classification and regression tree analysis and demographic estimates of wastewater treatments per watershed, septic systems seem to be the primary driver of fecal bacteria levels. In particular, watersheds with more than 1,621 septic systems exhibited significantly higher concentrations of *B. thetaiotaomicron*. This information is vital for evaluating water quality and health implications, determining the impacts of septic systems on watersheds, and improving management decisions for locating, constructing, and maintaining on-site wastewater treatment systems.

Escherichia coli | *Bacteroides thetaiotaomicron* | baseflow | reference conditions | septic system

Water quality degradation influenced by diffuse sources at large watershed scales has been difficult to describe. Human modifications of natural landscapes can permanently alter hydrologic cycles and affect water quality (1, 2). Deforestation (3) and increased impervious surface area (4) have been linked with decreased infiltration and thus increased surface runoff. Overland flows concentrate pollutants and rapidly transport them down gradient where they eventually enter surface water systems and affect water quality (5, 6). A number of models have been developed to calculate overland and surface water flows (7, 8) and nutrient/chemical transport (9), but few studies have focused on microbial movement from land to water, particularly nontraditional fecal indicator bacteria that can be used to track human sources of pollution.

Microbial contamination poses one of the greatest health risks to swimming areas, drinking water intakes, and fishing/shellfish harvesting zones where human exposures are highest (10–12). These highly visible areas often receive more attention than sources of contamination because identifying the origin of pollution in complex watersheds requires costly comprehensive investigation of environmental and hydrologic conditions across temporal and spatial scales (13). Grayson et al. (14) suggest using a "snapshot" approach that captures water quality characteristics at a single point in time across broad areas to provide information frequently missed during routine monitoring. Compared with long-term comprehensive investigations, the snapshot approach reduces the number of samples, cost, and personnel required to examine pollution sources.

Escherichia coli concentrations are commonly used to describe the relative human health risk during water quality monitoring in lieu of pathogen detection. Studies attempting to trace pollution in water back to a specific land use with *E. coli* have rarely produced definitive conclusions (15, 16). Using molecular approaches, specific source targets can be isolated in complex systems and have recently been used to investigate land use and water quality impairments (17). Furtula et al. (18) demonstrated ruminant, pig, and dog fecal contamination in an agriculturally dominated watershed (Canada) using *Bacteroides* markers. The *Bacteroides thetaiotaomicron* α-1–6 mannanase (*B. theta*) gene has a high human specificity (19–22), but no studies to date have linked its presence to land use patterns.

Reference conditions have been established for minimally disturbed environments based on measurements of macroinvertebrates, fish, and diatoms (23–25), but microbial reference conditions have not been adequately explored or defined. Based on 15 unimpaired California streams, microbial reference conditions for *E. coli* [1.0 $\log_{10}$ most probably number (MPN)·100 mL^{-1}] and enterococci (1.2 $\log_{10}$ MPN·100 mL^{-1}) were defined as being below state water quality thresholds (26). In the Great Lakes, a human health threshold of 2.37 $\log_{10}$ *E. coli* MPN·100 mL^{-1} (27), or a level equally protective of human health, has been adopted by all state governments. However, this health-associated reference level was derived from epidemiological studies undertaken at beaches throughout the United States (28, 29) with limited knowledge of local implications.

In response to water quality degradation from human stressors and the poorly understood microbial conditions in large-scale fresh water systems such as the Great Lakes basin, this paper aims to (*i*) examine the spatial distribution of *E. coli* and a human specific source marker (*B. theta*) in 64 river systems that drain most of the state's Lower Peninsula under baseflow conditions, (*ii*) identify baseflow reference levels of fecal contamination in rivers, and (*iii*) determine how key chemical, physical,

Significance

New microbial source-tracking tools can be used to elucidate important nonpoint sources of water quality degradation and potential human health risks at large scales. Pollution arising from septic system discharges is likely more important than previously realized. Identifying these sources and providing reference levels for water quality provides a basis to assess water quality trends and ultimately remediate degraded areas.

Author contributions: M.P.V., S.L.M., A.D.K., and D.W.H. designed research; M.P.V., S.L.M., and A.D.K. performed research; M.P.V. and A.D.K. contributed new reagents/analytic tools; M.P.V., S.L.M., and A.D.K. analyzed data; and M.P.V., S.L.M., A.D.K., D.W.H., and J.B.R. wrote the paper.

The authors declare no conflict of interest.

*This Direct Submission article had a prearranged editor.

Freely available online through the PNAS open access option.

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This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1415836112/-/DCSupplemental.

environmental, hydrologic, and land use variables are linked to river water quality at large scales.

Results and Discussion

To address microbial water quality impairment, this study examined fecal bacteria source tracking across a large spatial scale with classification and regression tree (CART) statistical method to link fecal contamination in rivers to landscape, geochemical, and hydrologic factors as well as potential human fecal sources such as septic systems and sewage effluent at the basin scale. The *B. theta* results suggest human fecal contamination was affecting 100% of the studied river systems. These results have significant implications for water and environmental quality managers. Further details on hydrologic, geochemical, and land use characteristics, as well as a CART analysis of the reduced dataset, are described in *SI Materials and Methods*.

Microbial Water Quality and Reference Conditions. This project measured *E. coli* and *B. theta* concentrations in 64 rivers under baseflow conditions. Across all sites, *E. coli* concentrations ranged from 0.3 to 3.0 $\log_{10}$ MPN·100 mL^{-1} (geometric mean of 1.4 $\log_{10}$ MPN·100 mL^{-1}) and *B. theta* ranged from 4.2 to 5.9 $\log_{10}$ cell equivalents (CE)·100 mL^{-1} (geometric mean of 5.1 $\log_{10}$ CE·100 mL^{-1}). *E. coli* levels were below the detection limit (<1 MPN·100 mL^{-1}) in four rivers, whereas *B. theta* was detected in all samples (Fig. 1 and Table S1). Nine rivers (14% of sites) exceeded the US Environmental Protecion Agency (USEPA) suggested *E. coli* criterion for safe contact (2.37 $\log_{10}$ MPN·100 mL^{-1}), ranging in concentrations from 2.4 to 3.0 $\log_{10}$ MPN·100 mL^{-1}. In these same nine rivers, *B. theta* concentrations ranged from 4.6 to 5.6 $\log_{10}$ CE·100 mL^{-1}. These nine *E. coli* values were significantly different ($P < 0.001$) from those of the other 55 sites, which had a geometric mean of 1.3 $\log_{10}$ MPN·100 mL^{-1}. In contrast, there was no statistically significant difference ($P = 0.433$) between *B. theta* concentrations from these two sets of sites.

E. coli concentrations (geometric mean of 1.4 $\log_{10}$ MPN·100 mL^{-1}) were generally below USEPA recreational water quality criteria and consistent with previously measured ranges in Great Lakes tributary rivers (30–32). A comprehensive review (33) found that *E. coli* levels in freshwater below 2.23 $\log_{10}$ MPN·100 mL^{-1} were associated with low relative risks of gastrointestinal illness for swimmers compared with nonswimmers. Because the *E. coli* geometric mean concentration observed in this study was below the safety level reported by Wade et al. (33), we suggest a reference condition for *E. coli* of 1.4 $\log_{10}$ MPN·100 mL^{-1} for Michigan's Lower Peninsula rivers under baseflow conditions in the absence of recent storm runoff. Wade et al. (28) reported positive associations between occurrence of illness and molecularly detected *Bacteroides* at one Great Lakes beach with a geometric mean concentration of 3.08 $\log_{10}$ CE·100 mL^{-1}, while noting that the associations were statistically weak ($P < 0.1$). Yampara-Iquise et al. (19) reported *B. theta* levels ranged from 5.8 to 9.8 $\log_{10}$ copies·100 mL^{-1} in multiple urban, agricultural, and small-town creek systems that represented various levels of human impact. In the current study, *B. theta* concentrations (range = 4.2–5.9 $\log_{10}$ CE·100 mL^{-1}; geometric mean = 5.1 $\log_{10}$ CE·100 mL^{-1}) averaged 1.6 times higher than levels reported by Wade et al. (28) but slightly lower than those reported by Yampara-Iquise et al. (19). Establishing *B. theta* reference conditions for Michigan rivers under other flow conditions would require additional sample analysis and a greater understanding of the bacterial distributions because comparative *B. theta* datasets are relatively small relative to available *E. coli* data, a key aspect to defining reference levels (34). Reference levels are important for establishing acceptable levels of disturbances, defining long-term water quality changes, and supporting management decisions (34). Although the concept of a reference condition lies in the notion of minimal impact, it is recognized that few streams or rivers are truly unimpaired because most receive treated sewage effluent, and the current study supports this premise.

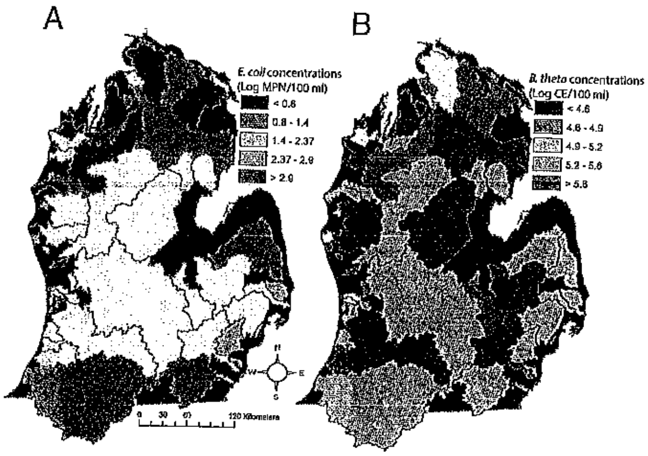

Fig. 1. (*A*) *E. coli* ($\log_{10}$ MPN·100 mL^{-1}) and (*B*) *B. theta* ($\log_{10}$ CE·100 mL^{-1}) concentrations measured in 64 rivers under baseflow conditions. Areas in black were not represented with samples.

CART Analysis of Microbial Water Quality. A primary goal of this study was to address diffuse pollution sources, historically a significant challenge in managing water quality. Major sources of nutrient loads from point and nonpoint sources of contamination were previously examined for Michigan's Lower Peninsula and shown to vary significantly between watersheds (35). The current study examines these drivers under baseflow conditions, where groundwater inputs dominate flows and wastewater effluent generally provides only a small fraction of total river discharges (Table S1). Effects of wastewater treatment plant (WWTP) effluent on microbial water quality were examined using multiple approaches (see *Supporting Information* for details), and it was ultimately determined that WWTP were not a driving factor of microbial water quality in the studied watersheds. Future analysis of the seasonal efficacy of WWTP could improve the understanding of wastewater impact on water quality by quantifying effluent discharge contributions in key urban areas.

The initial hypothesis of this research was that land use would best explain fecal bacterial concentrations in water. Instead, we found that land use characteristics such as septic systems and nutrients were the primary explanatory factors of microbial water quality. The influence of septic systems on microbial water quality, measured by *E.coli*, at a smaller watershed scale has also been reported in other regions (36, 37). In the current study, *E. coli* concentrations were linked primarily to total phosphorus and potassium. *B. theta* concentrations were primarily associated with the total number of septic systems in the watershed and within a 60-m buffer. Because WWTPs were not a driving factor of microbial water quality in the studied watersheds, these results indicate that under low flow conditions septic systems are a significant source of human fecal contamination to surface water in the studied watersheds.

CART analysis was used to evaluate the influence of the independent variables on *E. coli* and *B. theta*. Results from CART analyses for *E. coli* and *B. theta* concentrations at the full and reduced watersheds are summarized in Fig. 2 and Fig. S1, respectively. The CART outputs indicated complex causes of river water quality variability under baseflow conditions. For instance, *E. coli* concentrations at the full watershed scale were mainly related to total phosphorus (TP) concentrations, which is consistent with results by Carrillo et al. (38). TP concentrations accounted for 48% of *E. coli* variance with a threshold of 19.0 μg·L^{-1}.

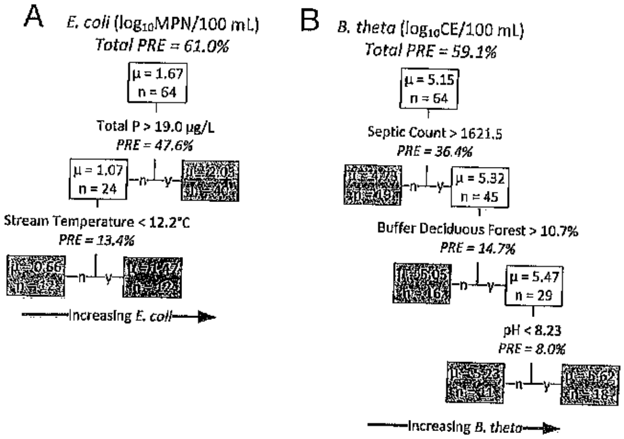

Fig. 2. CART analyses for (*A*) *E. coli* and (*B*) *B. theta* concentrations as dependent variables and land use, nutrient, chemical, hydrologic, and environmental parameters as independent variables in watersheds. PRE, proportion of reduction in error.

Although TP is essential for bacterial growth, the authors acknowledge that treated wastewater effluent includes high levels of both *E. coli* and TP. However, as stated above, WWTPs were not a driving factor of microbial water quality in the studied watersheds. Phosphorus, like *E. coli*, may be derived from sediments in the rivers, soil, plants, animal wastes, or manure and thus, unlike the *B. theta*, is not exclusive to fecal pollution.

The full watershed CART outputs and correlation analysis indicated *B. theta* concentrations were strongly associated with total numbers of septic systems in the watershed ($r = 0.364$, $P = 0.002$) and in the 60-m buffer ($r = 0.357$, $P = 0.004$). *B. theta* concentrations were not correlated with septic system density in the watershed ($P = 0.361$) or in the 60-m buffer ($P = 0.520$). Interestingly, the total number of septic systems in the watershed accounted for 36% of the *B. theta* concentration variance with a threshold count of 1,622 systems per watershed, as shown in Figs. 2*B* and 3. The snapshot sampling strategy used in this study focused on a spatial composite of the watersheds near the drainage point toward the Great lakes. Thus, the total number of people on septic tanks equates to the level of feces entering each watershed, and these levels are potentially dominated by failing septic systems contributing high concentrations of bacteria to nearby water systems. A Michigan health department reported a 26% on-site wastewater failure rate during time of sale or transfer inspections that discharged an estimated 65,000 gallons of untreated fecal waste each year to nearby water bodies (39). Future watershed-based studies should include analysis of total septic systems in the watershed and septic density, because it would be possible to overlook failing septic systems if the sample size were small or the focus were only on septic density. Additional efforts aimed at the condition of septic systems, their ability to remove bacteria, and microbial transport to nearby surface waters are required.

The direct and significant correlation between estimated number of septic systems and the human-specific marker *B. theta* in water (Fig. 3) illustrates a major issue for water quality of Michigan's streams and rivers, with an estimated 1.4 million on-site septic systems statewide (35, 40). In this study, the overall *B. theta* geometric mean was one $\log_{10}$ unit higher than secondary treated sewage effluent, whereas the highest measured concentrations were 1.5 logs higher than biologically treated septage effluent (20). Interestingly, when the CART analysis considered the entire upstream drainage area, including lakes, 2.5 times fewer septic systems were required to produce *B. theta* levels similar to when these drainage areas were restricted to downstream of the nearest lake, potentially indicating increased failure rates of septic systems surrounding lakes compared with rivers (see *Supporting Information* for details). Habteselassie et al. (41) identified that surface water and groundwater near failing on-site wastewater treatment systems contained higher concentrations of *E. coli* and enterococci than water surrounding properly functioning on-site wastewater treatment systems ($P < 0.001$). Combined, these results illustrate the importance and need for responsible development and septic system maintenance along lake and river riparian zones to protect water quality. Future analysis should include incremental spatial assessment of *B. theta* with respect to septic systems in watersheds to assess the fate and transport of bacteria from septic systems and define their acute/chronic impacts on water quality.

E. coli and *B. theta* Z-scores [(observed − mean)/SD] were compared using CART, as shown in Fig. 4, to identify the characteristics that could differentiate between *E. coli* and *B. theta* concentrations. Positive values of the Z-score differences occur when *E. coli* concentrations are higher, relative to their population mean, than *B. theta* concentrations. Negative values imply the opposite, with relatively higher *B. theta* concentrations. In catchments with discharge $<0.66\ m^3 \cdot s^{-1}$ and with fewer than 294 septic systems in the 60-m buffer, *E. coli* concentrations were much higher than those of *B. theta*. In contrast, *B. theta* concentrations were much higher than those of *E. coli* in rivers with discharge $>0.66\ m^3 \cdot s^{-1}$, particularly in catchments with dissolved organic carbon $>5.4\ \mu g \cdot L^{-1}$. *E. coli*, which occurs in the feces of all warm-blooded mammals and birds, has been shown to persist and regrow in the environment under some conditions and has been associated with suspended particles that have low settling rates (42–45). Therefore, in watersheds with low discharge it is possible that *E. coli* can attach to particles and persist longer than *B. theta*, which is an anaerobic organism with a faster decay rate in rivers (46).

We compared the concentrations and loads of *E. coli* and *B. theta* across all sites (Fig. S2). No statistically significant relationship was identified between *E. coli* and *B. theta* concentrations ($r = 0.18$; $P = 0.16$). Bacterial entry to rivers during baseflow seems to be occurring from some of the same diffuse sources, including septic systems. The comparison of *E. coli* versus *B. theta* concentrations illustrated that each of these microorganisms was entering rivers from similar sources (i.e., diffuse sources such as septic systems) (Fig. 2). However, each organism was influenced by different environmental parameters as identified by the Z-score CART analysis (Fig. 4). *E. coli* was ubiquitous in most rivers and concentrations were primarily associated with TP and K levels. This study indicates that *B. theta* can be used as a source-tracking marker to investigate diffuse sources of human-derived contaminants from septic systems under baseflow hydrologic conditions at watershed scales.

ENVIRONMENTAL SCIENCES

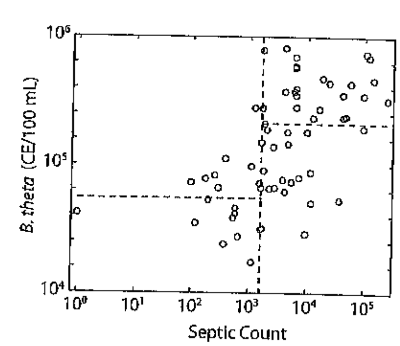

Fig. 3. *B. theta* versus septic systems illustrating the CART output from the first split of Fig. 2*B*.

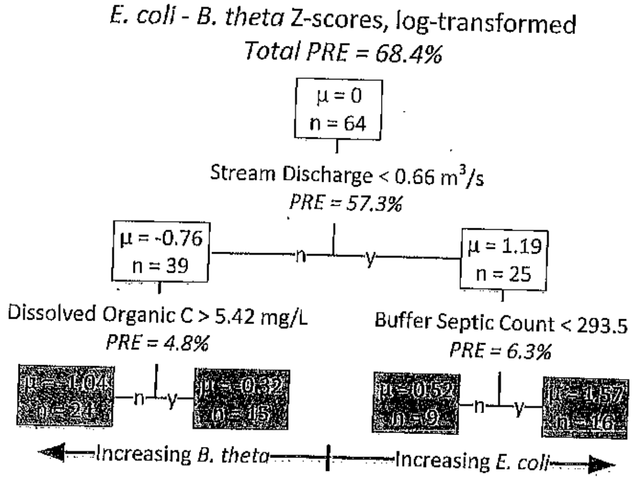

Fig. 4. CART of *E. coli* and *B. theta* Z-scores illustrating conditions associated with different concentrations between these two microbes. PRE, proportion of reduction in error.

Conclusions

To address impaired waters and restore them to designated uses, the process for total maximum daily loads (TMDLs) has been developed under the Clean Water Act. According to Stiles (47) there are currently 65,000 TMDLs and 43,000 listings that need to be addressed. Many stretches of water systems are impaired due to fecal pollution and *E. coli*, but there have been no established approaches or tools to identify nonpoint sources. This study provides a path forward to assess and ultimately improve water quality at large scales. More importantly, this study provides reference conditions for a large number of watersheds that, in the event of major landscape disturbance, could be used to measure remediation progress. Using a synoptic sampling approach for regional water quality assessment, this study found that human fecal contamination was prevalent under baseflow conditions. Baseflow in the study watersheds was generally dominated by groundwater and not by wastewater treatment effluent. Results suggest a regional *E. coli* reference condition below the current USEPA freshwater recreational criterion could be established. However, identifying specific sources of fecal contamination in rivers cannot be achieved using ubiquitous bacteria, such as *E. coli*. Assessing water quality using solely *E. coli* may mislead water quality managers and severely limit the ability to remediate impaired waterways. However, microbial source-tracking markers, such as the human-specific *B. theta* marker, can provide a more refined tool to identify the impacts of nonpoint sources of human fecal pollution, which could help prioritize restoration activities that should be implemented at watershed scales. The high variability of water quality measurements illustrates complex relationships between bacteria and landscape, geochemical, and hydrologic properties. The influence of septic systems in riparian zones also indicates that additional localized control measures, including septic system maintenance and construction, should be implemented to protect water quality and human health.

Materials and Methods

Study Area. This study investigated 64 watersheds draining Michigan's Lower Peninsula to the Great Lakes (Fig. S3). Watersheds were selected using the following criteria: (*i*) the 30 largest watersheds that represent >80% of Michigan's Lower Peninsula land area and (*ii*) 34 smaller watersheds randomly selected across the state from locations near their outlet to the lake. All sampling sites were located at bridge crossings and selected on the criteria that each was reasonably accessible, had adequate flow, river water dominated discharge, and the maximum amount of upstream land use was captured while meeting the above criteria.

Water Sample Collection. A synoptic sampling scheme was used to capture water quality characteristics under a single flow condition (i.e., baseflow) across broad spatial areas (14). Compared with long-term comprehensive investigations, this approach reduces the number of samples, cost, and personnel resources required to address pollution sources while providing essential information missed during routine monitoring.

Grab samples were collected from each river sampling site between October 1–13, 2010, which was chosen as a groundwater-dominated baseflow period based on historical hydrographs and antecedent precipitation. Groundwater-driven baseflow is critical to the preservation of water quality and quantity in the Great Lakes and provides year-round support for aquatic habitats. Before sampling each watershed, meteorological conditions were monitored to ensure that no significant precipitation had occurred within several days and hydrographs from nearby US Geological Survey (USGS) stream gauges were inspected to check that sampled rivers were at baseflow. October was chosen for the sampling period because the late growing season baseflow period is least likely to have large variability in water quality because flows are dominated by groundwater in the region. There is variability in water quality between baseflow periods (i.e., fall versus summer), but this variability is small relative to the variability between baseflow and other periods due to overland flow and dilution effects (48, 49). Water temperature (degrees Celcius), specific conductance (microsiemens per centimeter), and dissolved oxygen (milligrams per liter) were measured on-site using YSI 600R Sonde (YSI Incorporated). Field samples were placed on ice in coolers and transported to Michigan State University for other analyses, including bacterial testing (described below) within 24 h.

Water Analysis. Each sample was assayed for water chemistry as summarized in Table S2. The methods for assaying chemicals and nutrients are described in Table S3. *E. coli* analyses were performed within 24 h of collection using IDEXX Colilert Quanti-Tray 2000. Following incubation at 35 °C (±0.5 °C) for 24 h (±2 h), fluorescent wells were reported positive for *E. coli*, and reported as MPN per 100 mL. *E. coli* C-3000 (American Type Culture Collection 15597) was used as positive control for verification of media integrity. Sterile water was used for negative controls to verify method integrity. *E. coli* measurements below detection limits (1.0 MPN·100 mL^{-1}) were assigned the value of the detection limit.

Samples were analyzed for the human-specific marker *B. theta*, which has been shown to have a high sensitivity comparable to other human-associated markers in a multilaboratory evaluation (50). Compared with *B. theta*, HF183 and other source markers had greater false positive rates in animal feces collected in the same region as our study area (21). BacHum exhibited an even greater false positive rate than HF183 (51). Laboratories associated with our team and others have demonstrated that *B. theta* is a suitable human-specific marker and is related to human health outcomes (19–21, 52).

Analysis of the human-specific marker *B. theta* α-1–6 mannanase (5′CATCGTTCGTCAGCAGTAACA3′; 5′CCAAGAAAAAGGGACAGTGG3′) was performed according to Yampara-Iquise et al. (19), specifically by filtering 900 mL of water through a 0.45-μm hydrophilic mixed cellulose esters filter. Each filter was placed into a 50-mL centrifuge tube containing 20 mL of sterile phosphate-buffered water, vortexed, and centrifuged (30 min; 4,000 × *g*; 21 °C). Eighteen milliliters were decanted from the tube and the remaining eluent and pellet were stored at −80 °C. DNA was extracted from 200 μL of the thawed pellet via QIAamp DNA mini kit protocol. Quantitative PCR (qPCR) was performed on extracted DNA following Yampara-Iquise et al. (19) with a probe modification (20) using a Roche Light-Cycler 2.0 Instrument (Roche Applied Sciences). Each *B. theta* assay was carried out with 10 μL of LightCycler 480 Probe Mastermix (Roche Applied Sciences), 0.4 μL forward and reverse primers, 0.2 μL probe 62 (6FAM-ACCTGCTG-NFQ; Roche Applied Sciences Universal Probe Library), 1.0 μL BSA, 3.0 μL nuclease-free water, and 5.0 μL of extracted DNA and processed in triplicate. The qPCR analyses included a 15-min, 95 °C preincubation cycle, followed by 50 amplification cycles, and a 0.5-min 40 °C cooling cycle. A diluted plasmid standard was included during each qPCR run as a positive control and molecular-grade water was used in place of DNA template for negative controls. One copy of the targeted *B. theta* gene is assumed present per cell, and thus one gene copy number corresponded to one equivalent cell (19, 20). *B. theta* gene copies were converted to CE and reported as qPCR CE·100 mL^{-1}.

Climate and Hydrology. Hourly precipitation data were extracted from the Grand Rapids, Gaylord, and Detroit (Michigan) Next Generation Radar (NEXRAD) stations through the National Climate Data Center (www.ncdc.noaa.gov/nexradinv), with a base reflectivity of 0.50°, an elevation range of 124 nautical miles, and 16-km^2 cells. Hourly precipitation averages across each watershed were used to calculate total rainfall weighted by the proportion of each NEXRAD cell within the sampled watershed. Precipitation was categorized into cumulative hourly totals (millimeters) before sample collection at intervals of 6, 12, 18, and 24 h and 2, 3, 4, 6, and 8 d, reported as millimeters per time before sample collection.

Real-time river discharge was measured at each site during sample collection using an Acoustic Doppler Current Profiler (53), colocated USGS stream gauges (waterwatch.usgs.gov), or current meter via wading following USGS protocol (54). River discharge is reported as cubic meters per second.

Land Use. Watersheds were delineated and then land use and septic system statistics were calculated for each watershed using Esri ArcMap GIS software (Table S4). The spatial analyst watershed tool was used to develop surface watersheds for each sampling point at 1 arc-second. Two watersheds were defined for each river site, referred to in this paper as full watersheds, which include the entire upstream drainage area ($n = 64$), and reduced watersheds, which only include drainage areas upstream of the sampling site to the nearest lake, reservoir, or pond ($n = 52$). The full watershed analysis ($n = 64$) included 12 sites that were at or near lake outlets, resulting in significantly smaller watersheds (average = 108 km^2) than the other 52 watersheds (average = 366 km^2). These 12 sites were removed in the reduced watershed analysis because it was originally hypothesized that longer retention time in the lentic water systems would likely reduce microbe concentrations owing to environmental decay. A digital map of land cover from 30-m resolution Landsat imagery and the National Land Cover Database (NLCD 2006; www.mrlc.gov/nlcd2006.php) was used to define land use in each watershed and buffer. Land use was categorized using the NLCD classification system with 16 categories and seven categories using the Anderson Level 1 Land Cover Classification System (55); Table S5 describes the Anderson classifications and equivalent NLCD categories. A 60-m riparian buffer was applied to streams in both full and reduced watersheds because land parcels are generally located adjacent to roads and require a buffer between surface waters and septic tanks. The average septic system setback from surface waters in Michigan is 15 m. Additionally, the 60-m riparian buffer ensured all riparian land uses were accounted for if the land use/river/septic system GIS layers were not completely matched under the 30-m resolution.

A map of households that likely use on-site septic systems to treat wastewater was previously developed for this study region (35). Briefly, septic system totals and locations were estimated following the cumulative examination of WWTP infrastructure, incorporated municipality areas, household location according to 2010 census blocks, 2006 NLCD and road layers, and residential drinking water well information. Estimated septic system numbers (per watershed) and densities (per square kilometer) in each watershed and 60-m-wide buffer around surface water bodies were calculated for the 64 river systems.

Estimates of total population and population relying on WWTPs for water treatment were performed for each watershed and 60-m buffer. The total population in each watershed was estimated by multiplying the number of households (based on 2010 census data, described above during septic system estimates) by the average household size in each census block. The number of people relying on WWTPs was estimated by overlaying census block information and wastewater treatment plant service area boundaries. Additionally, the USEPA Discharge Monitoring Report (DMR) Pollutant Loading Tool (cfpub.epa.gov/dmr/ez_search.cfm) was used to estimate the ratio of average annual WWTP effluent to measured baseflow. A full description of this method is provided in *Supporting Information*.

Statistical Analysis. A constant value of 1 was added to *E. coli* and *B. theta* concentrations before log transformation and analysis. Soil hydraulic conductivity values were log_{10}-transformed before statistical analyses. Spearman correlation tests were used to examine relationships among physical, geochemical, and microbial measurements. Descriptive statistics were performed using IBM SPSS Statistics software (Version 19.0) with a significance threshold of (α) 0.01.

CART analysis was used to compare *E. coli* and *B. theta* (dependent variables) data to the independent geochemical, hydrologic, environmental, and land use variables. CART has been used to investigate pathogenic bacteria and parasite relationships with environmental and land use factors (56), to classify lakes based on chemistry and clarity (57), and to predict the occurrence of fecal indicator bacteria with respect to physiochemical variables (58). CART was selected because it allows for robust nonlinear model development using multiple potentially interacting predictor variables (59) that splits dependent variables into categories based on the influence of independent variables. Following previously published methods (56, 57), CART recursively split dependent variables using a recursive partitioning algorithm (rpart) and a 10-fold cross-validation criterion. The 10-fold cross-validation approach breaks all data into 10 subsets and calculates the split based on 9 of the 10 subsets. This method is used for each group until reaching a minimum stopping criterion of five observations per subgroup.

Fully developed CART outputs often required pruning to remove insignificant splits and ensure significant variable associations were not missed due to the splitting and stopping criteria (60). We first pruned CART outputs using the 1-SE rule (61–63), and, if needed, a subsequent pruning step was performed if splits did not reduce error by 5% or more. This rule minimized the cross-validated error of the model, which has been shown to produce optimal sized trees that are stable across replications (61, 64).

Detailed CART outputs were investigated to identify competitor and surrogate variables for each node. Competitor splits are ranked according to the reduction in model error from other potential splits, whereas surrogate splits are ranked according to how similar the resultant groups are relative to the primary split groups. Model accuracy was assessed by summing the proportional reduction of error from each split. All CART analyses were performed using the R software system (R Foundation for Statistical Computing).

To compare concentrations of the two organisms at each site relative to the average concentration of each organism, the Z-score of each sample was calculated. Z-scores [(observed − mean)/SD] for *E. coli* and *B. theta* were calculated in R using the "scale (dataset, center=TRUE, scale=TRUE)" command. This is defined as the sample concentration minus the mean of the population divided by the SD of the population. In this case, the Z-score of the log-transformed concentration was calculated. Positive Z-scores indicate samples with concentrations greater than the population mean, whereas negative Z-scores indicate the opposite. A CART analysis of the difference in Z-scores, calculated as *E. coli* – *B. theta*, was then performed using the same set of predictor variables in the single-organism models.

ACKNOWLEDGMENTS. We thank Steve Hamilton, Emily Luscz, Bobby Chrisman, Rebecca Ives, Sarah AcMoody, and Seth Hunt for vital support during this project and Drs. Shannon Briggs and Jon Bartholic for their technical support during the development of this manuscript. Partial funding for this project came from National Oceanic and Atmospheric Administration Great Lakes Environmental Research Laboratory Grant "Land Use Change and Agricultural Lands Indicators and Tipping Points." Partial support was also provided by the Environmental Protection Agency Grants 112013 and 118539.

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DELEGATION AGREEMENT

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

AND

TETON COUNTY, WYOMING

Article I. Authority

1. Pursuant to the authority of W.S. 35-11-304(a), the State of Wyoming, acting through the Administrator of the Water Quality Division, hereafter "WQD", and the Director of the Department of Environmental Quality, hereafter "DEQ", and Teton County, a duly organized county of the State of Wyoming, a local governmental entity, hereafter "Entity", enter into the following Delegation Agreement, hereafter "Agreement".

Article II. Introduction and Purpose

2. This Agreement is authorized by W.S. 35-11-304, which provides that, to the extent requested by a municipality, the water and sewer district or county, the Administrator of the Water Quality Division, with the approval of the Director of the Department of Environmental Quality, shall delegate the authority to enforce and administer the provisions of W.S. 35-11-301(a)(iii) to local governmental entities, subject to certain conditions.

   This Agreement provides for local assumption of such authority and for promulgation of local regulations consistent with the standards and provisions of the Wyoming Environmental Quality Act (Act) and applicable standards and regulations promulgated pursuant to the Act.

3. The purpose of this Agreement is to foster state-local cooperation and conformity in the regulation of small wastewater facilities and to provide uniform and effective application of the provisions of the Wyoming Environmental Quality Act relating to the construction and operation of these facilities.

4. Under this Agreement, the enforcement and administration of permitting and inspection of small wastewater facilities are delegated to qualifying local governmental entities that have complied with the requirements of W.S. 35-11-304, applicable Wyoming Water Quality Rules and Regulations, and the terms of the Wyoming Administrative Procedure Act, W.S. 16-3-101, et.seq..

Article III. Requirements for the Agreement

5. The State, by the WQD Administrator, and the Entity, by the Teton County Board of Commissioners, affirm that they will comply with all of the provisions of this Agreement, all applicable standards and Wyoming Water Quality Rules and Regulations, regulations promulgated by the entity, and that they will continue to meet all the conditions and requirements specified in this Agreement.

EXHIBIT E

(a) The WQD Administrator shall be responsible for administering this Agreement on behalf of the State of Wyoming. The Delegated Local Official shall administer this Agreement on behalf of the Entity, in accordance with W.S. 35-11-304(a)(ii).

(b) WQD has and shall continue to have authority to carry out this Agreement, and shall expend sufficient funds to effectively implement the delegation and oversight activities contemplated in W.S. 35-11-304(a).

Article IV. Terms of the Agreement

6. By execution of this Agreement, WQD delegates and the Entity accepts the authority and responsibility to enforce and administer the provisions of W.S. 35-11-301(a)(iii) for small wastewater facilities, as defined in W.S. 35-11-103(c)(ix). This delegation includes the authority to develop necessary rules, regulations, standards, and permit systems, to review and approve construction plans, conduct inspections, issue permits, to enforce against violations, and to develop rules governing the review and appeal of any decision made by the Entity.

This Agreement does not include authority or responsibility to enforce and administer any other provisions of W.S. 35-11-302(a)(iii), including wastewater systems with design flows greater than two thousand (2,000) gallons of domestic sewage per day or any system that discharges non-domestic wastewater.

To determine if a proposed small wastewater system exceeds the authority delegated to the Entity, refer to Attachment G.

(a) The Entity agrees to enforce and administer the permit program for the facilities identified above, for the areas within its boundaries. The boundaries are identified on the map included in Attachment A, incorporated into this Agreement by this reference.

(b) The Entity hereby designates the County Sanitarian as the "Delegated Local Official" who is authorized to enforce and administer the permitting program delegated herein. The authorizing resolution from the Entity is included in Attachment B, incorporated into this Agreement by this reference.

(c) The names of the individual(s) authorized to issue permits and their qualifications are included in Attachment C, incorporated into this Agreement by this reference.

(d) The Entity has established rules, regulations, and standards for the issuance of permits required under W.S. 35-11-301(a)(iii), that are at least as stringent as those promulgated by the State under W.S. 35-11-302(a)(iii). The local rules include the process by which as aggrieved party may seek a review of the Entity's action. Such standards and rules, as promulgated, are found in Attachment D, incorporated into this Agreement by this reference.

(e) The local Entity has developed and adopted permitting procedures consistent with those established in current rules and regulations of the State. The procedures, as adopted by the Entity are also included in Attachment D incorporated into this Agreement by this reference.

(f) The Delegated Local Official shall establish and maintain an adequate system of records and information for each project permit, inspection, and enforcement action. The records and information system to be used by the local agency is described in Attachment E, incorporated into this Agreement by this reference.

(g) The Entity agrees to submit status reports to the Administrator annually, no later than the last business day of the calendar year. The Administrator will review the status report and may conduct an on-site program evaluation of the local program to assess the Entity's compliance with the terms of this agreement. Upon request and reasonable notice, the Administrator may during business hours inspect the records and procedures of the Entity with regard to the review, issuance, inspection and enforcement of the permit program.

(h) When an applicant's septic system falls under the regulatory authority of the WQD Underground Injection Control (UIC) Class V Well Program, the entity shall instruct the applicant to submit a completed WQD UIC application to the WQD UIC Program for review and approval. If the Entity wishes to do so, the Entity may request a concurrent review of the application from the WQD UIC program. Any comments on the application or material generated from the application may be submitted to the WQD UIC program for review and consideration up until the end of the state required public comment period (for Class V Individual permits only).

Article V. Other Conditions of the Delegation

7. No permit shall be issued for any facility that would result in non-compliance with an approved Water Quality Management Plan prepared under Sections 208 or 201 of the Federal Clean Water Act.

8. Upon approval of this Agreement, the Entity will promptly proceed to assume the responsibility to implement this Agreement and to hire, train and organize personnel as necessary. WQD will provide technical and other assistance as requested in order to ensure a smooth transition period.

9. The Entity will commence performing the functions delegated by this Agreement upon the date of execution and continue until such time as the delegation is suspended or revoked or until the Entity provides ninety (90) days' notice of intent to terminate the Agreement.

10. This Agreement may be amended at any time by the written agreement of both parties.

Article VI. Changes in State or Entity Standards

11. The State may from time to time revise and promulgate new or revised construction and/or operation standards and administrative procedures. If necessary in order to meet the requirements of W.S. 35-11-304(a), the Entity shall make such changes as may be accomplished by rule-making within six (6) months of notice by the State. Such changes shall be made in conformity with the requirements of W.S. 16-3-101, et.seq.

12. The State and Entity shall provide such other with copies of any changes to their respective laws, rules, and regulations and standards that pertain to the administration and enforcement of this agreement.

Article VII. Inspection

13. The Delegated Local Official shall provide for the inspection of all facilities during construction to ensure the facilities have been constructed according to approved plans and specifications. The Delegated Local Official may also conduct periodic operation inspections of facilities permitted under the authority of this Agreement and may implement procedures for inspection and the reporting of inspection in conformity with W.S. 35-11-109(a)(vi). The Delegated Local Official will be the point of contact and inspection authority in dealing with permittees concerning operations and compliance with the permitting and operation standards covered by this Agreement.

14. For oversight purposes, the WQD may designate authorized representatives to enter and inspect the construction and/or operation of the facilities described in this Agreement. Said inspections shall be conducted in conformity with W.S. 35-11-109 (a)(vi). The Entity shall receive reasonable notice of such inspection and may participate in this inspection.

Article VIII. Enforcement

15. The Entity shall be the primary enforcement authority concerning local compliance with the requirements of the construction and permitting management activities delegated by this Agreement. A legal opinion or a copy of local regulations demonstrating that the Entity has necessary authority to enforce compliance at the local level is attached, Attachment F.

    (a) Should the local governmental entity and the State fail to agree regarding the propriety of any enforcement action or inaction, the WQD may take any action necessary to comply with the terms of the Wyoming Environmental Quality Act and applicable standards and regulations. The Agreement does not limit the State's authority to enforcement against other violations of State law.

    (b) Through periodic reports, the local governmental entity shall notify the WQD of all violations of applicable laws, regulations or orders and all actions taken with respect to such violations.

Article IX. Revocation, Suspension or Termination

16. This Agreement may be voluntarily terminated by the Entity upon ninety (90) days written notice. Additionally, the administrator, with the approval of the director, may revoke or temporarily suspend this Delegation Agreement if the Entity fails to perform its delegated duties or has otherwise violated the terms of this Agreement. The administrator shall immediately notify the Delegated Local Official in writing of any revocation or suspension of the permitting authority. Such administrative action is subject to review by the Environmental Quality Council if the Entity so requests within twenty (20) days or notice of the State's action. Unless a revocation or suspension is appealed to the Council, it becomes effective twenty (20) days after the receipt of such notice.

17. The Entity may not assign any of its functions or authority delegated by this Agreement without prior written consent of the administrator.

18. The parties to this Agreement have read and understand all of its provision. This Agreement is effective upon execution this 25th day of January, 2018 and shall remain in effect until terminated as provided above.

Department of Environmental Quality

[signature] 1/25/18

Todd Parfitt
Director, Department of Environmental Quality
Date

[signature] 1-25-18

Kevin Frederick
Administrator, Water Quality Division
Date

Local Governmental Entity

TETON COUNTY, WYOMING

[signature] 12/19/17

Mark Newcomb, Chair
Teton County Board of County Commissioners
Date

Attest:

STATE OF WYOMING COUNTY CLERK TETON COUNTY

[signature] 12/19/17

Sherry L. Daigle
Date

TETON VILLAGE RESORT

MOOSE WILSON ROAD
TETON VILLAGE, WYOMING

FOR CONSTRUCTION

DATE PRINTED
November 8, 2022

INDEX OF DRAWINGS

ALL CONTRACTORS AND SUBCONTRACTORS PERFORMING WORK SHOWN ON OR RELATED TO THESE PLANS SHALL CONDUCT THEIR OPERATIONS SO THAT ALL EMPLOYEES ARE PROVIDED A SAFE PLACE TO WORK AND THE PUBLIC IS PROTECTED. ALL CONTRACTORS AND SUBCONTRACTORS SHALL COMPLY WITH THE "OCCUPATIONAL SAFETY AND HEALTH REGULATIONS OF THE U.S. DEPARTMENT OF LABOR AND THE STATE OF UTAH DEPARTMENT OF INDUSTRIAL RELATIONS CONSTRUCTION SAFETY ORDERS." THE CIVIL ENGINEER SHALL NOT BE RESPONSIBLE IN ANY WAY FOR THE CONTRACTORS AND SUBCONTRACTORS COMPLIANCE WITH SAID REGULATIONS AND ORDERS.

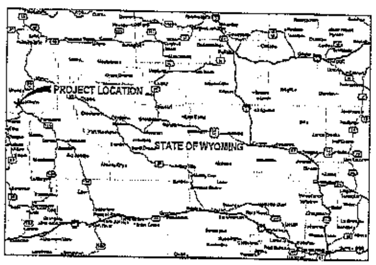
CONTRACTOR FURTHER AGREES TO ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB-SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY, THAT THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS, AND THAT THE CONTRACTOR SHALL DEFEND, INDEMNIFY AND HOLD THE OWNER AND THE CIVIL ENGINEER HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPTING FOR LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF THE OWNER OR ENGINEER.

NOTICE TO DEVELOPER/CONTRACTOR

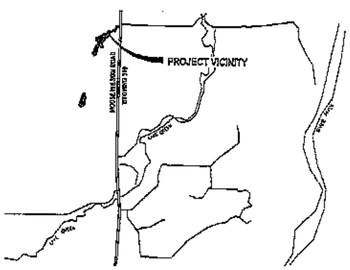
UNAPPROVED DRAWINGS REPRESENT WORK IN PROGRESS, ARE SUBJECT TO CHANGE, AND DO NOT CONSTITUTE A FINISHED ENGINEERING PRODUCT. ANY WORK UNDERTAKEN BY DEVELOPER OR CONTRACTOR BEFORE PLANS ARE APPROVED IS UNDERTAKEN AT THE SOLE RISK OF THE DEVELOPER, INCLUDING BUT NOT LIMITED TO BIDS, ESTIMATION, FINANCING, BONDING, SITE CLEARING, GRADING, INFRASTRUCTURE CONSTRUCTION, ETC.

UTILITY DISCLAIMER

THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION AND / OR ELEVATIONS OF EXISTING UTILITIES AS SHOWN ON THESE PLANS IS BASED ON RECORDS OF THE VARIOUS UTILITY COMPANIES AND WHERE POSSIBLE, MEASUREMENTS TAKEN IN THE FIELD. THE INFORMATION IS NOT TO BE RELIED ON AS BEING EXACT OR COMPLETE. THE CONTRACTOR MUST CALL THE LOCAL UTILITY LOCATION CENTER AT LEAST 48 HOURS BEFORE ANY EXCAVATION TO REQUEST EXACT FIELD LOCATIONS OF UTILITIES. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO RELOCATE ALL EXISTING UTILITIES WHICH CONFLICT WITH THE PROPOSED IMPROVEMENTS SHOWN ON THE PLANS.



LOCATION MAP
NO SCALE



VICINITY MAP
NO SCALE

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MOOSE WILSON ROAD
TETON VILLAGE, WYOMING

Professional Engineer
ROBERT J. ROUSSELLE
17107
WYOMING

FOR CONSTRUCTION

COVER SHEET

PROJECT NUMBER 11397
PRINT DATE 11/8/22
DESIGNED BY BKR
DRAFTED BY CFD
PROJECT MANAGER RJR

C-000

EXHIBIT F

ABBREVIATIONS

@	AT
⌀	DIAMETER
%	PERCENTAGE
'	FEET
"	INCHES
3PH	THREE PHASE POWER
AB	ANCHOR BOLT
ABUT	ABUTMENT
AC	ASBESTOS CEMENT PIPE OR ASPHALT CONCRETE
ADT	AVERAGE DAILY TRAFFIC
APPROX	APPROXIMATELY
APWA	AMERICAN PUBLIC WORKS ASSOCIATION
AL	AIR LINE
ALUM	ALUMINUM
AR	ACCESSIBLE ROUTE
ASPH	ASPHALT
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AWWA	AMERICAN WATER WORKS ASSOCIATION
AZ	AZIMUTH
BAL	BALANCE
BEG	BEGINNING / BEGIN
BFC	BACK FACE OF CURB
BGS	BELOW GROUND SURFACE
BLD FLG	BLIND FLANGE
BLDG	BUILDING
BLM	BUREAU OF LAND MANAGEMENT
BM	BENCHMARK
BLK	BLOCK
BOD	BIOCHEMICAL OXYGEN DEMAND
BOS	BOTTOM OF STEP
BOT	BOTTOM
BRG	BEARING
BSMT	BASEMENT
BTWN	BETWEEN
BVC	BEGIN VERTICAL CURVE
C	CURVE
C&G	CURB AND GUTTER
CALC	CALCULATED
CB	CATCH BASIN
C-C	CENTER TO CENTER
CCW	COUNTER CLOCKWISE
CF	CURB FACE
CFS	CUBIC FEET PER SECOND
CIP	CAST IRON PIPE
CJ	CONSTRUCTION JOINT
C	CENTER LINE
CLR	CLEARANCE
CMP	CORRUGATED METAL PIPE
CMP-A	CORRUGATED METAL PIPE - ARCH
CO	CLEAN OUT
COB	CLEAN OUT BOX
COL	COLUMN
COMM	COMMUNICATION
CONC	CONCRETE
CONN	CONNECT
CONT	CONTINUOUS
COR	CORNER
CTR	CENTER
CU FT	CUBIC FEET
CU YD	CUBIC YARD
CULV	CULVERT
CW	CLOCKWISE
D	DEGREE
DET	DETAIL
DIA	DIAMETER
DIP	DUCTILE IRON PIPE
DIST	DISTANCE
DL	DRAIN LINE
DMH	DRAINAGE MANHOLE
DN	DOWN
DW	DRINKING WATER
DWG	DRAWINGS
DWV	DRAIN WASTE VENT
E	EAST
EA	EACH
EB	ELECTRICAL BOX
EG	EDGE OF GRAVEL
ELEC	ELECTRIC / ELECTRICAL
ELEV	ELEVATION
EMB	EMBANKMENT
EMH	ELECTRICAL MANHOLE
ENGR	ENGINEER
ENT	ENTRANCE
EO	EDGE OF OIL
EOA	EDGE OF ASPHALT
EQUIP	EQUIPMENT
ES	EDGE OF SHOULDER
EST	ESTIMATE
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EXC	EXCAVATION
EX	EXISTING
EXIST	EXISTING
FD	FLOOR DRAIN
FDN	FOUNDATION
FEN COR	FENCE CORNER
FE	FIRE EXTINGUISHER
FF	FINISH FLOOR
FFC	FRONT FACE OF CURB
FG	FINISH GRADE
FH	FIRE HYDRANT
FIN	FINISH
FL	FLOW LINE / FLANGE
FLR	FLOOR
FRP	FIBERGLASS REINFORCED PIPE
FT	FEET
FTG	FOOTING
G	GAS
GA	GAGE / GAUGE
GALV	GALVANIZED
GB	GRADE BREAK
GEN	GENERAL
GF	GARAGE FLOOR
GLB	GLUED LAMINATED BEAM
GM	GAS METER
GSP	GALVANIZED STEEL PIPE
GV	GATE VALVE
HC	HANDICAP / HYPOCHLORITE
HDG	HOT DIPPED GALVANIZED
HDWL	HEADWALL
H&T	HUB & TACK
HORIZ	HORIZONTAL
HP	HIGH POINT
HSS	HOLLOW STRUCTURAL SECTION
HWL	HIGH WATER LEVEL
HWY	HIGHWAY
HX	HEAT EXCHANGER
HYD	HYDRANT
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IJ	ISOLATION JOINT
IN	INCH
INFO	INFORMATION
INV	INVERT
IRR	IRRIGATION
JCT	JUNCTION
K	RATE OF VERTICAL CURVATURE
L	LENGTH
LB	POUND
LD	LAND DRAIN
LF	LINEAR FEET
LIC	LICENSE
LIN	LINEAR / LINEAL
LP	LOW POINT / LIGHT POLE
LS	LAND SURVEYOR
LT	LEFT
LWL	LOW WATER LEVEL
MAG	MAGNETIC
MAINT	MAINTENANCE
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MH	MANHOLE
MI	MILE
MIN	MINIMUM
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MKR	MARKER
ML	MIXED LIQUOR
MON	MONUMENT
MPH	MILES PER HOUR
N	NORTH
NG	NATURAL GROUND
NIC	NOT IN CONTRACT
NPW	NON-POTABLE WATER
NO OR #	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OCEW	ON CENTER EACH WAY
OD	OUTSIDE DIAMETER
OFF REV	OFFICE REVISION
O-O	OUTSIDE TO OUTSIDE
OHP	OVERHEAD POWER
ORIG	ORIGINAL
OSB	ORIENTED STAND BOARD
PC	POINT OF CURVATURE / PRESSURE CLASS
PCC	POINT OF COMPOUND CURVATURE
PD	POND EFFLUENT
PE	PLANT EFFLUENT
PERF	PERFORATED
PI	POINT OF INTERSECTION / PRIMARY INFLUENT
PIV	POST INDICATOR VALVE
PL	PROPERTY LINE
POB	POINT OF BEGINNING
POC	POINT ON CURVATURE
PP	POWER POLE
PRC	POINT OF REVERSE CURVATURE
PRO	PROPOSED
PROJ	PROJECT
PROP	PROPERTY
PS	PUMP STATION
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PT	POINT OF TANGENCY
PVC	POINT OF VERTICAL CURVATURE / POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
PW	POTABLE WATER
QTY	QUANTITY
R	RADIUS / RANGE
RAS	RETURN ACTIVATED SLUDGE
RCP	REINFORCED CONCRETE PIPE
RCCP	REINFORCED CONCRETE CYLINDER PIPE
RD	ROOF DRAIN
REF	REFERENCE
REINF	REINFORCED
REQD	REQUIRED
REV	REVISION
ROW	RIGHT OF WAY
RP	REFERENCE POINT
RR	RAILROAD
RT	RIGHT / ROUTE
R/W	RIGHT OF WAY
S	SLOPE / SOUTH
SAN	SANITARY
SAN SWR	SANITARY SEWER
SCH	SCHEDULE
SD	STORM DRAIN
SE	SECONDARY EFFLUENT
SEC	SECONDARY
SEC COR	SECTION CORNER
SHT	SHEET
SJ	SAWED JOINT
SKT	SOCKET
SL	SOLIDS LINE
SOVFL	SURFACE OVERFLOW
SPECS	SPECIFICATIONS
SQ	SQUARE
SQ FT	SQUARE FEET
SQ YD	SQUARE YARDS
SS	SANITARY SEWER / STAINLESS STEEL
ST	STREET
STA	STATION
STD	STANDARD
STL	STEEL
STN STL	STAINLESS STEEL
STRUCT	STRUCTURE
SW	SIDEWALK
SWR	SEWER
SWL	SECONDARY WATER LINE
T	TOWNSHIP / TELEPHONE
TAN	TANGENT
TBC	TOP BACK OF CURB
TEMP	TEMPORARY
TELE	TELEPHONE / TELEGRAM
THD	THREADED
THK	THICK
TKN	TOTAL KJELDAHL NITROGEN
TOA	TOP OF ASPHALT
TOC	TOP OF CONCRETE
TOF	TOP OF FOUNDATION / TOP OF FOOTING
TOG	TOP OF GRATE / TOP OF GRAVEL
TOP	TOP OF PIER
TOW	TOP OF WALL
TOS	TOP OF STEP / TOP OF SLAB
TSS	TOTAL SUSPENDED SOLIDS
TYP	TYPICAL
UB	UTILITY BOX
UG	UNDERGROUND
UNO	UNLESS NOTED OTHERWISE
UW	UTILITY WATER
VC	VERTICAL CURVE
VERT	VERTICAL
VIC	VIC COUPLING
VOL	VOLUME
VPI	VERTICAL POINT OF INTERSECTION
VPC	VERTICAL POINT OF CURVE
VPT	VERTICAL POINT OF TANGENCY
VSS	VOLATILE SUSPENDED SOLIDS
W	WEST / WATER
WAS	WASTE ACTIVATED SLUDGE
WIV	WALL INDICATOR VALVE
WL	WATER LINE
WM	WATER METER
WO	WEIR OVERFLOW
W/	WITH
W/O	WITHOUT
XING	CROSSING
X-SEC	CROSS SECTION
YH	YARD HYDRANT

LEGEND

- SECTION CORNER
- EXISTING MONUMENT
- PROPOSED MONUMENT
- EXISTING REBAR AND CAP
- SET ENSIGN REBAR AND CAP
- EXISTING WATER METER
- PROPOSED WATER METER
- EXISTING WATER MANHOLE
- PROPOSED WATER MANHOLE
- EXISTING WATER BOX
- EXISTING WATER VALVE
- PROPOSED WATER VALVE
- EXISTING FIRE HYDRANT
- PROPOSED FIRE HYDRANT
- PROPOSED FIRE DEPARTMENT CONNECTION
- EXISTING SECONDARY WATER VALVE
- PROPOSED SECONDARY WATER VALVE
- EXISTING IRRIGATION BOX
- EXISTING IRRIGATION VALVE
- PROPOSED IRRIGATION VALVE
- EXISTING SANITARY SEWER MANHOLE
- PROPOSED SANITARY SEWER MANHOLE
- EXISTING SANITARY CLEAN OUT
- EXISTING STORM DRAIN CLEAN OUT BOX
- PROPOSED STORM DRAIN CLEAN OUT BOX
- EXISTING STORM DRAIN INLET BOX
- EXISTING STORM DRAIN CATCH BASIN
- PROPOSED STORM DRAIN CATCH BASIN
- EXISTING STORM DRAIN COMBO BOX
- PROPOSED STORM DRAIN COMBO BOX
- EXISTING STORM DRAIN CLEAN OUT
- EXISTING STORM DRAIN CULVERT
- PROPOSED STORM DRAIN CULVERT
- TEMPORARY SAG INLET PROTECTION
- TEMPORARY IN-LINE INLET PROTECTION
- ROOF DRAIN
- EXISTING ELECTRICAL MANHOLE
- EXISTING ELECTRICAL BOX
- EXISTING TRANSFORMER
- EXISTING UTILITY POLE
- EXISTING LIGHT
- PROPOSED LIGHT
- EXISTING GAS METER
- EXISTING GAS MANHOLE
- EXISTING GAS VALVE
- EXISTING TELEPHONE MANHOLE
- EXISTING TELEPHONE BOX
- EXISTING TRAFFIC SIGNAL BOX
- EXISTING CABLE BOX
- EXISTING BOLLARD
- PROPOSED BOLLARD
- EXISTING SIGN
- PROPOSED SIGN
- EXISTING SPOT ELEVATION
- PROPOSED SPOT ELEVATION
- EXISTING FLOW DIRECTION
- EXISTING TREE
- DENSE VEGETATION

- EXISTING EDGE OF ASPHALT
- PROPOSED EDGE OF ASPHALT
- EXISTING STRIPING
- PROPOSED STRIPING
- EXISTING FENCE
- PROPOSED FENCE
- EXISTING FLOW LINE
- PROPOSED FLOW LINE
- GRADE BREAK
- EXISTING STORM DRAIN LINE
- PROPOSED STORM DRAIN LINE
- ROOF DRAIN LINE
- CATCHMENTS
- HIGH WATER LINE
- EXISTING SANITARY SEWER
- PROPOSED SANITARY SEWER LINE
- PROPOSED SAN. SWR. SERVICE LINE
- EXISTING LAND DRAIN LINE
- PROPOSED LAND DRAIN LINE
- PROPOSED LAND DRAIN SERVICE LINE
- EXISTING CULINARY WATER LINE
- PROPOSED CULINARY WATER LINE
- PROPOSED CULINARY WATER SERVICE LINE
- EXISTING SECONDARY WATER LINE
- PROPOSED SECONDARY WATER LINE
- PROPOSED SEC. WATER SERVICE LINE
- EXISTING IRRIGATION LINE
- PROPOSED IRRIGATION LINE
- EXISTING OVERHEAD POWER LINE
- EXISTING ELECTRICAL LINE
- EXISTING GAS LINE
- EXISTING TELEPHONE LINE
- ACCESSIBLE ROUTE
- SAW CUT LINE
- STRAW WATTLE
- TEMPORARY BERM
- TEMPORARY SILT FENCE
- LIMITS OF DISTURBANCE
- EXISTING WALL
- PROPOSED WALL
- EXISTING CONTOURS
- PROPOSED CONTOURS
- BUILDABLE AREA WITHIN SETBACKS
- PUBLIC DRAINAGE EASEMENT
- EXISTING ASPHALT TO BE REMOVED
- PROPOSED ASPHALT
- EXISTING CURB AND GUTTER
- PROPOSED CURB AND GUTTER
- PROPOSED REVERSE PAN CURB AND GUTTER
- TRANSITION TO REVERSE PAN CURB
- CONCRETE TO BE REMOVED
- EXISTING CONCRETE
- PROPOSED CONCRETE
- BUILDING TO BE REMOVED
- EXISTING BUILDING
- PROPOSED BUILDING

NOTE: MAY CONTAIN SYMBOLS THAT ARE NOT USED IN THIS PLAN SET.

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MOOSE WILSON ROAD
TETON VILLAGE, WYOMING

Professional Engineer ROBERT J. ROUSSELLE 17107 WYOMING

FOR CONSTRUCTION

LEGEND AND ABBREVIATIONS.

PROJECT NUMBER 11207 | PRINT DATE 10/20/22
DRAWN BY BKR | CHECKED BY CFD
PROJECT MANAGER RJR

C-001

GENERAL NOTES

1. ALL CONSTRUCTION MUST STRICTLY FOLLOW THE STANDARDS AND SPECIFICATIONS SET FORTH BY: DESIGN ENGINEER, LOCAL AGENCY JURISDICTION, APWA (LATEST EDITION), THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (M.U.T.C.D.), AND OTHER REGULATORY AGENCIES EXERCISING AUTHORITY OVER ANY PORTION OF THE WORK WHERE APPLICABLE. THE ORDER LISTED ABOVE IS ARRANGED BY SENIORITY. THE LATEST EDITION OF ALL STANDARDS AND SPECIFICATIONS MUST BE ADHERED TO. IF A CONSTRUCTION PRACTICE IS NOT SPECIFIED BY ANY OF THE LISTED SOURCES, CONTRACTOR MUST CONTACT DESIGN ENGINEER FOR DIRECTION.
2. ALL CONSTRUCTION AND MATERIALS SHALL BE IN ACCORDANCE WITH THESE CONTRACT DOCUMENTS, LOCAL JURISDICTION OF AUTHORITY AND STATE REQUIREMENTS AND THE MOST RECENT EDITIONS OF THE FOLLOWING: THE INTERNATIONAL PLUMBING CODE, WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY (WYDEQ), WYOMING DEPARTMENT OF TRANSPORTATION (WYDOT) STANDARD PLANS AND SPECIFICATIONS, AND APWA MANUAL OF STANDARD PLANS AND SPECIFICATIONS. THE CONTRACTOR IS REQUIRED TO ADHERE TO ALL OF THE ABOVE-MENTIONED DOCUMENTS UNLESS OTHERWISE NOTED AND APPROVED BY THE ENGINEER.
3. SPECIFIC NOTES AND DETAILS SHALL TAKE PRECEDENCE OVER GENERAL NOTES, TYPICAL DETAILS, AND SPECIFICATIONS.
4. THE CONTRACTOR SHALL REFER TO THE TECHNICAL PROVISIONS FOR INFORMATION NOT COVERED BY THESE GENERAL NOTES OR DRAWINGS.
5. THE CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS BEFORE SUBMITTING A BID OR PRICE TO THE OWNER AND SHALL NOTIFY OWNER OF ANY DISCREPANCIES OR CONFLICTS BEFORE PROCEEDING WITH THE WORK OR SUBMITTING THE BID.
6. PRIOR TO STARTING CONSTRUCTION, THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THAT ALL REQUIRED PERMITS AND APPROVALS HAVE BEEN OBTAINED. NO CONSTRUCTION OR FABRICATION SHALL BEGIN UNTIL THE CONTRACTOR HAS RECEIVED AND THOROUGHLY REVIEWED ALL PLANS AND OTHER DOCUMENTS APPROVED BY ALL OF THE PERMITTING AUTHORITIES.
7. ALL DIMENSIONS, GRADES, AND UTILITY DESIGN SHOWN ON THE PLANS SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION. CONTRACTOR SHALL NOTIFY THE ENGINEER IF ANY DISCREPANCIES EXIST BETWEEN THE ACTUAL CONDITIONS AND INFORMATION SHOWN ON THE DRAWINGS, PRIOR TO PROCEEDING WITH CONSTRUCTION FOR NECESSARY PLAN OR GRADE CHANGES. NO EXTRA COMPENSATION SHALL BE PAID TO THE CONTRACTOR FOR WORK HAVING TO BE REDONE DUE TO THE DIMENSIONS OR GRADES SHOWN INCORRECTLY ON THESE PLANS, IF SUCH NOTIFICATION HAS NOT BEEN GIVEN.
8. CONTRACTOR SHALL PROVIDE A CONSTRUCTION SCHEDULE IN ACCORDANCE WITH LOCAL AGENCY JURISDICTION, STATE, OR COUNTY REGULATIONS FOR WORKING IN THE PUBLIC WAY.
9. THE CONTRACTOR SHALL PROVIDE AND BE RESPONSIBLE FOR THE TEMPORARY ERECTION OF BRACING AND SHORING AS REQUIRED FOR STABILITY OF STRUCTURES AND EXCAVATIONS DURING ALL PHASES OF CONSTRUCTION. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR CONFORMING TO LOCAL AND FEDERAL CODES GOVERNING SHORING AND BRACING OF EXCAVATIONS AND TRENCHES AND FOR THE PROTECTION OF WORKERS.
10. THE CONTRACTOR IS REQUIRED TO KEEP ALL CONSTRUCTION ACTIVITIES WITHIN THE APPROVED PROJECT LIMITS. THIS INCLUDES, BUT IS NOT LIMITED TO VEHICLE AND EQUIPMENT STAGING, MATERIAL STORAGE AND LIMITS OF TRENCH EXCAVATION. IT IS THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN PERMISSION AND/OR EASEMENTS FROM THE APPROPRIATE GOVERNING ENTITY AND/OR INDIVIDUAL PROPERTY OWNER(S) FOR WORK OR STAGING OUTSIDE OF THE PROJECT LIMITS.
11. PROJECT HORIZONTAL AND VERTICAL DATUM ARE SHOWN ON SHEET C-100.
12. CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO ADJACENT SURFACE IMPROVEMENTS.
13. CONTRACTOR SHALL BE RESPONSIBLE FOR CORRECTING ANY SETTLEMENT OF OR DAMAGE TO EXISTING UTILITIES.
14. THE CONTRACTOR IS RESPONSIBLE TO FURNISH ALL MATERIALS TO COMPLETE THE PROJECT.
15. THE LOCATIONS OF UNDERGROUND FACILITIES SHOWN ON THESE PLANS ARE BASED ON FIELD SURVEYS AND LOCAL UTILITY COMPANY RECORDS. IT SHALL BE THE CONTRACTOR'S FULL RESPONSIBILITY TO CONTACT THE VARIOUS UTILITY COMPANIES TO LOCATE THEIR FACILITIES PRIOR TO PROCEEDING WITH CONSTRUCTION. NO ADDITIONAL COMPENSATION SHALL BE PAID TO THE CONTRACTOR FOR DAMAGE AND REPAIR TO THESE FACILITIES CAUSED BY HIS WORK FORCE. CONTRACTOR SHALL START INSTALLATION AT LOW POINT OF ALL NEW GRAVITY UTILITY LINES.
16. NO CHANGE IN DESIGN LOCATION OR GRADE WILL BE MADE BY THE CONTRACTOR WITHOUT THE WRITTEN APPROVAL OF THE PROJECT ENGINEER.
17. NATURAL VEGETATION AND SOIL COVER SHALL NOT BE DISTURBED PRIOR TO ACTUAL CONSTRUCTION OF A REQUIRED FACILITY OR IMPROVEMENT. MASS CLEARING OF THE SITE IN ANTICIPATION OF CONSTRUCTION SHALL BE AVOIDED.
18. CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING, MAINTAINING, OR RESTORING ALL MONUMENTS AND MONUMENT REFERENCE MARKS WITHIN THE PROJECT SITE. CONTACT THE CITY OR COUNTY SURVEYOR FOR MONUMENT LOCATIONS AND CONSTRUCTION DETAILS.
19. CONTRACTOR TO LAYOUT AND POTHOLE FOR ALL POTENTIAL CONFLICTS WITH UTILITY LINES ON- OR OFF-SITE AS REQUIRED PRIOR TO ANY CONSTRUCTION, AND THE CONTRACTOR WILL VERIFY DEPTHS OF UTILITIES IN THE FIELD BY POTHOLING A MINIMUM OF 300 FEET AHEAD OF PIPELINE CONSTRUCTION TO AVOID CONFLICTS WITH DESIGNED PIPELINE GRADE AND ALIGNMENT. IF A CONFLICT ARISES RESULTING FROM THE CONTRACTOR'S NEGLIGENCE TO POTHOLE UTILITIES, THE CONTRACTOR WILL BE REQUIRED TO RESOLVE THE CONFLICT WITHOUT ADDITIONAL COST OR CLAIM TO THE OWNER OR ENGINEER.
20. ANY AREA OUTSIDE THE LIMIT OF WORK THAT IS DISTURBED SHALL BE RESTORED TO ITS ORIGINAL CONDITION AT NO COST TO OWNER.
21. CONSULT ALL OF THE DRAWINGS AND SPECIFICATIONS FOR COORDINATION REQUIREMENTS BEFORE COMMENCING CONSTRUCTION.
22. AT ALL LOCATIONS WHERE EXISTING PAVEMENT ABUTS NEW CONSTRUCTION, THE EDGE OF THE EXISTING PAVEMENT SHALL BE SAWCUT TO A CLEAN, SMOOTH EDGE.
23. ALL CONSTRUCTION AND MATERIALS SHALL BE IN ACCORDANCE WITH THE MOST RECENT, ADOPTED EDITION OF ADA ACCESSIBILITY GUIDELINES.
24. CONTRACTOR SHALL, AT THE TIME OF BIDDING AND THROUGHOUT THE PERIOD OF THE CONTRACT, BE LICENSED IN THE STATE OF WYOMING AND SHALL BE BONDABLE FOR AN AMOUNT REQUIRED BY THE OWNER.
25. CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE ALL WATER, POWER, SANITARY FACILITIES AND TELEPHONE SERVICES AS REQUIRED FOR THE CONTRACTOR'S USE DURING CONSTRUCTION.
26. CONTRACTOR SHALL BE RESPONSIBLE FOR ADEQUATELY SCHEDULING INSPECTION AND TESTING OF ALL FACILITIES CONSTRUCTED UNDER THIS CONTRACT. ALL TESTING SHALL CONFORM TO THE REGULATORY AGENCY'S STANDARD SPECIFICATIONS. ALL RE-TESTING AND/OR RE-INSPECTION SHALL BE PAID FOR BY THE CONTRACTOR.
27. IF EXISTING IMPROVEMENTS NEED TO BE DISTURBED AND/OR REMOVED FOR THE PROPER PLACEMENT OF IMPROVEMENTS TO BE CONSTRUCTED BY THESE PLANS, THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTING EXISTING IMPROVEMENTS FROM DAMAGE. COST OF REPLACING OR REPAIRING EXISTING IMPROVEMENTS SHALL BE INCLUDED IN THE UNIT PRICE BID FOR ITEMS REQUIRING REMOVAL AND/OR REPLACEMENT. THERE WILL BE NO EXTRA COST DUE TO THE CONTRACTOR FOR REPLACING OR REPAIRING EXISTING IMPROVEMENTS.
28. WHENEVER EXISTING FACILITIES ARE REMOVED, DAMAGED, BROKEN, OR CUT IN THE INSTALLATION OF THE WORK COVERED BY THESE PLANS OR SPECIFICATIONS, SAID FACILITIES SHALL BE REPLACED AT THE CONTRACTOR'S EXPENSE WITH MATERIALS EQUAL TO OR BETTER THAN THE MATERIALS USED IN THE ORIGINAL EXISTING FACILITIES. THE FINISHED PRODUCT SHALL BE SUBJECT TO THE APPROVAL OF THE OWNER, THE ENGINEER, AND THE RESPECTIVE REGULATORY AGENCY.
29. CONTRACTOR SHALL MAINTAIN A NEATLY MARKED SET OF FULL-SIZE RECORD DRAWINGS SHOWING THE FINAL LOCATION AND LAYOUT OF ALL STRUCTURES AND OTHER FACILITIES. RECORD DRAWINGS SHALL REFLECT CHANGE ORDERS, ACCOMMODATIONS, AND ADJUSTMENTS TO ALL IMPROVEMENTS CONSTRUCTED. WHERE NECESSARY, SUPPLEMENTAL DRAWINGS SHALL BE PREPARED AND SUBMITTED BY THE CONTRACTOR. PRIOR TO ACCEPTANCE OF THE PROJECT, THE CONTRACTOR SHALL DELIVER TO THE ENGINEER ONE SET OF NEATLY MARKED RECORD DRAWINGS SHOWING THE INFORMATION REQUIRED ABOVE. RECORD DRAWINGS SHALL BE REVIEWED AND THE COMPLETE RECORD DRAWING SET SHALL BE CURRENT WITH ALL CHANGES AND DEVIATIONS REDLINED AS A PRECONDITION TO THE FINAL PROGRESS PAYMENT APPROVAL AND/OR FINAL ACCEPTANCE.
30. WHERE THE PLANS OR SPECIFICATIONS DESCRIBE PORTIONS OF THE WORK IN GENERAL TERMS BUT NOT IN COMPLETE DETAIL, IT IS UNDERSTOOD THAT ONLY THE BEST GENERAL PRACTICE IS TO PREVAIL AND THAT ONLY MATERIALS AND WORKMANSHIP OF THE FIRST QUALITY ARE TO BE USED.
31. ALL EXISTING GATES AND FENCES TO REMAIN UNLESS OTHERWISE NOTED ON PLANS. PROTECT ALL GATES AND FENCES FROM DAMAGE.
32. ALL EXISTING TREES ARE TO REMAIN UNLESS OTHERWISE NOTED ON PLANS. PROTECT ALL TREES FROM DAMAGE.
33. CONTRACTORS ARE RESPONSIBLE FOR ALL OSHA REQUIREMENTS ON THE PROJECT SITE.
34. CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE AND MAINTAIN ANY EQUIPMENT NECESSARY TO DEWATER EXCAVATIONS AS NOTED ON THE PROJECT DRAWINGS.
35. CONTRACTOR SHALL NOTIFY ONE-CALL OF WYOMING, 811 OR 1-800-849-2476, 48 HOURS PRIOR TO BEGINNING EXCAVATION. CONTRACTOR SHALL LOCATE EXISTING WATER LINE AND OTHER UTILITIES BOTH VERTICALLY AND HORIZONTALLY. IF DISCREPANCIES, CONFLICTS OR UNFORESEEN CONDITIONS ARE DISCOVERED, CONTRACTOR SHALL IMMEDIATELY CONTACT ENGINEER FOR RESOLUTION.
36. ALL CONSTRUCTION SHALL CONFORM TO APPLICABLE SECTIONS OF THE WYOMING DEQ WATER QUALITY DIVISION, WYOMING ADMINISTRATIVE RULES (WAR) WATER QUALITY 0011 SERIES, WATER QUALITY.

UTILITY NOTES

1. PRIOR TO COMMENCING ANY WORK, IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO HAVE EACH UTILITY COMPANY LOCATE, IN THE FIELD, THEIR MAIN AND SERVICE LINES. THE CONTRACTOR SHALL NOTIFY ONE-CALL OF WYOMING, 811 OR 1-800-849-2476, 48 HOURS IN ADVANCE OF PERFORMING ANY EXCAVATION WORK. THE CONTRACTOR SHALL RECORD THE ONE-CALL ORDER NUMBER AND FURNISH ORDER NUMBER TO OWNER AND ENGINEER PRIOR TO ANY EXCAVATION. IT WILL BE THE CONTRACTOR'S SOLE RESPONSIBILITY TO DIRECTLY CONTACT ANY OTHER UTILITY COMPANIES THAT ARE NOT MEMBERS OF ONE-CALL. IT SHALL BE THE CONTRACTOR'S SOLE RESPONSIBILITY TO PROTECT ALL EXISTING UTILITIES SO THAT NO DAMAGE RESULTS TO THEM DURING THE PERFORMANCE OF THIS CONTRACT. ANY REPAIRS NECESSARY TO DAMAGED UTILITIES SHALL BE PAID FOR BY THE CONTRACTOR. THE CONTRACTOR SHALL BE REQUIRED TO COOPERATE WITH OTHER CONTRACTORS AND UTILITY COMPANIES INSTALLING NEW STRUCTURES, UTILITIES AND SERVICES TO THE PROJECT.
2. CARE SHOULD BE TAKEN IN ALL EXCAVATIONS DUE TO POSSIBLE EXISTENCE OF UNRECORDED UTILITY LINES. EXCAVATION REQUIRED WITHIN PROXIMITY OF EXISTING UTILITY LINES SHALL BE DONE BY HAND. CONTRACTOR SHALL REPAIR ANY DAMAGE TO EXISTING UTILITY LINES OR STRUCTURES INCURRED DURING CONSTRUCTION OPERATIONS AT CONTRACTOR'S EXPENSE.
3. TRENCH BACKFILL MATERIAL AND COMPACTION TESTS ARE TO BE TAKEN PER WYOMING PUBLIC WORKS STANDARD SPECIFICATIONS (LATEST EDITION), SECTION 02225 - TRENCH BACKFILL, OR AS REQUIRED BY THE GEOTECHNICAL REPORT IF NATIVE MATERIALS ARE USED. NO NATIVE MATERIALS ARE ALLOWED IN THE PIPE ZONE. THE MAXIMUM LIFT FOR BACKFILLING EXCAVATIONS IS 8-INCHES.
4. THE CONTRACTOR IS RESPONSIBLE FOR REPAIRING ANY DAMAGE, CAUSED BY ANY CONDITION INCLUDING SETTLEMENT, TO EXISTING UTILITIES FROM WORK PERFORMED AT OR NEAR EXISTING UTILITIES. THE CONTRACTOR SHALL TAKE ALL MEASURES NECESSARY TO PROTECT ALL EXISTING PUBLIC AND PRIVATE ROADWAY AND UTILITY FACILITIES. DAMAGE TO EXISTING FACILITIES CAUSED BY THE CONTRACTOR MUST BE REPAIRED BY THE CONTRACTOR AT HIS/HER EXPENSE TO THE SATISFACTION OF THE OWNER OF SAID FACILITIES.
5. ALL WATER LINE AND SEWER LINE INSTALLATION AND TESTING TO BE IN ACCORDANCE WITH LOCAL GOVERNING AGENCY'S OR WYOMING PUBLIC WORKS STANDARD SPECIFICATIONS (LATEST EDITION).
6. ALL MANHOLES, HYDRANTS, VALVES, CLEANOUT BOXES, CATCH BASINS, METERS, ETC. MUST BE RAISED OR LOWERED TO FINAL GRADE PER WYOMING PUBLIC WORKS STANDARD SPECIFICATIONS (LATEST EDITION) AND INSPECTOR REQUIREMENTS. CONCRETE COLLARS MUST BE CONSTRUCTED ON ALL MANHOLES, CLEANOUT BOXES, CATCH BASINS, AND VALVES PER APWA STANDARDS. ALL MANHOLE, CATCH BASIN, OR CLEANOUT BOX CONNECTIONS MUST BE MADE WITH THE PIPE CUT FLUSH WITH THE INSIDE OF THE BOX AND GROUTED OR SEALED.
7. CONTRACTOR SHALL NOT ALLOW ANY GROUNDWATER OR DEBRIS TO ENTER THE NEW OR EXISTING PIPE DURING CONSTRUCTION.
8. SILT AND DEBRIS ARE TO BE CLEANED OUT OF ALL STORM DRAIN BOXES. CATCH BASINS ARE TO BE MAINTAINED IN A CLEANED CONDITION AS NEEDED UNTIL AFTER THE FINAL BOND RELEASE INSPECTION.
9. CONTRACTOR SHALL CLEAN ASPHALT, TAR OR OTHER ADHESIVES OFF OF ALL MANHOLE LIDS AND INLET GRATES TO ALLOW ACCESS.
10. EACH TRENCH SHALL BE EXCAVATED SO THAT THE PIPE CAN BE LAID TO THE ALIGNMENT AND GRADE AS REQUIRED. THE TRENCH WALL SHALL BE SO BRACED THAT THE WORKMEN MAY WORK SAFELY AND EFFICIENTLY. ALL TRENCHES SHALL BE DRAINED SO THE PIPE LAYING MAY TAKE PLACE IN DEWATERED CONDITIONS.
11. CONTRACTOR SHALL PROVIDE AND MAINTAIN AT ALL TIMES AMPLE MEANS AND DEVICES WITH WHICH TO REMOVE PROMPTLY AND TO PROPERLY DISPOSE OF ALL WATER ENTERING THE TRENCH EXCAVATION.
12. WYOMING STATE REGULATIONS ON THE SEPARATION OF DRINKING WATER, SURFACE WATER, AND SEWER LINES SHALL BE FOLLOWED. THESE ARE LISTED UNDER WAR CHAPTER 12, SECTION 14. (a).
13. ALL DUCTILE IRON PIPE SHALL BE PRESSURE CLASS OR SPECIAL THICKNESS CLASS CONFORMING TO ANSI/AWWA C150/A21.50 & C151/A21.51 WITH 8 MIL POLYETHYLENE WRAP FOR BURIED INSTALLATIONS.
14. ALL DUCTILE IRON FITTINGS SHALL BE RATED FOR WORKING PRESSURES AS SPECIFIED ON THE DRAWINGS.
15. POLYVINYL CHLORIDE PIPE SHALL CONFORM TO AWWA C900 (12-INCH DIAMETER OR LESS) OR AWWA C905 (DIAMETER LARGER THAN 12-INCHES) WITH A DIMENSION RATIO (DR) OF 18.
16. ALL GATE VALVES SHALL BE RESILIENT WEDGE GATE VALVES AND SHALL CONFORM TO AWWA C-509 OR C-515. GATE VALVES INSTALLED IN VAULTS SHALL BE FURNISHED WITH HANDWHEEL OPERATORS. VALVES INSTALLED IN DIRECT BURY APPLICATIONS SHALL BE FURNISHED WITH A TWO-INCH SQUARE OPERATING NUT AND SLIP TYPE, CAST IRON VALVE BOX.
17. ALL BUTTERFLY VALVES FOR STANDARD PRESSURE APPLICATIONS SHALL BE TIGHT-CLOSING RUBBER SEAT BUTTERFLY VALVES AND SHALL MEET THE REQUIREMENTS OF AWWA C-504 FOR CLASS 150 B VALVES AND RATED FOR WORKING PRESSURE OF 150 PSI. HIGH PRESSURE BUTTERFLY VALVES SHALL BE RATED FOR WORKING PRESSURES AS SPECIFIED ON THE DRAWINGS.
18. ALL BOLTS FOR DIRECT BURY FITTINGS SHALL BE COATED WITH FM GREASE, AND THE ENTIRE FITTING SHALL BE WRAPPED WITH 8 MIL POLYETHYLENE PRIOR TO BACKFILLING.
19. CONTRACTOR SHALL INSTALL TRACER WIRE AND MAGNETIC LOCATING TAPE CONTINUOUSLY OVER ALL PIPE UNLESS NOTED ON THE DRAWINGS.
20. ALL DRINKING WATER LINES, TANKS, WELLS, FITTINGS AND APPURTENANCES SHALL BE INSTALLED, TESTED, AND DISINFECTED PER WAR CHAPTER 12, WATER QUALITY RULES AND REGULATIONS. ALL MATERIAL THAT MAY CONTACT DRINKING WATER, INCLUDING PIPES, GASKETS, LUBRICANTS, O-RINGS, SHALL COMPLY WITH ANSI/NSF 61, DRINKING WATER SYSTEM COMPONENTS - HEALTH EFFECTS. TO PERMIT FIELD VERIFICATION OF THIS COMPLIANCE, ALL SUCH COMPONENTS SHALL BE APPROPRIATELY STAMPED WITH THE NSF LOGO. FLUSHING AND DISINFECTION OF DRINKING WATER LINES, TANKS, WELLS, FITTINGS AND APPURTENANCES SHALL BE IN ACCORDANCE WITH AWWA STANDARD C651.
21. ALL BURIED MECHANICAL JOINTS SHALL BE RESTRAINED W/MEGALUG AND THRUST BLOCKS.
22. ALL OPEN ENDS OF PIPE SHALL BE EFFECTIVELY SEALED AT THE END OF THE DAY'S WORK.
23. PVC PIPE SHALL BE PRESSURE TESTED ACCORDING TO AWWA C605.
24. WATER LINE TO BE LAID WITHOUT HIGH POINTS OR LOW POINTS, EXCEPT WHERE SHOWN ON THE PLAN AND PROFILE SHEETS.
25. DRINKING WATER LINES TO BE INSTALLED WITH MINIMUM COVER AS NOTED ON PROJECT PLANS AND DETAILS.
26. CONTRACTOR TO OBSERVE REQUIRED SEPARATION BETWEEN WATER AND SEWER PIPELINES PER WAR CHAPTER 12, SECTION 14. (a).
27. ALL ELBOWS, TEES, CROSSES, CAPPED ENDS, VALVES AND OTHER APPURTENANCES SHALL BE FULLY RESTRAINED USING THRUST BLOCKS AND RESTRAINED JOINTS OR OTHER ACCEPTED METHODS UNLESS NOTED ON THE PROJECT DRAWINGS. CONTRACTOR SHALL NOTIFY ENGINEER IF A THRUST BLOCK CANNOT BE POURED FOR A FITTING.
28. ENGINEER WILL PROVIDE ELECTRONIC FILE SHOWING PIPELINE ALIGNMENT IN COORDINATES TO USE FOR PIPELINE STAKING.
29. CONTRACTOR SHALL COORDINATE ALL RESTORATION EFFORTS WITH THE OWNER AND AGENCIES HAVING JURISDICTION.
30. CONTRACTOR SHALL COORDINATE LOCATION OF NEW "DRY UTILITIES" WITH THE APPROPRIATE UTILITY COMPANY, INCLUDING BUT NOT LIMITED TO: TELEPHONE & INTERNET SERVICE, GAS SERVICE, CABLE, AND POWER.
31. ALL UNDERGROUND UTILITIES SHALL BE IN PLACE PRIOR TO INSTALLATION OF CURB, GUTTER, SIDEWALK AND STREET PAVING.

CONCRETE NOTES

1. UNLESS OTHERWISE NOTED, ALL ON-GRADE CONCRETE WILL BE PLACED ON A MINIMUM 6-INCH GRAVEL BASE OVER A WELL COMPACTED (95% DENSITY PER ASTM D-1557) SUB GRADE.
2. REFER TO GENERAL STRUCTURAL NOTES FOR ADDITIONAL CONCRETE NOTES.

TRAFFIC CONTROL AND SAFETY NOTES

1. THE CONTRACTOR SHALL BE REQUIRED TO PROVIDE ALL FLAGGING, BARRICADES, AND TRAFFIC CONTROL AS MAY BE NECESSARY TO ENSURE SAFETY TO THE GENERAL PUBLIC DURING CONSTRUCTION. A TRAFFIC CONTROL PLAN SHALL BE DEVELOPED BY THE CONTRACTOR AND SUBMITTED TO THE AGENCIES HAVING JURISDICTION.
2. TRAFFIC CONTROL, BARRICADES, DETOURING, AND STRIPING TO CONFORM TO THE CURRENT MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES (M.U.T.C.D.).
3. NO STREET SHALL BE CLOSED TO TRAFFIC WITHOUT WRITTEN PERMISSION FROM THE APPROPRIATE AGENCY, EXCEPT WHEN DIRECTED BY LAW ENFORCEMENT OR FIRE OFFICIALS.
4. THE CONTRACTOR SHALL MAKE EVERY EFFORT TO PROVIDE FOR SMOOTH TRAFFIC FLOW AND SAFETY. ACCESS SHALL BE MAINTAINED FOR ALL PROPERTIES ADJACENT TO THE WORK.
5. DETOURING OPERATIONS FOR A PERIOD OF SIX CONSECUTIVE CALENDAR DAYS, OR MORE, REQUIRE THE INSTALLATION OF TEMPORARY STREET STRIPING AND REMOVAL OF INTERFERING STRIPING BY SANDBLASTING. THE DETOURING STRIPING PLAN OR CONSTRUCTION TRAFFIC CONTROL PLAN MUST BE SUBMITTED TO THE CITY TRAFFIC ENGINEER OR LOCAL JURISDICTION OF AUTHORITY FOR REVIEW AND APPROVAL.
6. ALL TRAFFIC CONTROL DEVICES SHALL BE RESTORED TO THEIR ORIGINAL CONDITION AT THE END OF THE WORK TO THE SATISFACTION OF THE CITY TRAFFIC ENGINEER OR LOCAL JURISDICTION OF AUTHORITY.
7. TRAFFIC CONTROL DEVICES (TCDS) SHALL REMAIN VISIBLE AND OPERATIONAL AT ALL TIMES.
8. ALL PERMANENT TCDS CALLED FOR HEREON SHALL BE IN PLACE AND IN FINAL POSITION PRIOR TO ALLOWING ANY PUBLIC TRAFFIC ONTO THE PORTIONS OF THE ROAD(S) BEING IMPROVED HEREUNDER, REGARDLESS OF THE STATUS OF COMPLETION OF PAVING OR OTHER OFF-SITE IMPROVEMENTS CALLED FOR BY THESE PLANS.
9. THE CONTRACTOR SHALL PROVIDE BARRICADES, SIGNS, FLASHERS, OTHER EQUIPMENT AND FLAG PERSONS NECESSARY TO ENSURE THE SAFETY OF WORKERS AND VISITORS.

GRADING AND DRAINAGE NOTES

1. SITE GRADING SHALL BE PERFORMED IN ACCORDANCE WITH THESE PLANS AND SPECIFICATIONS AND THE RECOMMENDATIONS SET FORTH IN THE GEOTECHNICAL REPORT AND ALL RELATED ADDENDUMS.
2. THE CONTRACTOR SHALL STRIP AND CLEAR THE TOPSOIL, MAJOR ROOTS AND ORGANIC MATERIAL FROM ALL PROPOSED BUILDING, PIPELINES, AND PAVEMENT AREAS PRIOR TO SITE GRADING. (THE TOPSOIL MAY BE STOCKPILED FOR LATER USE IN LANDSCAPED AREAS.)
3. THE CONTRACTOR SHALL REMOVE ALL ORGANIC MATERIAL AND OTHER DELETERIOUS MATERIALS PRIOR TO PLACING GRADING FILL OR BASE COURSE. THE AREA SHOULD BE PROOF-ROLLED TO IDENTIFY ANY SOFT AREAS. WHERE SOFT AREAS ARE ENCOUNTERED, THE CONTRACTOR SHALL REMOVE THE SOIL AND REPLACE WITH COMPACTED FILL.
4. ALL DEBRIS PILES AND BERMS SHOULD BE REMOVED AND HAULED AWAY FROM SITE OR USED AS GENERAL FILL IN LANDSCAPED AREAS.
5. THE CONTRACTOR SHALL CONSTRUCT THE BUILDING PAD TO THESE DESIGN PLANS AS PART OF THE SITE GRADING CONTRACT.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DAMAGE AND DEBRIS ON ADJACENT STREETS WHEN EQUIPMENT IS TRAVELING THOSE STREETS.
7. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO PERFORM ALL NECESSARY CUTS AND FILLS WITHIN THE LIMITS OF THIS PROJECT AND THE RELATED OFF-SITE WORK, SO AS TO GENERATE THE DESIRED SUBGRADE, FINISH GRADES, AND SLOPES SHOWN.
8. THE CONTRACTOR IS WARNED THAT AN EARTHWORK BALANCE WAS NOT NECESSARILY THE INTENT OF THIS PROJECT. ANY ADDITIONAL MATERIAL REQUIRED OR LEFTOVER MATERIAL FOLLOWING EARTHWORK OPERATIONS BECOMES THE RESPONSIBILITY OF THE CONTRACTOR AND SHALL BE HAULED OFF SITE AND DISPOSED OF IN A LAWFUL MANNER.
9. ALL CUT AND FILL SLOPES SHALL BE PROTECTED UNTIL EFFECTIVE EROSION CONTROL HAS BEEN ESTABLISHED.
10. THE USE OF DRINKING WATER WITHOUT A SPECIAL PERMIT FOR BUILDING OR CONSTRUCTION PURPOSES INCLUDING CONSOLIDATION OF BACKFILL OR DUST CONTROL IS PROHIBITED. THE CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS FOR CONSTRUCTION WATER FROM GOVERNING AGENCY.
11. THE CONTRACTOR SHALL MAINTAIN THE STREETS, SIDEWALKS, AND ALL OTHER PUBLIC RIGHTS-OF-WAY IN A CLEAN, SAFE AND USABLE CONDITION. ALL SPILLS OF SOIL, ROCK OR CONSTRUCTION DEBRIS SHALL BE PROMPTLY REMOVED AND DISPOSED OF IN A LAWFUL MANNER FROM THE PUBLICLY-OWNED PROPERTY DURING CONSTRUCTION AND UPON COMPLETION OF THE PROJECT. ALL ADJACENT PROPERTY, PRIVATE OR PUBLIC, SHALL BE MAINTAINED IN A CLEAN, SAFE, AND USABLE CONDITION.
12. TOPSOIL SHALL BE REPLACED AND GRADED PRIOR TO REVEGETATION. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE DEPTH OF EXISTING TOPSOIL AND REPLACING AND THE EXISTING TOPSOIL DEPTH. DISTURBED AREAS SHALL BE RESEEDED USING A SEED MIX SPECIFIED ON THE EROSION CONTROL PLAN AND DETAILS.
13. IMPROVEMENT ELEVATION LABELS AND ELEVATION CONTOURS REFERENCE FINISH ELEVATIONS. REFER TO ABBREVIATIONS AND SYMBOL LEGEND INCLUDED HEREIN.

EROSION CONTROL NOTES

1. PER WYDEQ, STORM WATER GENERAL PERMIT FOR CONSTRUCTION ACTIVITIES GENERAL PERMIT NO. WYR10A000, CONSTRUCTION ACTIVITY INCLUDING CLEARING, GRADING, EXCAVATION, AND DEMOLITION THAT DISTURBS ONE OR MORE ACRES OF LAND SHALL REQUIRE INCLUSION IN THE GENERAL PERMIT AND COMPLY WITH THE REQUIREMENTS THEREIN.
2. THE TOTAL PROJECT AREA OF DISTURBANCE IS GREATER THAN 1 ACRE; THEREFORE, AN WYPDES STORM WATER PERMIT IS REQUIRED.
3. THE CONTRACTOR SHALL OBTAIN A STORM WATER PERMIT FOR THIS PROJECT, IF APPLICABLE, AND MAINTAIN A STORM WATER POLLUTION PREVENTION PLAN (SWPPP) ON SITE DURING ALL PHASES OF CONSTRUCTION.
4. THE PRIME CONTRACTOR SHALL ASSUME FULL RESPONSIBILITY FOR COMPLIANCE WITH GENERAL PERMIT.
5. THE CONTRACTOR SHALL CREATE THEIR OWN EROSION CONTROL PLAN FOR PERMITTING PURPOSES. THE CONTRACTOR SHALL REVISE THE EROSION CONTROL PLAN TO FIT SPECIFIC SITE CONDITIONS AS REQUIRED TO MEET THE REQUIREMENTS AND CONDITIONS OF THE PERMIT.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COMPLIANCE WITH THE PERMIT THROUGHOUT CONSTRUCTION AND UNTIL THE NOTICE OF TERMINATION (NOT) IS ISSUED BY WYDEQ. THE CONTRACTOR SHALL BE FAMILIAR WITH ALL PERMIT REQUIREMENTS.
7. MAINTAIN DUST CONTROL WITH WATER AND/OR DUST PALLIATIVE AT ALL TIMES. PROVIDE SUFFICIENT LABOR, EQUIPMENT, AND MATERIALS ONSITE TO MAINTAIN DUST CONTROL WHEN CONDITIONS REQUIRE.

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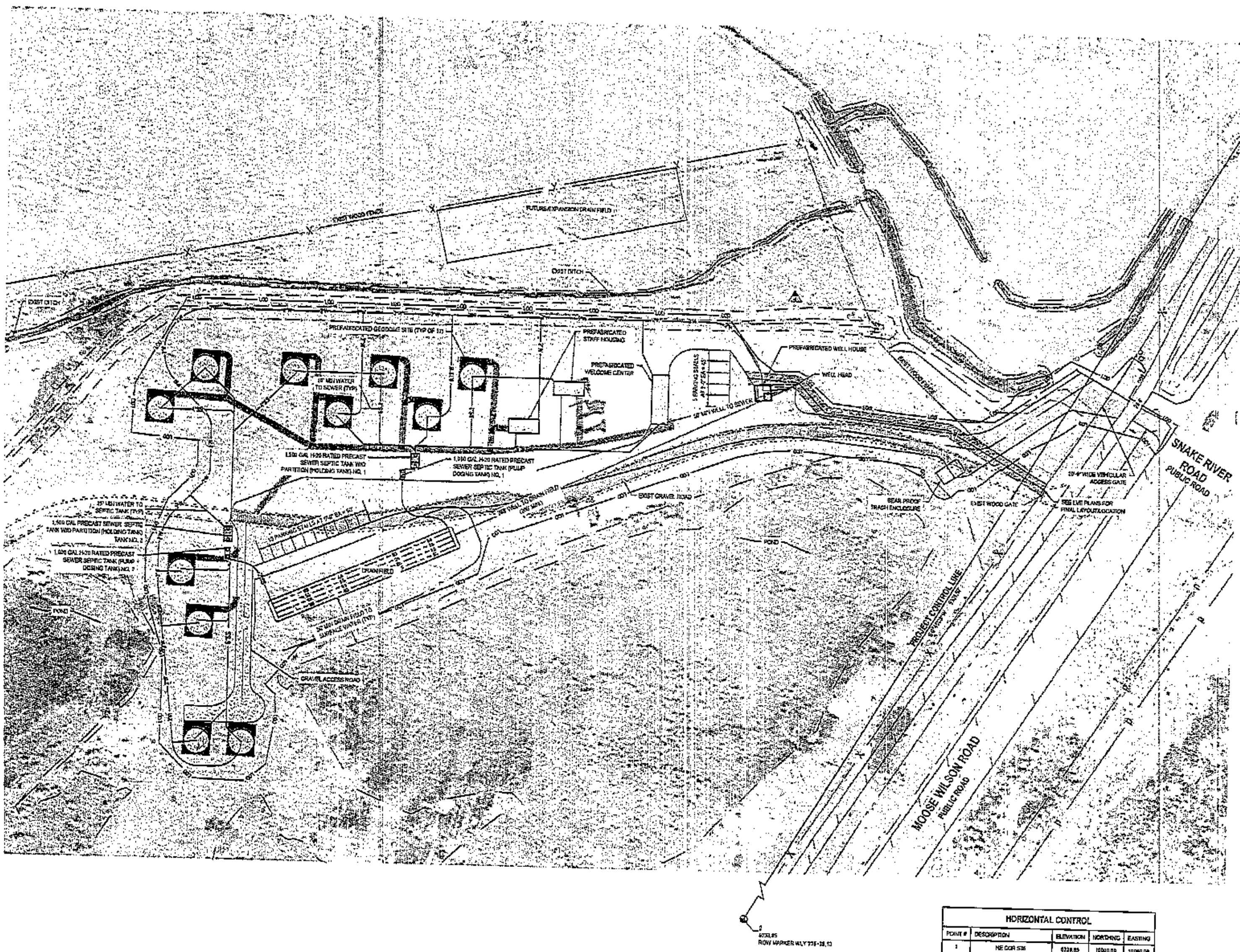
TETON VILLAGE RESORT

MOOSE WILSON ROAD
TETON VILLAGE, WYOMING

FOR CONSTRUCTION

GENERAL NOTERS

C-002



HORIZONTAL GRAPHIC SCALE

(IN FEET)
HORZ: 1 inch = 40 ft.

⚠ TRASH ENCLOSURE WAS REVISED TO "BEAR PROOF TRASH ENCLOSURE", WELCOME CENTER GEODOMES WERE REPLACED WITH TWO (2) 24" X 11'4" PREFABRICATED BUILDINGS AND ONE (1) 40" X 13'-2" BUILDING. 5 PARKING SPACES WERE PLACED NEAR THE WELCOME CENTER AND THE REMAINDER PLACED NORTHWEST OF THE DRAIN FIELD. ELECTRICAL MODIFIED TO REDUCE SYSTEM LOADS.

HORIZONTAL CONTROL				
POINT #	DESCRIPTION	ELEVATION	NORTHING	EASTING
1	NE COR 536	6238.85	10000.00	10000.00
2	ROW MARKER WLY 229+28.13	6230.85	4999.66	9809.57
41785	ROW MARKER ELY 229+38.13	6213.10	4809.40	10050.46

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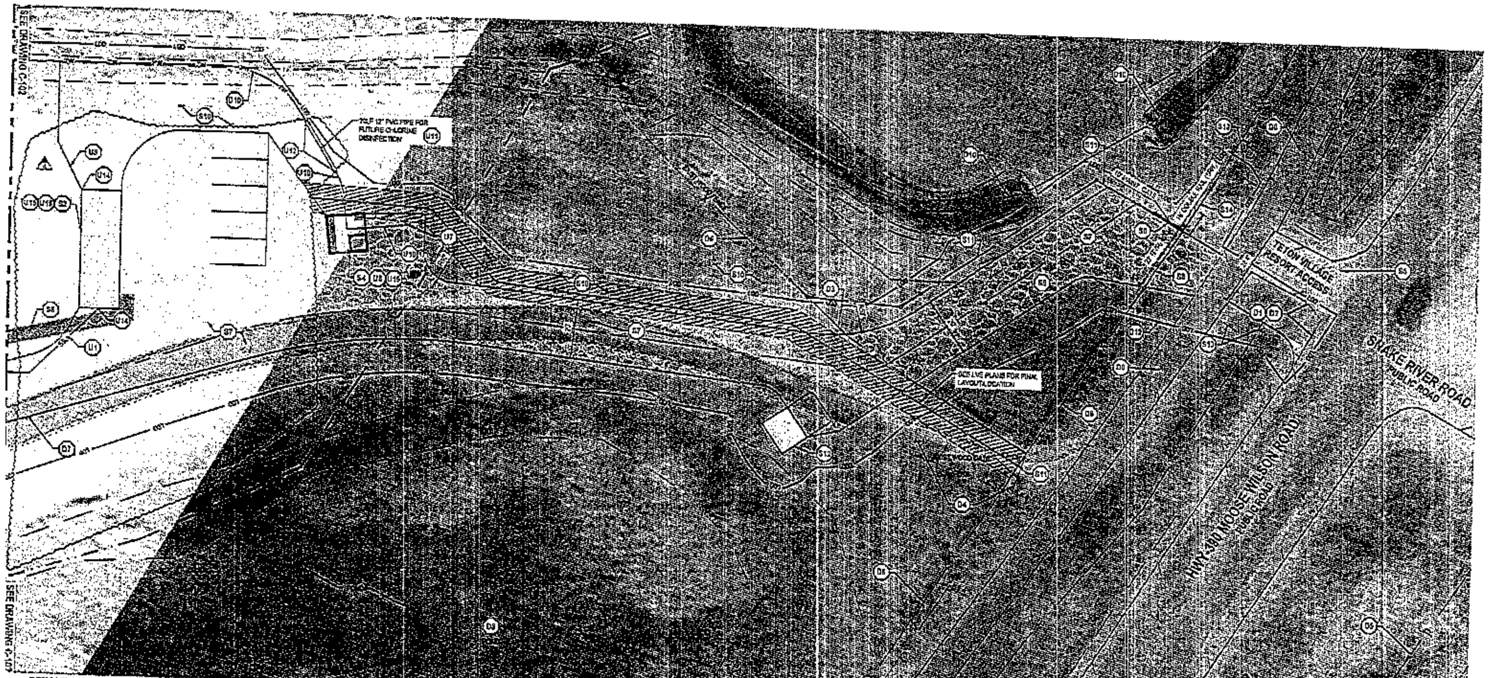
MOOSE WILSON ROAD
TETON VILLAGE, WYOMING

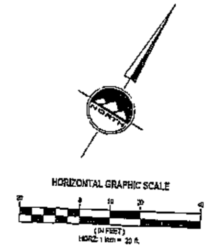
Professional Engineer
ROBERT J. ROUSSELLE
17107
WYOMING

FOR CONSTRUCTION

OVERALL SITE, UTILITY, AND HORIZONTAL CONTROL PLAN

C-100





DEMOLITION GENERAL NOTES

1. ALL WORK TO COMPLY WITH THE GOVERNING AGENCY'S STANDARDS AND SPECIFICATIONS.
2. EXISTING UNDERGROUND UTILITIES AND IMPROVEMENTS ARE SHOWN IN THEIR APPROXIMATE LOCATIONS BASED UPON RECORD INFORMATION AVAILABLE AT THE TIME OF PREPARATION OF THESE PLANS. LOCATIONS MAY NOT HAVE BEEN VERIFIED IN THE FIELD AND NO GUARANTEE IS MADE AS TO THE ACCURACY OR COMPLETENESS OF THE INFORMATION SHOWN. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO DETERMINE THE EXISTENCE AND LOCATION OF THE UTILITIES SHOWN ON THESE PLANS OR INDICATED IN THE FIELD BY LOCATING SERVICES. ANY ADDITIONAL COSTS INCURRED AS A RESULT OF THE CONTRACTOR'S FAILURE TO VERIFY THE LOCATIONS OF EXISTING UTILITIES PRIOR TO THE BEGINNING OF CONSTRUCTION IN THEIR VICINITY SHALL BE BORNE BY THE CONTRACTOR AND ASSUMED INCLUDED IN THE CONTRACT. THE CONTRACTOR IS TO VERIFY ALL CONNECTION POINTS WITH THE EXISTING UTILITIES. THE CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE CAUSED TO THE EXISTING UTILITIES AND UTILITY STRUCTURES THAT ARE TO REMAIN. IF CONFLICTS WITH EXISTING UTILITIES OCCUR, THE CONTRACTOR SHALL NOTIFY THE ENGINEER PRIOR TO CONSTRUCTION TO DETERMINE IF ANY FIELD ADJUSTMENTS SHOULD BE MADE.
3. ALL SURFACE IMPROVEMENTS DISTURBED BY CONSTRUCTION SHALL BE RESTORED OR REPLACED, INCLUDING TREES AND DECORATIVE SHRUBS, SOD, FENCES, WALLS AND STRUCTURES, WHETHER OR NOT THEY ARE SPECIFICALLY SHOWN ON THE CONTRACT DOCUMENTS.
4. ALL CONSTRUCTION SIGNAGE, BARRICADES, TRAFFIC CONTROL DEVICES, ETC. SHALL CONFORM TO THE LATEST EDITION OF THE M.U.T.C.D. THE CONTRACTOR WILL MAINTAIN SUCH SO THAT THEY ARE PROPERLY PLACED AND VISIBLE AT ALL TIMES.
5. SIDEWALKS AND CURBS DESIGNATED TO BE DEMOLISHED SHALL BE DEMOLISHED TO THE NEAREST EXPANSION JOINT, MATCHING THESE PLANS AS CLOSELY AS POSSIBLE.
6. THE CONTRACTOR IS TO PROTECT AND PRESERVE ALL EXISTING IMPROVEMENTS, UTILITIES, AND SIGNS, ETC. UNLESS OTHERWISE NOTED ON THESE PLANS.

DEMOLITION SCOPE OF WORK:

PROVIDE, INSTALL AND/OR CONSTRUCT THE FOLLOWING PER THE SPECIFICATIONS GIVEN OR REFERENCED, THE DETAILS NOTED, AND/OR AS SHOWN ON THE CONSTRUCTION DRAWINGS:

- (D1) SAWCUT EXISTING ASPHALT PAVEMENT TO PROVIDE A CLEAN EDGE FOR THE TRANSITION BETWEEN EXISTING AND PROPOSED ASPHALT PAVEMENT.
- (D2) REMOVE AND PROPERLY DISPOSE OF EXISTING ASPHALT PAVEMENT.
- (D3) REMOVE AND PROPERLY DISPOSE OF EXISTING FENCE AND GATE.
- (D4) REMOVE EXIST WOODEN GATE AND REPLACE WITH BARBED WIRE FENCE PER WYDOT STANDARD DETAIL 607-1A. REMOVE EXISTING GRAVEL ACCESS ROAD AND REVEGETATE.
- (D5) PROTECT AND PRESERVE ALL EXISTING IMPROVEMENTS, UTILITIES, SIGNS, ETC. (TYPICAL UNLESS OTHERWISE NOTED).
- (D6) PROTECT EXISTING FENCE TO REMAIN THROUGHOUT CONSTRUCTION.
- (D7) PROTECT EXISTING GRAVEL ROAD TO REMAIN THROUGHOUT CONSTRUCTION.
- (D8) PROTECT EXISTING ASPHALT TRAIL TO REMAIN THROUGHOUT CONSTRUCTION.
- (D9) PROTECT EXISTING WETLANDS AND PONDS THROUGHOUT CONSTRUCTION.
- (D10) PROTECT EXISTING IRRIGATION DITCH TO REMAIN THROUGHOUT CONSTRUCTION.
- (D11) REFER TO LANDSCAPING PLANS FOR ADDITIONAL INFORMATION ON VEGETATION TO PROTECT AND PLANT.
- (D12) LIMIT OF DISTURBANCE.

SITE PLAN GENERAL NOTES

1. ALL WORK TO COMPLY WITH THE GOVERNING AGENCY'S STANDARDS AND SPECIFICATIONS.
2. ALL IMPROVEMENTS MUST COMPLY WITH ADA STANDARDS AND RECOMMENDATIONS.
3. SEE LANDSCAPE/ARCHITECTURAL PLANS FOR CONCRETE MATERIAL, COLOR, FINISH, AND SCORE PATTERNS THROUGHOUT SITE.
4. ALL PAVEMENT MARKINGS SHALL CONFORM TO THE LATEST EDITION OF THE M.U.T.C.D. (MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES).
5. ALL SURFACE IMPROVEMENTS DISTURBED BY CONSTRUCTION SHALL BE RESTORED OR REPLACED, INCLUDING TREES AND DECORATIVE SHRUBS, SOD, FENCES, WALLS AND STRUCTURES, WHETHER OR NOT THEY ARE SPECIFICALLY SHOWN ON THE CONTRACT DOCUMENTS.
6. NOTIFY ENGINEER OF ANY DISCREPANCIES IN DESIGN OR STAKING BEFORE PLACING CONCRETE OR ASPHALT.
7. THE CONTRACTOR IS TO PROTECT AND PRESERVE ALL EXISTING IMPROVEMENTS, UTILITIES, AND SIGNS, ETC. UNLESS OTHERWISE NOTED ON THESE PLANS.

SITE PLAN SCOPE OF WORK:

PROVIDE, INSTALL AND/OR CONSTRUCT THE FOLLOWING PER THE SPECIFICATIONS GIVEN OR REFERENCED, THE DETAILS NOTED, AND/OR AS SHOWN ON THE CONSTRUCTION DRAWINGS:

- (S1) PREFABRICATED GEODOME SITES ON WOOD DECKS PROVIDED AND DESIGNED BY MANUFACTURER. FINAL LOCATION TO BE DETERMINED BY OWNER.
- (S2) PREFABRICATED WELCOME CENTER PROVIDED AND DESIGNED BY MANUFACTURER. FINAL LOCATION TO BE DETERMINED BY OWNER. (4)
- (S3) PREFABRICATED STAFF HOUSING PROVIDED AND DESIGNED BY MANUFACTURER. FINAL LOCATION TO BE DETERMINED BY OWNER.
- (S4) PREFABRICATED WELL HOUSE. DESIGN AND STRUCTURAL CALCULATIONS PROVIDED BY MANUFACTURER. REFER TO MECHANICAL AND ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
- (S5) 25-FOOT WIDE WYDOT ACCESS PER WYDOT STANDARD DRAWINGS AND STANDARD SPECIFICATIONS SECTION 200, 300, AND 400. MATCH EXISTING PAVEMENT SECTION, MIN. 3-INCH ACC ON 6-INCH UTBC.
- (S6) 6-FOOT WIDE DECOMPOSED GRANITE SURFACE TRAIL PER DETAIL 3/C-401. COORDINATE WITH OWNER FOR FINAL TRAIL ORIENTATION AND LAYOUT.
- (S7) 20-FOOT WIDE GRAVEL SECTION WITH 2% MIN SLOPE. GRAVEL SECTION PER DETAIL 2/C-401.
- (S8) BARBED WIRE GATE PER WYDOT STANDARD PLAN 607-1A.
- (S9) 24-FOOT WIDE VEHICULAR ACCESS GATE PER DETAIL 6/C-401.
- (S10) REFER TO LANDSCAPING PLANS FOR ADDITIONAL INFORMATION.
- (S11) BARBED WIRE FENCE WYDOT STANDARD PLAN 607-1A.
- (S12) BEAR PROOF TRASH ENCLOSURE. (4)
- (S13) STOP SIGN ON POST PER DETAIL 1/C-401.
- (S14) DOUBLE RAIL GATE INSTALLATION PER WYDOT STANDARD PLAN 607-1A.

UTILITY GENERAL NOTES

1. ALL WORK TO COMPLY WITH THE GOVERNING AGENCY'S STANDARDS AND SPECIFICATIONS.
2. EXISTING UNDERGROUND UTILITIES AND IMPROVEMENTS ARE SHOWN IN THEIR APPROXIMATE LOCATIONS BASED UPON RECORD INFORMATION AVAILABLE AT THE TIME OF PREPARATION OF THESE PLANS. LOCATIONS MAY NOT HAVE BEEN VERIFIED IN THE FIELD AND NO GUARANTEE IS MADE AS TO THE ACCURACY OR COMPLETENESS OF THE INFORMATION SHOWN. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO DETERMINE THE EXISTENCE AND LOCATION OF THE UTILITIES SHOWN ON THESE PLANS OR INDICATED IN THE FIELD BY LOCATING SERVICES. ANY ADDITIONAL COSTS INCURRED AS A RESULT OF THE CONTRACTOR'S FAILURE TO VERIFY THE LOCATIONS OF EXISTING UTILITIES PRIOR TO THE BEGINNING OF CONSTRUCTION IN THEIR VICINITY SHALL BE BORNE BY THE CONTRACTOR AND ASSUMED INCLUDED IN THE CONTRACT. THE CONTRACTOR IS TO VERIFY ALL CONNECTION POINTS WITH THE EXISTING UTILITIES. THE CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE CAUSED TO THE EXISTING UTILITIES AND UTILITY STRUCTURES THAT ARE TO REMAIN. IF CONFLICTS WITH EXISTING UTILITIES OCCUR, THE CONTRACTOR SHALL NOTIFY THE ENGINEER PRIOR TO CONSTRUCTION TO DETERMINE IF ANY FIELD ADJUSTMENTS SHOULD BE MADE.
3. ALL SANITARY SEWER INFRASTRUCTURE TO BE INSTALLED PER GOVERNING AGENCY STANDARD PLANS AND SPECIFICATIONS.
4. ALL WATER INFRASTRUCTURE TO BE INSTALLED PER GOVERNING AGENCY OR APWA STANDARD PLANS AND SPECIFICATIONS.
6. DEFLECT OR LOOP ALL WATERLINES TO AVOID CONFLICTS WITH OTHER UTILITIES PER GOVERNING AGENCY'S STANDARDS AND SPECIFICATIONS.
7. PROJECT SHALL COMPLY WITH ALL WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY RULES AND REGULATIONS INCLUDING, BUT NOT LIMITED TO, THOSE PERTAINING TO BACKFLOW PROTECTION AND CROSS CONNECTION PREVENTION.
8. THE CONTRACTOR IS TO COORDINATE ALL UTILITIES WITH MECHANICAL/PLUMBING PLANS.
9. NOTIFY ENGINEER OF ANY DISCREPANCIES IN DESIGN OR STAKING BEFORE PLACING UTILITY STRUCTURES OR PIPES.
10. THE CONTRACTOR SHALL ADJUST TO GRADE ALL EXISTING UTILITIES AS NEEDED PER LOCAL GOVERNING AGENCY'S STANDARDS AND SPECIFICATIONS.
11. THE CONTRACTOR IS TO PROTECT AND PRESERVE ALL EXISTING IMPROVEMENTS, UTILITIES, AND SIGNS, ETC. UNLESS OTHERWISE NOTED ON THESE PLANS.

UTILITY SCOPE OF WORK:

PROVIDE, INSTALL AND/OR CONSTRUCT THE FOLLOWING PER THE SPECIFICATIONS GIVEN OR REFERENCED, THE DETAILS NOTED, AND/OR AS SHOWN ON THE CONSTRUCTION DRAWINGS:

- (U1) 4-INCH DR 17 OR DR 21 PE 4710 IPS HDPE SANITARY SEWER LATERAL AT MIN. 2% SLOPE, INCLUDING CLEANOUTS, SEE DETAIL 5/C-400, AT MAXIMUM 100-FOOT SPACING, PER GOVERNING AGENCY'S STANDARDS AND SPECIFICATIONS OR LATEST EDITION OF INTERNATIONAL PLUMBING CODE. PROVIDE CLEANOUTS WITHIN 5-FEET OF BUILDING PER CODE, SEE DETAIL 3/C-400. ESTIMATED LENGTHS PER PLAN. REFER TO TYPICAL TRENCH DETAIL 1/C-400 FOR TRENCH INSTALLATION. PIPE SHALL BE INSULATED MINIMUM 10-INCHES AND PIPE SHALL BE INSULATED MINIMUM INCHES ABOVE DECK OF GEODOME UNTIL PIPE IS BELOW FROST DEPTH. REFER TO INSULATED UTILITY TRENCH DETAIL 2/C-400 FOR INSULATION THICKNESSES BASED ON BURIED DEPTH.
- (U2) 6-INCH DR 17 OR DR 21 PE 4710 IPS HDPE SANITARY SEWER LATERAL AT MIN. 2% SLOPE, INCLUDING CLEANOUTS, SEE DETAIL 5/C-400, AT MAXIMUM 100-FOOT SPACING, PER GOVERNING AGENCY'S STANDARDS AND SPECIFICATIONS OR LATEST EDITION OF INTERNATIONAL PLUMBING CODE. ESTIMATED LENGTHS PER PLAN. REFER TO TYPICAL TRENCH DETAIL 1/C-400 FOR TRENCH INSTALLATION. PIPE SHALL BE INSULATED UNTIL PIPE IS BELOW FROST DEPTH. REFER TO INSULATED UTILITY TRENCH DETAIL 2/C-400 FOR INSULATION THICKNESSES BASED ON BURIED DEPTH.
- (U3) 1,000 GALLON PRECAST H-20 RATED CONCRETE SEPTIC TANK (PUMP DOSING TANK) PER DETAIL 5/C-400. FURNISH AND INSTALL CONCRETE BALLASTS AS RECOMMENDED BY THE TANK MANUFACTURER.

  PUMP DOSING TANK NO. 1
  RIM= 6222.46
  TOP OF TANK EXTERIOR= 6218.69± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)
  4-INCH INVERT IN= 6218.36± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)
  2-INCH INVERT OUT= 6218.11± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)

  PUMP DOSING TANK NO. 2
  RIM= 6220.59
  TOP OF TANK EXTERIOR= 6218.10± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)
  6-INCH INVERT IN= 6217.77± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)
  2-INCH INVERT OUT= 6217.52± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)
- (U4) 2-INCH DR 9 OR DR 11 PE 4710 IPS HDPE SOLID DRAIN FIELD PIPE PER UTILITY TRENCH DETAIL 1/C-400. REFER TO INSULATED UTILITY TRENCH DETAIL 2/C-400 FOR INSULATION THICKNESSES BASED ON BURIED DEPTH.
- (U5) 1-1/2 INCH SCH 40 PERFORATED DRAIN FIELD PIPE PER MOUNDED SAND DRAIN FIELD DETAIL 5/C-400.
- (U6) 1,500 GALLON PRECAST CONCRETE H-20 RATED SEWER SEPTIC TANK WITHOUT PARTITION (HOLDING TANK) PER DETAIL 6/C-400. FURNISH AND INSTALL CONCRETE BALLASTS AS RECOMMENDED BY THE TANK MANUFACTURER.

  SEPTIC TANK NO. 1
  RIM= 6222.79
  TOP OF TANK EXTERIOR= 6218.64± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)
  6-INCH INVERT IN= 6217.72± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)

  SEPTIC TANK NO. 2
  RIM= 6220.59
  TOP OF TANK EXTERIOR= 6218.17± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)
  6-INCH INVERT IN= 6217.25± (FINAL ELEVATION DETERMINED DURING CONSTRUCTION)
- (U7) WELL HEAD AND PITLESS ADAPTER PER SHEET M-100.
- (U8) WELL HOUSE DRAWINGS PER M-XXX SHEETS.
- (U9) 3/4-INCH DR 9 OR DR 11 PE 4710 IPS HDPE WATER SERVICE LATERAL PER DETAIL 4/C-400. ESTIMATED LENGTHS PER PLAN. REFER TO TYPICAL TRENCH DETAIL 1/C-400 FOR TRENCH INSTALLATION. PIPE SHALL BE INSULATED PER INSULATED UTILITY TRENCH DETAIL 2/C-400 BASED ON BURY DEPTH. MINIMUM COVER FOR WATER LINE IS 2-FEET.
- (U10) 2-INCH DR 9 OR 11 PE 4710 IPS HDPE WATER MAIN LINE. ESTIMATED LENGTHS PER PLAN. REFER TO TYPICAL TRENCH DETAIL 1/C-400 FOR TRENCH INSTALLATION. PIPE SHALL BE INSULATED PER INSULATED UTILITY TRENCH DETAIL 2/C-400 BASED ON BURY DEPTH. MINIMUM COVER FOR WATER LINE IS 2-FEET.
- (U11) 12-INCH DR 25 C900 PVC WATER MAIN LINE. 20-FOOT LENGTH. REFER TO TYPICAL TRENCH DETAIL 1/C-400 FOR TRENCH INSTALLATION. PIPE SHALL BE INSULATED PER INSULATED UTILITY TRENCH DETAIL 2/C-400 BASED ON BURY DEPTH. MINIMUM COVER FOR WATER LINE IS 2-FEET.
- (U12) PIPE SIZE TRANSITION FROM 12-INCH TO 2-INCH PIPE. INSTALL 2-INCH COMPRESSION X 2-INCH MIP COUPLER AND 12-INCH X 2-INCH ROMAC ALPHA END CAP, OR APPROVED EQUAL, TO CONNECT 2-INCH HDPE PIPE TO 12-INCH C900 PVC PIPE.
- (U13) SEE STRUCTURE PLUMBING PLANS FOR CONTINUATION (TYPICAL). (4)
- (U14) SEE WELCOME CENTER PLUMBING PLANS FOR CONTINUATION (TYPICAL).
- (U15) REFER TO ELECTRICAL PLANS FOR ELECTRICAL DRAWINGS.
- (U16) PHONE AND CABLE SERVICES TO BE PROVIDED BY OTHERS.

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TETON VILLAGE RESORT

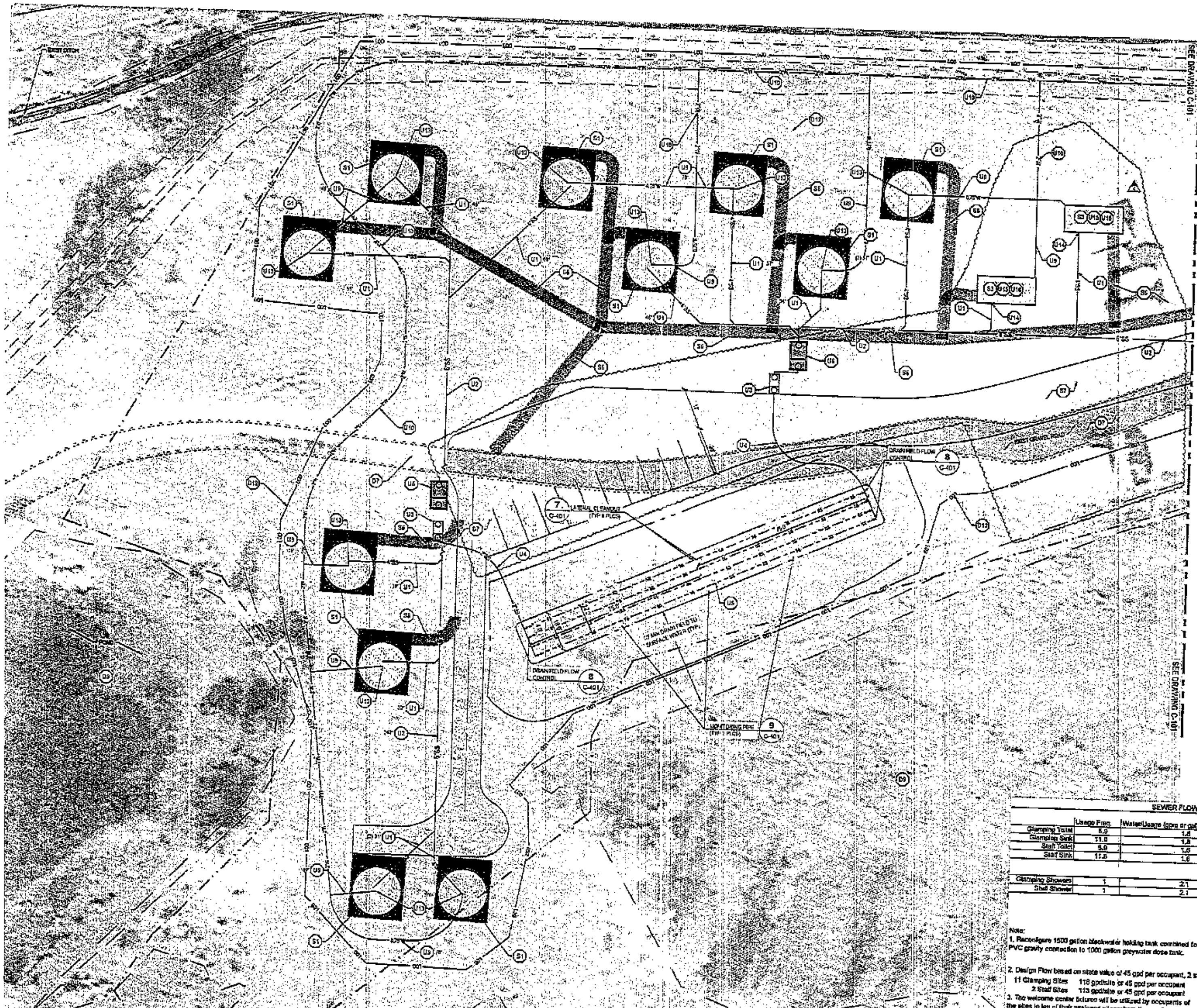
MOOSE WILSON ROAD
TETON VILLAGE, WYOMING

Professional Engineer — ROBERT J. ROUSSELLE — 17107 — WYOMING

FOR CONSTRUCTION

SITE, UTILITY AND DEMOLITION PLAN

C-101



NOTE:
SEE SHEET C-101 FOR KEYNOTES AND GENERAL NOTES

SEWER FLOW CALCULATIONS - 45 GPD PER OCCUPANT

	Usage Freq.	Water/Usage (gpm or gpf)	Duration (min)	Occupants	Sites	Design Flow/Site	Design Flow	Occupants
Glamping Toilet	5.9	1.6	-	2.6	11	24.4	268.4	28.3
Glamping Sink	11.8	1.8	0.5	2.6	11	27.5	302.0	
Staff Toilet	5.9	1.6	-	2.5	2	23.7	47.4	5
Staff Sink	11.8	1.6	0.5	2.5	2	26.6	53.3	
				45%	Black		671.1	33
Glamping Showers	1	2.1	11.6	2.6	11	64.1	704.6	
Staff Shower	1	2.1	11.6	2.5	2	62.2	124.3	
				55%	Grey		828.9	

Total gpd	1500
Septic Tank 48-hour Retention:	3000

Note:
1. Reconfigure 1500 gallon blackwater holding tank combined flow septic tank with partition baffle and 6-inch PVC gravity connection to 1000 gallon greywater dose tank.

2. Design Flow based on state value of 45 gpd per occupant, 2 staff per site plus one manager.
11 Glamping Sites 118 gpd/site or 45 gpd per occupant
2 Staff Sites 113 gpd/site or 45 gpd per occupant
3. The welcome center fixtures will be utilized by occupants of the sites in lieu of their assigned sites when the use is

Gallon Per Minute (gpm)
Gallon Per Flush (gpf)
Gallon Per Day (gpd)

Loading Rate (gpd/ft²)=	0.62
Design Flow Rate (gpd)=	1,500
Infiltration Area A = Max Day Flow÷Loading Rate	
A (square feet) = 1500÷0.62 =	2419
Infiltration Width W (feet)=	4.0
Total Pipe Length (feet) = A÷W=	605
# Legs	8
L of Legs (feet)	76

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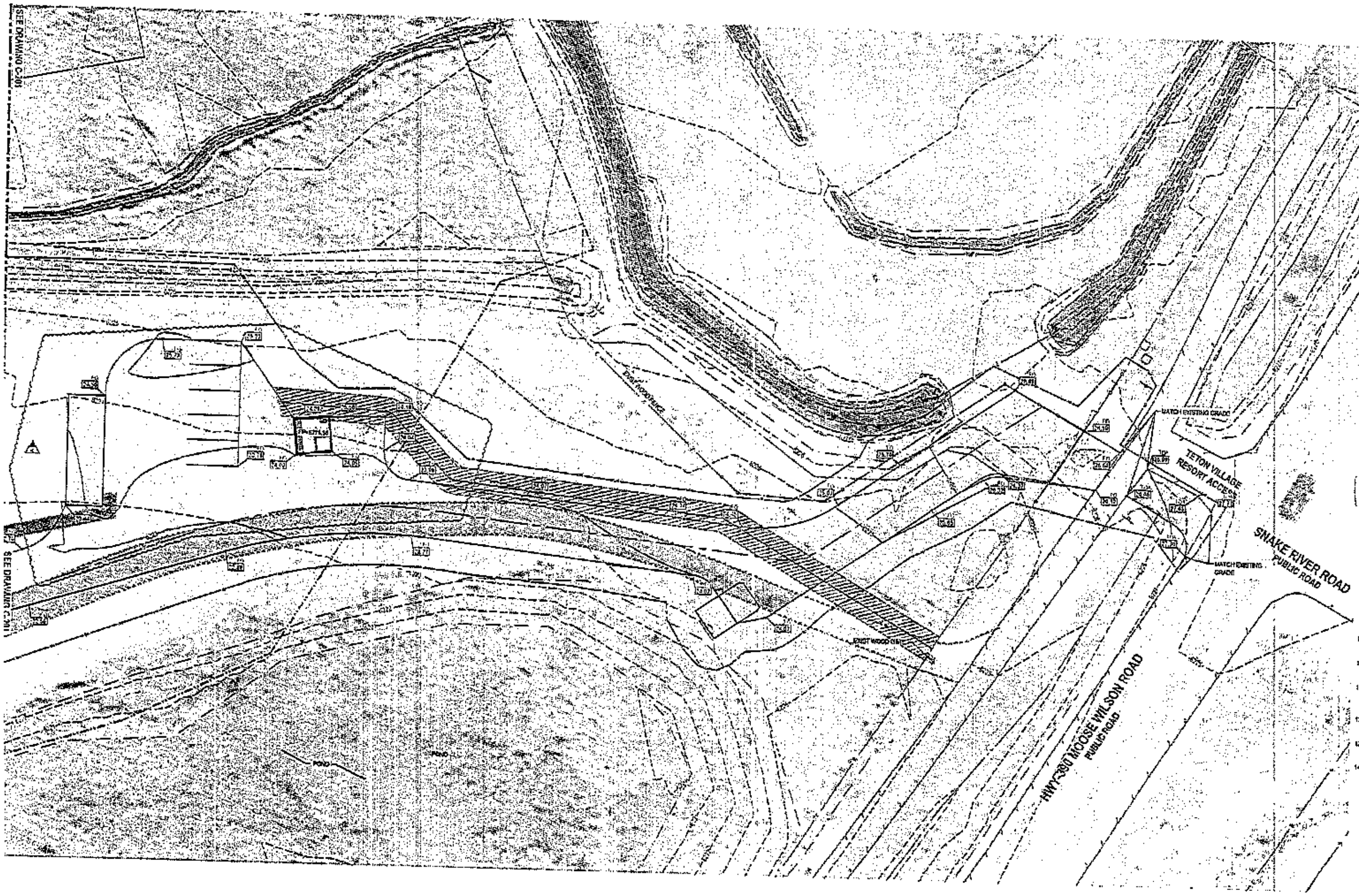
FOR CONSTRUCTION

SITE, UTILITY AND DEMOLITION PLAN

C-102



HORIZONTAL GRAPHIC SCALE

40 0 20 40 80

(IN FEET)
HORZ: 1 inch = 40 ft.

GENERAL NOTES

1. ALL WORK TO COMPLY WITH THE GOVERNING AGENCY'S STANDARDS AND SPECIFICATIONS.
2. ALL IMPROVEMENTS MUST COMPLY WITH ADA STANDARDS AND RECOMMENDATIONS.
3. ALL WORK SHALL COMPLY WITH THE RECOMMENDATIONS OF THE GEOTECHNICAL ENGINEER POSSIBLY INCLUDING, BUT NOT LIMITED TO, REMOVAL OF UNCONSOLIDATED FILL, ORGANICS, AND DEBRIS, PLACEMENT OF SUBSURFACE DRAIN LINES AND GEOTEXTILE, AND OVEREXCAVATION OF UNSUITABLE BEARING MATERIALS AND PLACEMENT OF ACCEPTABLE FILL MATERIAL.
4. THE CONTRACTOR SHALL BECOME FAMILIAR WITH THE EXISTING SOIL CONDITIONS.
5. ELEVATIONS HAVE BEEN TRUNCATED FOR CLARITY. XX.XX REPRESENTS AN ELEVATION OF 63XX.XX ON THESE PLANS.
6. LANDSCAPED AREAS REQUIRE SUBGRADE TO BE MAINTAINED AT A SPECIFIC ELEVATION BELOW FINISHED GRADE AND REQUIRE SUBGRADE TO BE PROPERLY PREPARED AND SCARIFIED. SEE LANDSCAPE PLANS FOR ADDITIONAL INFORMATION.
7. SLOPE ALL LANDSCAPED AREAS AWAY FROM BUILDING FOUNDATIONS TOWARD CURB AND GUTTER OR STORM DRAIN INLETS.
8. EXISTING UNDERGROUND UTILITIES AND IMPROVEMENTS ARE SHOWN IN THEIR APPROXIMATE LOCATIONS BASED UPON RECORD INFORMATION AVAILABLE AT THE TIME OF PREPARATION OF THESE PLANS. LOCATIONS MAY NOT HAVE BEEN VERIFIED IN THE FIELD AND NO GUARANTEE IS MADE AS TO THE ACCURACY OR COMPLETENESS OF THE INFORMATION SHOWN. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO DETERMINE THE EXISTENCE AND LOCATION OF THE UTILITIES SHOWN ON THESE PLANS OR INDICATED IN THE FIELD BY LOCATING SERVICES. ANY ADDITIONAL COSTS INCURRED AS A RESULT OF THE CONTRACTOR'S FAILURE TO VERIFY THE LOCATIONS OF EXISTING UTILITIES PRIOR TO THE BEGINNING OF CONSTRUCTION IN THEIR VICINITY SHALL BE BORNE BY THE CONTRACTOR AND ASSUMED INCLUDED IN THE CONTRACT. THE CONTRACTOR IS TO VERIFY ALL CONNECTION POINTS WITH THE EXISTING UTILITIES. THE CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE CAUSED TO THE EXISTING UTILITIES AND UTILITY STRUCTURES THAT ARE TO REMAIN. IF CONFLICTS WITH EXISTING UTILITIES OCCUR, THE CONTRACTOR SHALL NOTIFY THE ENGINEER PRIOR TO CONSTRUCTION TO DETERMINE IF ANY FIELD ADJUSTMENTS SHOULD BE MADE.
9. ALL STORM DRAIN INFRASTRUCTURE TO BE INSTALLED PER GOVERNING AGENCY OR APWA STANDARD PLANS AND SPECIFICATIONS.
10. ENSURE MINIMUM COVER OVER ALL STORM DRAIN PIPES PER MANUFACTURER'S RECOMMENDATIONS. NOTIFY ENGINEER IF MINIMUM COVER CANNOT BE ATTAINED.
11. ALL FACILITIES WITH DOWNSPOUTS/ROOF DRAINS SHALL BE CONNECTED TO THE STORM DRAIN SYSTEM. SEE PLUMBING PLANS FOR DOWNSPOUT/ROOF DRAIN LOCATIONS AND SIZES. ALL ROOF DRAINS TO HAVE MINIMUM 1% SLOPE.
12. THE CONTRACTOR SHALL ADJUST TO GRADE ALL EXISTING UTILITIES AS NEEDED PER LOCAL GOVERNING AGENCY'S STANDARDS AND SPECIFICATIONS.
13. NOTIFY ENGINEER OF ANY DISCREPANCIES IN DESIGN OR STAKING BEFORE PLACING CONCRETE, ASPHALT, OR STORM DRAIN STRUCTURES OR PIPES.
14. THE CONTRACTOR IS TO PROTECT AND PRESERVE ALL EXISTING IMPROVEMENTS, UTILITIES, AND SIGNS, ETC. UNLESS OTHERWISE NOTED ON THESE PLANS.

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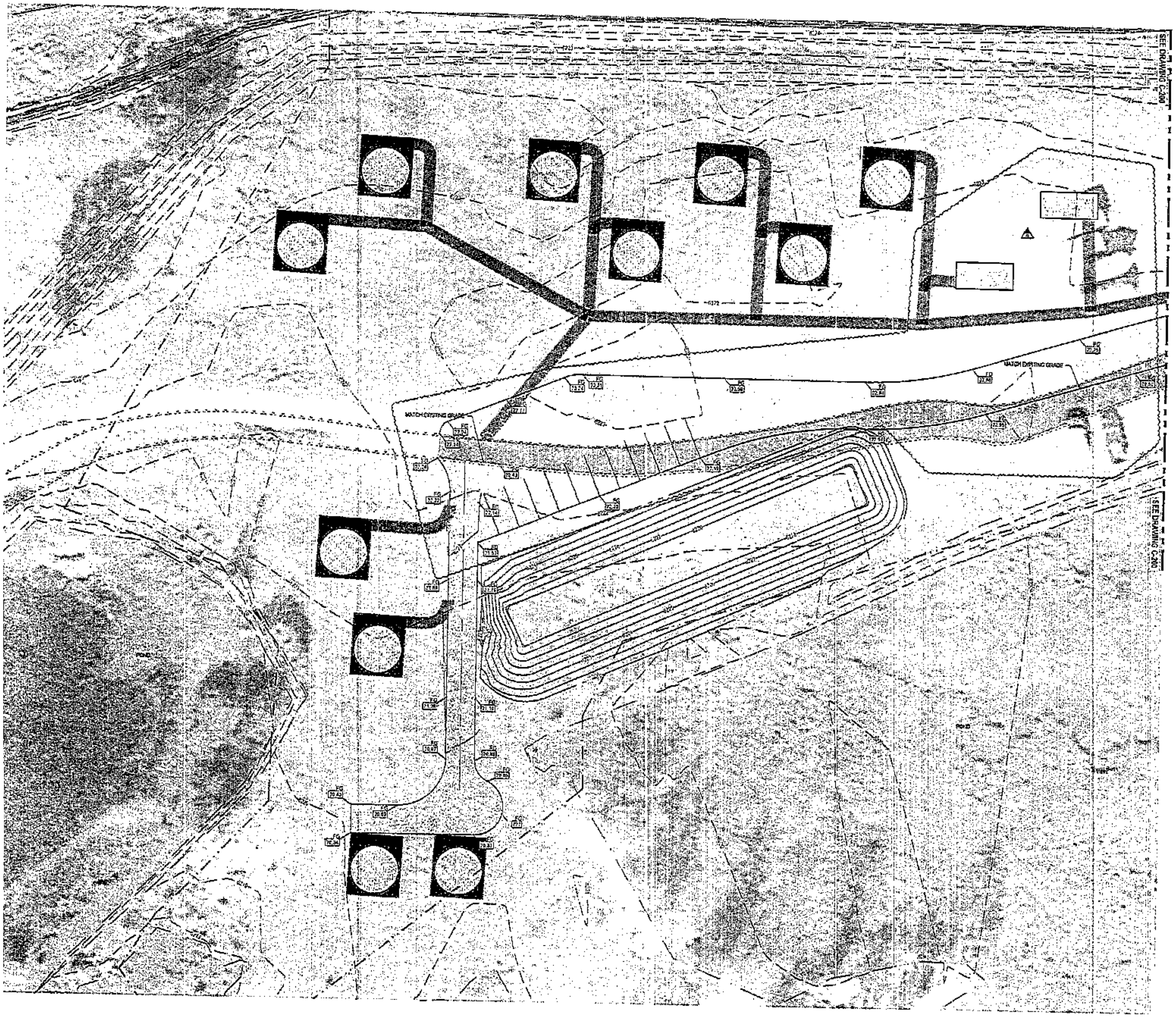
TETON VILLAGE RESORT

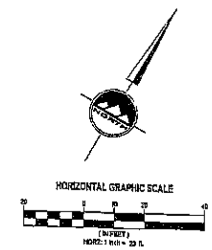
MOOSE WILSON ROAD
TETON VILLAGE, WYOMING

FOR CONSTRUCTION

GRADING AND DRAINAGE PLAN

C-200





NOTE:
SEE SHEET C-200 FOR GENERAL NOTES.

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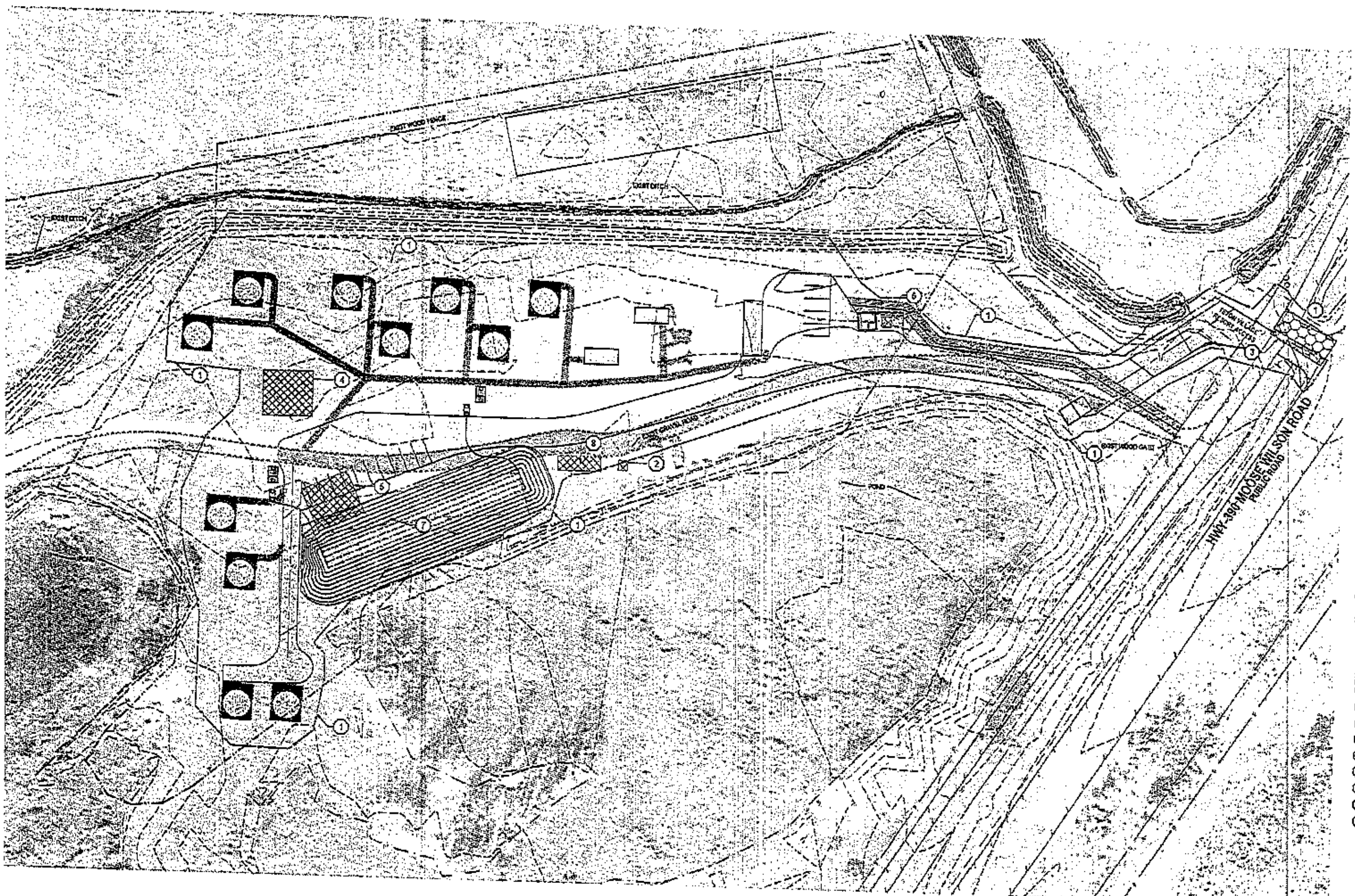
FOR CONSTRUCTION

GRADING AND
DRAINAGE PLAN

C-201



HORIZONTAL GRAPHIC SCALE

(IN FEET)
HORZ: 1 inch = 40 ft.

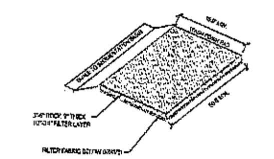
GENERAL NOTES

1. THIS PLAN IS DESIGNED AS A FIRST APPRAISAL OF NECESSARY MEANS TO PROTECT THE WATERS OF THE STATE FROM POTENTIAL POLLUTION. IT IS THE RESPONSIBILITY OF THE OWNER/OPERATOR TO ADD WARRANTED BEST MANAGEMENT PRACTICES (BMP'S) AS NECESSARY, MODIFY THOSE SHOWN AS APPROPRIATE, AND DELETE FROM THE PROJECT THOSE FOUND TO BE UNNECESSARY. FEDERAL AND STATE LAW ALLOWS THESE UPDATES TO BE MADE BY THE OWNER/OPERATOR ONSITE AND RECORDED BY THE OWNER/OPERATOR ON THE COPY OF THE SWPPP KEPT ONSITE.
2. DISTURBED LAND SHALL BE KEPT TO A MINIMUM. STABILIZATION MEASURES SHALL BE INITIATED AS SOON AS PRACTICABLE IN PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, BUT IN NO CASE MORE THAN 14 DAYS AFTER THE CONSTRUCTION ACTIVITY IN THAT PORTION OF THE SITE HAS TEMPORARILY OR PERMANENTLY CEASED. HOWEVER, WHERE CONSTRUCTION ACTIVITY ON A PORTION OF THE SITE IS TEMPORARILY CEASED, AND EARTH DISTURBING ACTIVITIES WILL BE RESUMED WITHIN 21 DAYS, TEMPORARY STABILIZATION MEASURES DO NOT HAVE TO BE INITIATED ON THAT PORTION OF THE SITE.
3. RESEED DISTURBED LAND WITH NATIVE GRASS MIXTURE WITHIN 14 CALENDAR DAYS OF ACHIEVEMENT OF FINISH GRADE TO STABILIZE SOILS IF LAND IS NOT TO BE REWORKED WITHIN 14 CALENDAR DAYS OF THE CESSATION OF CONSTRUCTION ACTIVITIES AT THAT LOCATION.
4. DETAILS SHOWN ARE TO BE EMPLOYED TO PROTECT RUNOFF AS APPROPRIATE DURING CONSTRUCTION. NOT ALL DETAILS ARE NECESSARY AT ALL PHASES OF THE PROJECT. IT SHALL BE THE RESPONSIBILITY OF THE OWNER/OPERATOR TO USE APPROPRIATE BEST MANAGEMENT PRACTICES AT THE APPROPRIATE PHASE OF CONSTRUCTION. SEE SWPPP FOR BMP IMPLEMENTATION SCHEDULE.
5. VARIOUS BEST MANAGEMENT PRACTICES HAVE BEEN SHOWN ON THE PLANS AT SUGGESTED LOCATIONS. THE CONTRACTOR MAY MOVE AND RECONFIGURE THESE BMP'S TO OTHER LOCATIONS IF PREFERRED, PROVIDED THE INTENT OF THE DESIGN IS PRESERVED.
6. NOT ALL POSSIBLE BMP'S HAVE BEEN SHOWN. THE CONTRACTOR IS RESPONSIBLE TO APPLY CORRECT MEASURES TO PREVENT THE POLLUTION OF STORM WATER PER PROJECT SWPPP.
7. COMPLIANCE WITH THE WYOMING SCGP (SMALL CONSTRUCTION GENERAL PERMIT) IS REQUIRED FOR ALL CONSTRUCTION ACTIVITIES GREATER THAN OR EQUAL TO 1 ACRE OR LESS THAN 5 ACRES.

SCOPE OF WORK:

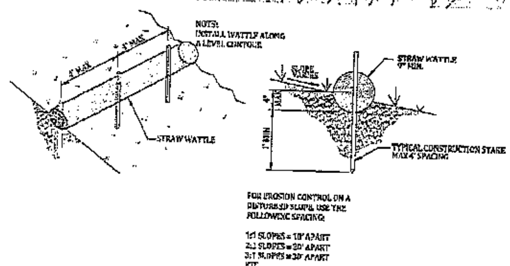
PROVIDE, INSTALL AND/OR CONSTRUCT THE FOLLOWING PER THE SPECIFICATIONS GIVEN OR REFERENCED, THE DETAILS NOTED, AND/OR AS SHOWN ON THE CONSTRUCTION DRAWINGS:

(1) LIMITS OF DISTURBANCE, INSTALL STRAW WATTLES AS NEEDED PER DETAIL 2/C-500 INLET PROTECTION.
(2) PORTABLE TOILET
(3) VEHICLE WASHDOWN AND STABILIZED CONSTRUCTION ENTRANCE PER DETAIL 1/C-500.
(4) SUGGESTED TEMPORARY CONSTRUCTION SITE PARKING, STAGING, AND MATERIAL STORAGE AREA.
(5) SUGGESTED STOCKPILE AREA.
(6) TRASH RECEPTACLE
(7) GREY WATER DRAIN FIELD
(8) TRUCK REFUEL AREA (HAND REFUEL)



NOTE:
1. PLACE WITH ADJACENT TO ENTRANCE ... CONSTRUCTION TRAFFIC ONLY ...

(1) STABILIZED CONSTRUCTION ENTRANCE — SCALE: NONE



FOR EROSION CONTROL ON A DISTURBED SLOPE, USE THE FOLLOWING SPACING:
1:1 SLOPES = 10' APART
2:1 SLOPES = 20' APART
3:1 SLOPES = 30' APART
ETC.

(2) STRAW WATTLES — SCALE: NONE

REVISION SCHEDULE

NUMBER	DATE	AUTHOR	COMPANY REPRESENTATIVE SIGNATURE
1			
2			
3			
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12			

ENSIGN
THE STANDARD IN ENGINEERING
SALT LAKE CITY
45 W. 10000 S., Suite 500
Sandy, UT 84070
Phone: 801.255.0529
LAYTON
Phone: 801.547.1100
TOOELE
Phone: 435.843.3590
CEDAR CITY
Phone: 435.865.1453
RICHFIELD
Phone: 435.896.2983
WWW.ENSIGNENG.COM

TETON VILLAGE RESORT

MOOSE WILSON ROAD
TETON VILLAGE, WYOMING

FOR CONSTRUCTION

EROSION CONTROL PLAN

C-500