

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
BENEFICIAL USE FIELD REPORT

A. GENERAL INFORMATION

Permit No: 97-7531

Exam Date: 04/13/2021

1. Current Owner:
DAN TERRY 4827 GLEASON MC ABEE FALLS RD PRIEST RIVER ID 83856
2. Accompanied by: Dan Terry
Phone No: 208-920-0209
Address: Same as above
Relationship to permit Holder: Permit Holder

3. **SOURCE:**
SPRING

Tributary
SINKS

Method of Determination: Arcmap and DRG.

B. OVERLAP REVIEW

1. Other water rights with the same place of use: YES Overlap

Water Right No.	Source	Purpose of Use	Basis
97-4197	SPRING	DOMESTIC	STATUTORY CLAIM
97-4242	UNNAMED STREAM	STOCKWATER	STATUTORY CLAIM

Comments: Both rights 97-4197 and 97-4242 have POU(s) that overlap this right's POU, but use different sources and are not associated with the power beneficial used with this right. Neither 97-4197 nor 97-4242 constitute overlap concerns.

2. Other water rights with the same point-of-diversion: NO Overlap

C. DIVERSION AND DELIVERY SYSTEM1. **LOCATION OF POINT(S) OF DIVERSION:**

SPRING SW¼ SW¼ NE¼, Sec. 8, Twp 58N, Rge 04W, B.M. BONNER County

Method of Determination: GPS. POD is a submerged metal cube (penstock inflow) located at -116° 52.974, 48° 23.702.

PLACE OF USE: POWER

Twp	Rng	Sec	NE				NW				SW				SE				Totals
			NE	NW	SW	SE	NE	NW	SW	SE	NE	NW	SW	SE	NE	NW	SW	SE	
58N	04W	8			X														

Method of Determination: Field exam and Arcmap Aerial imagery.

3.
 - ☒ Delivery System Diagram Attached (required). Indicate all major components and distances between components.
 - ☒ Indicate weir size/pipe as applicable.
 - ☒ Map Attached Showing Location(s) of point(s) of diversion and place(s) of use (required). Scale must be 1:24,000 or greater.
 - ☒ Aerial Photo Attached (required for irrigation of 10+ acres).
 - ☒ Photo of Diversion and System Attached

4.

Well or Diversion ID No.*	Motor Make	Hp	Motor Serial No.	Pump Make	Pump Serial No. or Discharge Size
SPRING	GRAVITY FLOW				

D. FLOW MEASUREMENTS

1.

Measurement Equipment	Type	Make	Model No.	Serial No.	Size	Calib. Date
5 GALLON BUCKET TEST						

2. Measurements: Three 5-gallon bucket measurements were taken at the outflow from power station, with 4ea 5/16 inch nozzles producing power. The average of the three measurements resulted in a flow rate equal to 53.19 gpm or 0.12 cfs considering department rounding standards.

E. FLOW CALCULATIONS

X Additional Computation Sheets Attached

Measured Method: 5 GAL Bucket Test = (5 gal / 5.12 sec) x 60 sec/min = 58.59 gpm
 = (5 gal / 6.17 sec) x 60 sec/min = 48.62 gpm
 = (5 gal / 5.73 sec) x 60 sec/min = 52.36 gpm

Average of 3ea 5 GAL Bucket Tests = (58.59 gpm + 48.62 gpm + 52.36 gpm) / 3 = 53.19 gpm = **0.12 cfs**

F. VOLUME CALCULATIONS

1. Volume Calculations for irrigation: N/A
2. Volume Calculations for Other Uses:

HYDROPOWER = 53.19 GPM x 60 min x 5 hour per day x 90 days per year = 1,436,130 GPY / 325,850 GAL/AF
 = **4.4 AF (NON-CONSUMPTIVE)**

G. NARRATIVE/REMARKS/COMMENTS

Field exam performed on 4/13/2021 with the applicant, Dan Terry, showed a micro hydropower system that used water from a spring. At the POD, the applicant captured spring water in a small 24-HR impoundment earthen basin with a metal cube penstock inflow submerged in the low point of the basin. The basin had two corrugated storm pipes at different elevations to allow any overflow to discharge downgrade in a small ravine before entering a wetland area on the applicant's property. The overflow pipes were blocked to allow water collection sufficient to allow hydropower use each time the applicant ran the system. The penstock incorporates a 3 inch run of poly pipe that has 45 feet of head before reaching the small power station at the base of a hill. There is a vertical access pipe with manual shutoff valve installed on the penstock inflow pipe.

The applicant has a rectangle metal overflow that allows water to pass through the power system and gravity flow downgrade into a nearby wetland area where it sinks on the applicant's property. Three 5-gallon bucket measurements were taken at the outflow from power station, with 4ea nozzles producing power. The average of the three measurements resulted in a flow rate equal to 53.19 GPM or **0.12 CFS** considering department rounding standards, which is recommended for licensing purposes.

At the hydropower station (POU), the power system is composed of a Harris pelton turbine style 4-nozzle unit equipped with 4ea 5/16 inch nozzles. Mr. Terry explained that once the 24HR impoundment basin was full, he could operate the system, which starts with a 70 PSI operating pressure. As water levels drop the pressure will reduce down to 15 PSI, and the system is shut off. Power wires from the power station routed to a wooden structure near the applicant's home, where it supplies electricity to a battery bank system. Mr. Terry asserts the hydropower is operated up to 5 hours each day, with the spring supporting adequate flow to operation the system from mid-February to mid-May each year. As such, the season of use was adapted to reflect 15 February – 15 May annually. The annual volume and maximum diversion volume recommended for licensing purposes equals $53.19 \text{ GPM} \times 60 \text{ GPH} \times 5 \text{ hour per day} \times 90 \text{ days per year} = 1,436,130 \text{ GPY} / 325,850 \text{ GAL/AF} = \mathbf{4.4 \text{ AF (NON-CONSUMPTIVE)}}$.

The electricity generated by this micro hydropower system is used by the applicant in conjunction with a solar system that recharges the shared battery bank. Additionally, the applicant stated he is hooked up to the local electric provider in the event both the hydropower are off-line for power generation. Mr. Terry stated his system doesn't have enough head pressure to run at peak efficiency, and his hydropower uses have become more back-up to solar than primary. Despite the reduced use, the system has been operated regularly during the development period, and continued to use ensuring the system functions properly. With this reduced use, the 90 day season of use is reasonable toward determining the annual volume derived above.

Condition(s) 26A, 08A, and 01N were removed from the permit during licensing review. Condition 17H was replaced with R22 at time of licensing. All other condition on the permit have been carried forward to the license. Overlap concerns: rights 97-4197 and 97-4242 have POU(s) that overlap this right's POU, but use different sources and are not associated with the power beneficial used with this right. Neither 97-4197 nor 97-4242 constitute overlap concerns. There are no additional overlap concerns for this right.

Have conditions of permit approval been met? ☒ Yes ☐ No

H. RECOMMENDATIONS

1. Recommended Amounts

<u>Beneficial Use</u>	<u>Period of Use</u>	<u>Rate of Diversion</u>	<u>Annual Volume</u>
POWER	02/15 to 05/15	0.12 CFS	4.4 AF
<u>Totals:</u>		0.12 CFS	4.4 AF

2. Recommended Amendments

☐ Change P.D. as reflected above ☐ Add P.D. as reflected above ☒ None

☐ Change P.U. as reflected above ☐ Add P.U. as reflected above ☒ None

I. AUTHENTICATION

Luke Bates - Water Resource Agent

Field Examiner's Name  Date 4/14/2021

Reviewer  Date 4/30/2021

State of Idaho
Department of Water Resources
Attachment to Field Exam
97-7531

POWER system diagram.

04W



- Point of Diversion
- Place Of Use Boundary
- Townships
- PLS Sections
- Quarter Quarters

0 0.035 0.07 0.14 Miles



How much power can you generate with a hydroelectric turbine?

The amount of power available depends on the dynamic head, the amount of water flow and the efficiency of the turbine generator combination. To get an idea about available power in watts, multiply the head in feet, times flow in gallons per minute, times 0.18, times turbine efficiency. Turbine efficiency ranges from 35% to 70%, with higher efficiency at higher heads. To get a rough idea, use 0.40 (representing 40%) as a multiplier for efficiency. The Harris Pelton turbines are well suited to higher head and lower flow situations. Flow is limited by nozzle size (a maximum 1/2"). Harris turbines are now available with permanent magnet (PM) alternators providing up to 50% efficiency. Higher flows are accommodated by the ESD Turgo Turbines. They can have nozzles of up to 1" diameter, and provide better efficiency at low heads. The HI-Power

Hydros are ideal for sites where water is available at long distances from power needs. They generate 100+ volts AC that is stepped down and rectified at the batteries. This allows the use of relatively small wire for a distance of up to 10,000 feet. Transmitting the power from the generator to the battery at twice the battery voltage allows you to use 1/4 of the wire size for the same power loss. At 4 times the battery voltage, you can use 1/16 of the wire size required to transmit power at the battery voltage. The HI-Power hydroelectric generator can also deliver up to 3600 watts where higher power is needed. The LV Hydroelectric Generator and the ES&D Water Baby are a good solution for very low flow situations where the head is high enough to make some power.

Pipelines

A hydroelectric turbine operates from the pressure at the bottom end of a pipeline. This pressure, usually measured in pounds per square inch (psi), is directly related to the head, the vertical drop from the top of the pipeline where the water goes into the turbine located at the bottom of the pipeline. The pressure at the lowest point of a pipeline is equal to 0.433 times the head, (the vertical distance in feet).

Pressure is important because it is a determining factor in how much power is available and what type of pipe is required. Polyethylene pipe can be used for pressures up to 100 psi, PVC pipe is available with pressure ratings from 160 to 350 psi and steel pipe can withstand 1000 psi or more. Check with your local plumbing supplier for pipe ratings. Pipe diameter is very important. All pipelines will cause the water flowing in them to lose some energy to friction. The pipe must be large enough for the maximum quantity of water it will carry.

The pressure at the bottom of a pipeline when water is not flowing is called static pressure. When water is flowing through the outlet or nozzle of the hydroelectric turbine, the pressure at the outlet is the dynamic pressure or running head. If you install a gate valve on the pipeline just above the turbine and a pressure gauge on a "T" fitting just above the gate valve, you will read the static pressure on the gauge when the valve is closed and the dynamic pressure when the valve is opened. The maximum power that can be delivered by a pipeline will occur when the dynamic pressure is approximately 2/3 of the static pressure.

The actual flow rate of the water in a hydroelectric system is determined by the diameter of the nozzle. We will supply a turbine with the proper size nozzle for your site, depending on the head, flow, length and diameter of the pipe. We carry hydroelectric generators made by Energy Systems and Design, HI-Power Hydroelectric, and Harris Hydroelectric. Use the descriptions on the following pages to help determine which turbine will work best for your site and power requirements.

We can help you design your system

If you think you have a suitable site, contact us and we will help you choose the best unit for your situation. Please provide the following information about your site:

1. **Head** – The total vertical elevation from the place where the water enters the pipe to the point where the turbine will be located.
2. **Flow** – The number of gallons per minute that are available.
3. **Distance** – The length of pipe that will be necessary to carry the water from the pickup to the turbine. If the pipe is already installed, what is the type and diameter?
4. **Location** – Distance from turbine to batteries.

Nozzle selection

Power output of a hydroelectric generator is determined by the pressure of the water at the nozzle and the amount of water flowing out of the nozzle. The larger the nozzle, the greater the flow will be. The nozzle must also be sized small enough to keep your pipeline full and keep the speed of the water in the pipe below 5 feet per second. The nozzle selection table on the next page shows water flow through various size nozzles at given pressures. Use this table to determine what size nozzle and how many nozzles you need to accommodate the flow of water you have and to deliver the amount of power you need. A pressure gauge in the pipe feeding your turbine, installed before the shutoff valve, can help you check proper operation and diagnose problems. When the valve is shut off, the gauge will read the static pressure in pounds per square inch psi (head in feet x 0.433). When the valve is turned on the gauge will read a lower (dynamic) pressure.

The difference between these two pressures represents your loss to friction in the pipe. The greater the flow, the greater your loss will be. (See PVC pipe loss table on the next page.)

Hydroelectric Power Output Estimation Formula:

Dynamic Head (ft) x Flow (GPM) x 0.18 x Turbine Efficiency (use 0.40) = Output Watts

Suggested retail prices are subject to change. check with us for latest pricing

$$45 \text{ ft} \times 53.19 \text{ GPM} \times 0.18 \times 0.40 = 172.3 \text{ Watts}$$

Water Flow Information for Pumping and Hydroelectric Design

Flow Through Nozzles

The table below shows the flow in gallons per minute (gpm) through various diameter nozzles at a range of heads from 5 feet to 400 feet. Use table to choose what nozzle size to use and how many nozzles a turbine must have to give the required flow to use all of the water available in the system.

Per Nozzle

Head		Flow in gpm through these nozzle diameters:											Rpm for 4" turbine
feet	psi	1/8"	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1.0"	
5	2.2	-	-	-	-	6.18	8.4	11	17.1	24.7	33.6	43.9	460
10	4.3	-	-	3.88	6.05	8.75	11.6	15.6	24.2	35	47.6	62.1	650
15	6.5	-	2.68	4.76	7.4	10.7	14.6	19	29.7	42.8	58.2	76	800
20	8.7	1.37	3.09	5.49	8.56	12.4	16.8	22	34.3	49.4	67.3	87.8	925
30	13	1.68	3.78	6.72	10.5	15.1	20.6	26.9	42	60.5	82.4	107	1140
40	17.3	1.94	4.37	7.76	12.1	17.5	23.8	31.1	48.5	69.9	95.1	124	1310
50	21.7	2.17	4.88	8.68	13.6	19.5	26.6	34.7	54.3	78.1	106	139	1470
60	26	2.38	5.35	9.51	14.8	21.4	29.1	38	59.4	85.6	117	152	1600
80	34.6	2.75	6.18	11	17.1	24.7	33.6	43.9	68.6	98.8	135	176	1850
100	43.3	3.07	6.91	12.3	19.2	27.6	36.6	49.1	76.7	111	150	196	2070
120	52	3.36	7.56	13.4	21	30.3	41.2	53.8	84.1	121	165	215	2270
150	65	3.76	8.95	15	23.5	33.8	46	60.1	93.9	135	184	241	2540
200	86.6	4.34	9.77	17.4	27.1	39.1	53.2	69.4	109	156	213	278	2930
250	108	4.86	10.9	19.9	30.3	43.6	59.4	77.6	121	175	238	311	3270
300	130	5.32	12	21.3	33.2	47.8	65.1	85.1	133	191	261	340	3590
400	173	6.14	13.8	24.5	38.3	55.2	75.2	98.2	154	221	301	393	4140

15psi
↓
to
↓
70psi

PVC Pipe Loss Table

Use the table below to determine what pipe size is required to efficiently allow necessary flow for your power need. Once you know the required flow for your system (gpm), find the head loss for various pipe sizes. Multiply the head loss number by the length of the pipe divided by 100 and you will get the loss of head for that pipe size. The actual head minus the head loss will give you the effective dynamic head in the system.

Pipe Friction Loss Table – Head Loss in Feet per 100 Feet of Schedule 40 PVC Pipe

		Flow (gallons per minute)																						
		1	2	3	4	5	7	10	15	20	25	30	40	50	60	70	80	100	150	200	250	300	400	500
Pipe diameter (inches)	1/2	2.08	4.16	8.7	14.8	23.5	43																	
	3/4	0.51	1.02	2.2	3.7	5.73	10.5	20.1	42.5															
	1	0.1	0.55	0.68	1.15	1.72	3.17	6.02	12.8	21.8	32.9	46.1												
	1-1/4	0.03	0.14	0.19	0.31	0.44	0.81	1.55	3.28	5.59	8.45	11.9	22	30.5	45.6									
	1-1/2		0.07	0.08	0.13	0.22	0.38	0.72	1.53	2.61	3.95	5.53	9.43	14.3	20	28.6	36.7							
	2			0.03	0.05	0.07	0.11	0.21	0.45	0.76	1.15	1.62	2.75	4.16	5.84	7.76	9.94	15.1	34.8	59.3				
	2-1/2				0.03	0.04	0.05	0.09	0.19	0.32	0.49	0.68	1.16	1.75	2.46	3.27	4.19	6.33	13.4	25.0	37.8	46.1		
	3						0.02	0.03	0.07	0.11	0.17	0.23	0.4	0.6	0.85	1.13	1.44	2.18	4.63	7.88	11.9	18.4	40.1	
	4										0.04	0.06	0.11	0.16	0.22	0.3	0.38	0.58	1.22	2.08	3.15	4.41	7.52	
	5											0.03	0.04	0.05	0.07	0.1	0.13	0.19	0.4	0.69	1.05	1.46	2.49	3.76
6														0.02	0.03	0.04	0.05	0.08	0.16	0.28	0.43	0.6	1.01	1.53

3" Pipe For 45ft → Reduced down to 2" Pipe at Power unit.

Harris Hydroelectric

Pelton Turbines

This hydroelectric battery charger uses a cast bronze Pelton wheel and a brushless permanent magnet alternator on a white powder-coated aluminum housing.

- Head range: 20 to 600 feet
- Flow range: 4 to 250 gpm
- Maximum 12-volt power: 700 watts
- Maximum 24-volt power: 1400 watts
- Maximum 48-volt power: 2500 watts

They are available with one, two or four nozzles, depending on water flow and power requirements. (PVC manifold with one shut-off valve on two-nozzle machines and 3 shut-off valves on 4-nozzle machines is available). These turbines can be fitted with nozzles up to 1/2" in diameter. Each hydroelectric system is custom-built to match your site specifications. Please tell us your head, flow, pipe size and length, electrical transmission line length and battery voltage when ordering. The new permanent magnet (PM) brushless alternator pictured here is 15-30% more efficient than the automotive alternator used in the past; and they last longer. Allow 5 to 6 weeks for delivery. 1-year warranty.



Description	Item code	Price
Harris PM 1-Nozzle 12/24V/48V	017-01030	\$2,300
Harris PM 2-Nozzle 12/24V/48V	017-01032	\$2,387
Harris PM 4-Nozzle 12/24V/48V	017-01034	\$2,555
Fan kit (recommended when producing over 500W)	017-01092	\$70

ES&D

ES&D's micro hydro systems employ high-efficiency, precision-cast parts and non-corrosive alloys for long life and durability. A digital multimeter accompanies each turbine for measuring output amperage. These units can be used in off-grid/standalone or grid-tie systems.

Stream Engine Turbines

ES&D hydroelectric battery chargers use a cast bronze turgo runner to drive a long-life, brushless permanent magnet alternator.

- Head Range: 5 to 200 feet
- Flow range: 10 to 400 gpm
- Maximum Power: 1000 watts
- Voltage from 12 to 48 VDC



A simple change of wiring in the junction box allows this turbine to charge 12, 24, or 48-volt battery systems. These turbines come with cut-to-size nozzles that can be user-set for up to 1", allowing a very large flow in low head situations. They can operate on heads as low as five feet with a flow of 40 gpm.

Description	Item code	Price
ES&D 2-Nozzle Stream Engine	017-03241	\$3,493
ES&D 4-Nozzle Stream Engine	017-03244	\$3,920

Water Baby

- Head Range: 50 to 500 feet
- Flow range: 3 to 30 gpm
- Max Power: 350 watts
- Voltage from 12 to 48 VDC

This new tiny turbine, a miniature version of the Stream Engine above, is ideal for sites with good head but with very little flow.



Two models are available; one for 12- to 48-volt charging and one for high voltage transmission. At 3 gpm and 100 feet of head, the Water Baby will charge at 25 watts. Comes with a selection of nozzles.

Description	Item code	Price
ES&D 1-Nozzle Water Baby - 12 - 24V	017-03245	\$1,945
ES&D 2-Nozzle Water Baby - 12 - 24V	017-03247	\$2,095
ES&D 4-Nozzle Water Baby - 12 - 24V	017-03249	\$2,395
ES&D 1-Nozzle Water Baby - 48V	017-03252	\$2,095
ES&D 2-Nozzle Water Baby - 48V	017-03254	\$2,245
ES&D 4-Nozzle Water Baby - 48V	017-03256	\$2,645



FIELD EXAM 4/13/2021



POD – SPRING BOX WITH 2 INCH POLY PIPE DIVERTING WATER FROM A 24-HR IMPOUNDMENT BASIN



SPRING SOURCE FLOWS DOWN MAN-MADE CUT BANK TO DIVERSION POINT



24-HR IMPOUNDMENT FOR SPRING WATER PRIOR TO HYDRO-POWER USE



2EA OVERFLOW PIPES AT DIFFERENT ELEVATIONS ALLOW SPRING WATER TO FLOW DOWNGRADE



MANUAL VALVE OPERATION FOR HYDRO-POWER 2 INCH POLY PIPE – LOCATED AT POD

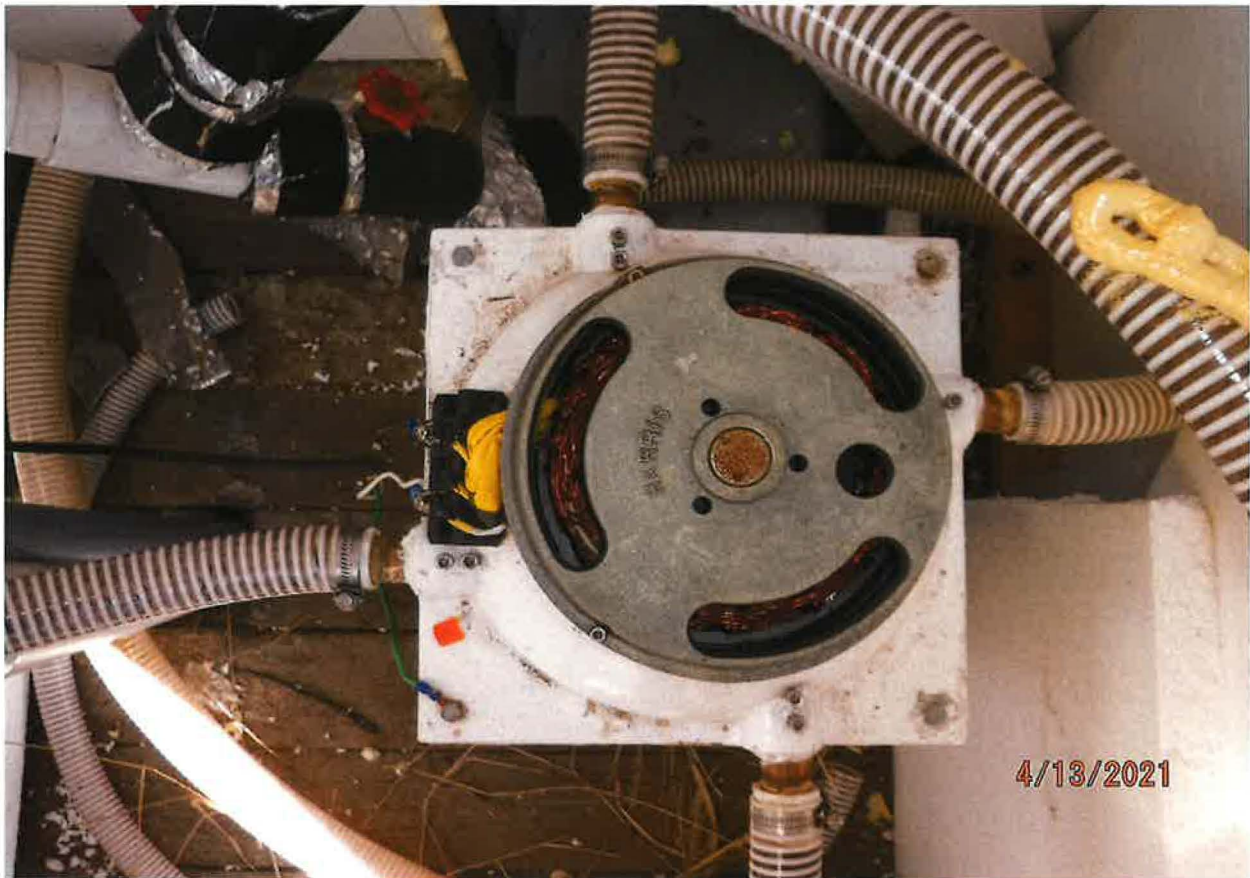


POWER STATION





OVERFLOW DISCHARGE FROM HYDRO-POWER UNIT



POWER POU – HARRIS PM 4-NOZZLE 12/24V/48V, ITEM No. 017-01034

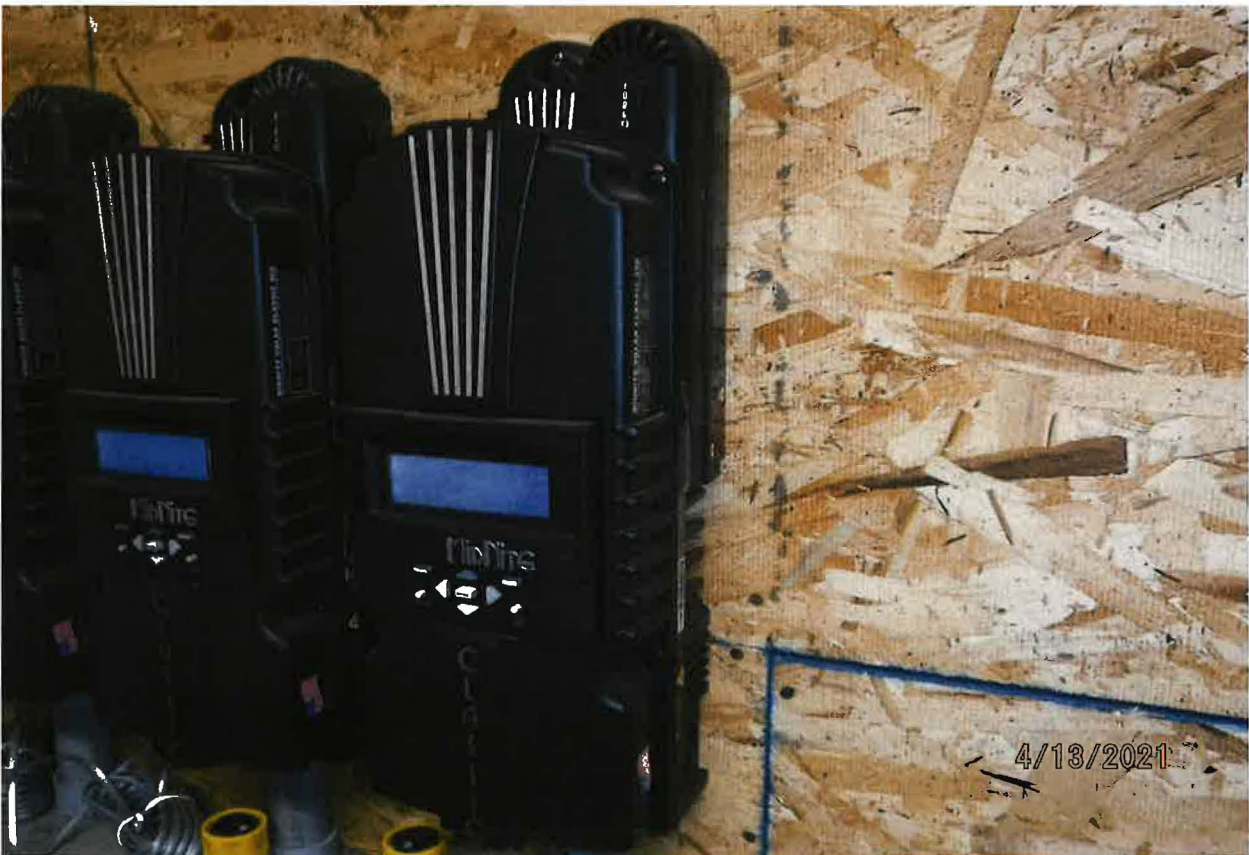


POWER POU – HARRIS HYDRO-POWER SYSTEM





POWER POU – SYSTEM OPERATION STARTS AT 70 PSI, AND DROPS TO 15 PSI BEFORE APPLICANT SHUTS SYSTEM OFF



CONVERTOR FOR HYDRO-POWER TO BATTERY BANK PRIOR TO IN-HOME USE