

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
BENEFICIAL USE FIELD REPORT

A. GENERAL INFORMATION

Permit No: 98-7850
Exam Date: 06/04/2013

1. Current Owner:
THOMAS LIVING TRUST PO BOX 852 MOYIE SPRINGS ID 83845-0852
2. Accompanied by: Brandon Keyes
Phone No: 208-267-9725
Address: 1203 Christmas LN Naples ID 83845
Relationship to permit Holder: Current Permit holder's son

3. SOURCE:
SPRING

Tributary
DEEP CREEK

Method of Determination: Arcmap and DRG.

B. OVERLAP REVIEW

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

C. DIVERSION AND DELIVERY SYSTEM**1. LOCATION OF POINT(S) OF DIVERSION:**

SPRING SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$, Sec. 32, Twp 60N, Rge 01W, B.M. BOUNDARY County
SPRING NW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$, Sec. 32, Twp 60N, Rge 01W, B.M. BOUNDARY County

Method of Determination: POD(s) are spring sources located at -116°29.242, 48°30.651 (#1, NW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$) and -116°29.170, 48°30.561 (#2, SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$).

PLACE OF USE: POWER and DOMESTIC

Twp	Rng	Sec	NE				NW				SW				SE				Totals
			NE	NW	SW	SE	NE	NW	SW	SE	NE	NW	SW	SE	NE	NW	SW	SE	
60N	01W	32				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 #1 (NW¼ SE¼ NE¼)	GRAVITY FLOW				
Spring #2 (SW¼ SE¼ NE¼)	GRAVITY FLOW				

D. FLOW MEASUREMENTS

1.

Measurement Equipment	Type	Make	Model No.	Serial No.	Size	Calib. Date
5-GAL bucket test – spring #1						
NONE - Spring #2						

2. Measurements: a 5-GAL bucket measurement was taken at the outflow from power station (Spring source #1), with 1ea 5/16-inch nozzle producing power; the resulting flow rate equals 5-gal / 18.76 sec x 60 sec/min = 15.99 gpm, or **0.04 cfs** considering department rounding standards. I was unable to take a flow measurement from spring source #2 due to inadequate pipe requirements; the flow into the cistern demonstrated to be approximately 18 gpm or **0.04 cfs**.

E. FLOW CALCULATIONS

Measured Method:

Spring source #1 (NW¼ SE¼ NE¼) = 5-GAL Bucket Test = (5 gal / 18.76 sec) x 60 sec/min = 15.99 gpm or 0.04 cfs
 Spring source #2 (SW¼ SE¼ NE¼) = visual estimation determined flow to be approximately 18 gpm or 0.04 cfs

F. VOLUME CALCULATIONS

1. Volume Calculations for irrigation: N/A

2. Volume Calculations for Other Uses:

- Power Annual Volume = 15.99 GPM x 60 min x 24 hour per day x 167 days per year = 3,847,680 GPY / 325,850 GAL/AF = **11.8 AF** (NON-CONSUMPTIVE USE)
- Domestic Annual Volume = **1.2 AF**
- Maximum Diversion Volume = **13.0 AF**

G. NARRATIVE/REMARKS/COMMENTS

An initial field exam was performed by Department staff on 8/16/2012, but for unknown reasons the beneficial use report & licensing approval process was not finalized following the exam up to year 2021. A follow-up field exam was performed to capture sufficient data to finalize for licensing.

Field exam performed on 4/1/2021 with the current permit holder's son, Brandon Keyes, showed two springs being used for domestic purposes, and one of the springs serving a micro hydropower system. At the POD for Spring source #1 located in the NW¼ SE¼ NE¼ of Sec 32, the permit holder captured spring water in small 24-HR impoundment tanks located beneath roofing material. From the tanks, a 2-inch poly pipe serving as the penstock routes down slope and through a 'Y' connection splitting between domestic use and power use. The 2-inch pipe enters the power station and supplies spring water to a Harris Pelton Turbine which uses a single 5/16 Nozzle to generate electricity. A 5-GAL bucket measurement was taken at the outflow from power station (Spring source #1), with 1ea 5/16-inch nozzle producing power; the resulting flow rate equals 5-gal / 18.76 sec x 60 sec/min = 15.99 gpm, or **0.04 cfs** considering department rounding standards which is recommended as the diversion rate for the power beneficial use component of the permit. The power POU is designated as the power station shed located uphill from a nearby pond on the property.

The permit holder's power system uses a single nozzle for generation, based on limiting flow-through capacity to keep consistent gravity flow from the spring to the hydroelectric Pelton turbine. If additional nozzles were installed, the spring storage tanks at the POD would be depleted faster than the spring filling capacity could maintain. Based on how the system is installed, it is reasonable to assign a diversion rate for domestic beneficial use as 0.04 cfs, as this is the approximate amount observed flowing into the storage tank at spring #1.

At the POD for Spring source #2 located in the SW¼ SE¼ NE¼ of Sec 32, the applicant has an earthen spring impoundment vessel located beneath a large rock feature. I was unable to take a flow measurement from spring source #2 due to inadequate pipe requirements; the flow into the cistern was observed to be approximately 18 gpm or 0.04 cfs. Mr. Keyes asserts that domestic use for the home is provided by alternating use between the two spring sources, functioning as lead-lag system(s) so that spring cisterns can replenish while the other is being depleted. As a result, the recommended diversion rate for domestic beneficial use is limited to **0.04 cfs**, combined use between the two spring sources respectively. The maximum diversion rate recommended to license the permit equals 0.04 cfs (Power) + 0.04 cfs (Domestic) = **0.08 cfs**.

During the exam, field maps were used to sketch the power POU and domestic POU. During licensing review, Arcmap aerial imagery was along with GPS points to accurately trace out each respective POU. The power system PSI is unknown, as there was no pressure gage installed on the small Harris Pelton turbine. The hydro system has a dynamic head of 250 ft and operates 24/7 during the power season of use. The output power with unit running equals 250 ft (dynamic head) x 16 gpm (flow) x 0.18 (formula factor) x 0.48 (turbine efficiency) = 345.6 Watts = 2.88 Amps. Mr. Keyes asserts he produces up to 5-amp hr power when the spring flows at peak capacity. The annual volume associated with power production equals 15.99 GPM x 60 min x 24 hour per day x 167 days per year = 3,847,680 GPY / 325,850 GAL/AF = **11.8 af** and is a non-consumptive beneficial use.

The domestic POU consists of a large multi-story log home with daylight basement and adjoined greenhouse. Arcmap aerial imagery was used to trace out the domestic POU during licensing review. Mr. Keyes asserts the two poly pipes running from each spring flow into a 1,100-gal storage reservoir in the basement where spring(s) water co-mingles prior to use. Mr. Keyes asserts each spring's flow seasonally is dependent on seasonal recharge, with spring #2 drying up earlier in the season than spring #1. The diverting works for spring #1 is gravity fed from the source via 2-inch poly line, and subsequent 'Y' connection to the storage cistern. The diverting works for spring #2 consists of 2ea Ram pumps located side by side from the ¾" delivery poly pipe from spring cistern. Mr. Keyes explained there is a ¾ inch hose supplied Ram pump, and a ½ inch hose supplied Ram pump which are used independently based on spring flow capacity at different times in the season. Both Ram pumps rejoin a common 1-inch service poly pipe that routes down slope, around a pond on the property and up slope to the storage reservoir in the house.

Mr. Keyes asserts the combined use from both springs is sufficient to support domestic use, provided they manage water consumption during dry years. Water is used in home, as well as small green house to grow fruit and vegetables. The domestic annual volume recommended for licensing equals **1.2 af**. The maximum diversion volume for licensing purposes equals 11.8 af (power) + 1.2 af (domestic) = **13.0 af**, with the majority being non-consumptive water use.

Conditions 01N and 08A were removed from the permit during licensing review. Condition(s) 187, 027, and 004 were added following field examination water use validation. Condition 17K was replaced with R23; condition 17M was replaced with 916. All other conditions on the permit shall be carried forward to licensing. There are no overlap concerns for this water right. During licensing review the 2ea sources were clarified and revised to reflect SPRING tributary to Deep Creek vice the plural form permit approved for "Springs".

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	12/01 to 05/30	0.04 CFS	11.8 AF
DOMESTIC	01/01 to 12/31	0.04 CFS	1.2 AF

Totals: 0.08 CFS 13.0 AF

2. Recommended Amendments

____ Change P.D. as reflected above ____ Add P.D. as reflected above X None

____ Change P.U. as reflected above ____ Add P.U. as reflected above X None

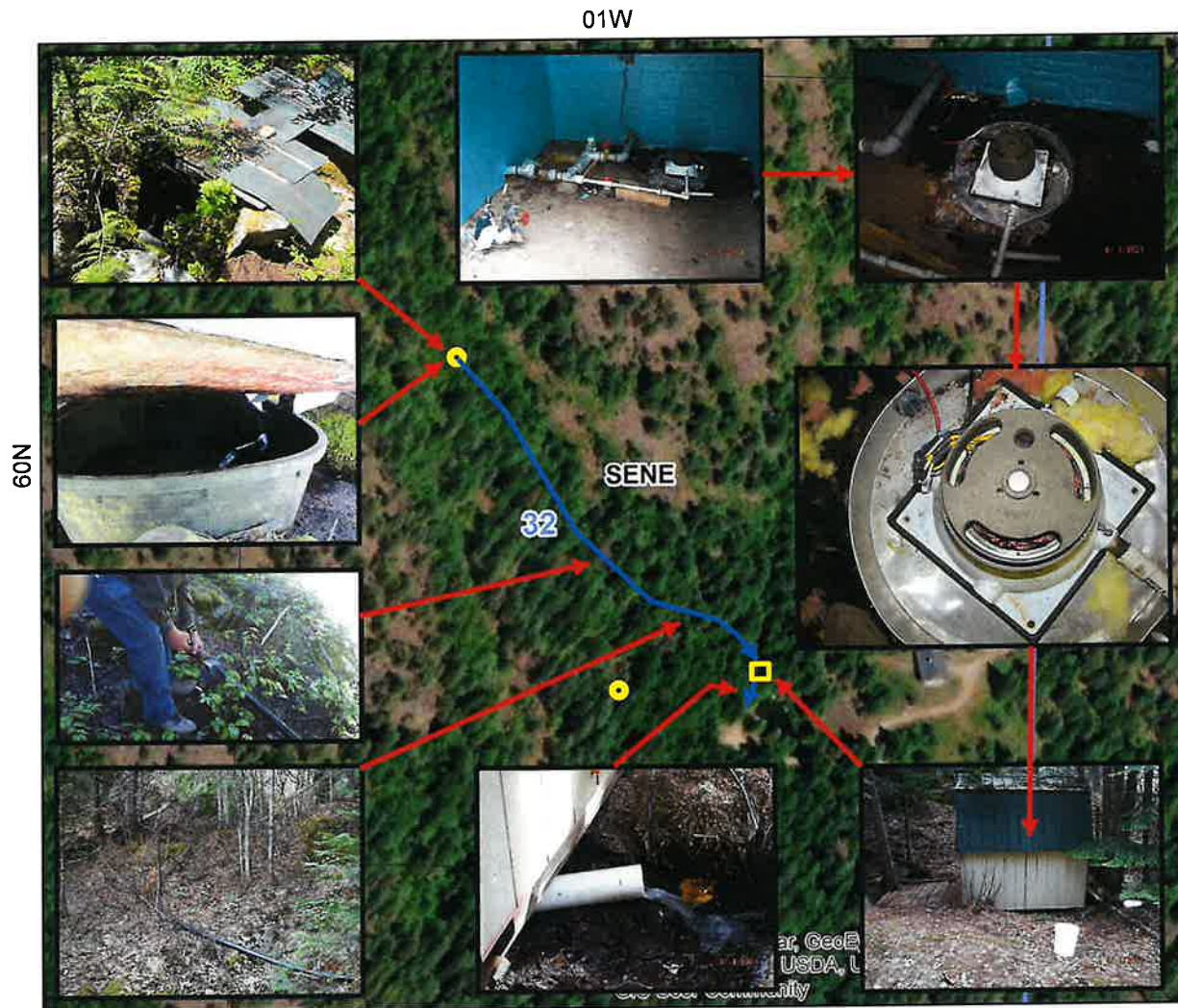
I. AUTHENTICATION Luke Bates - Water Resource Agent

Field Examiner's Name  Date 9/22/2021

Reviewer  Date 11/5/2021

State of Idaho
Department of Water Resources
Attachment to Field Exam
98-7850

POWER system diagram.



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

0 0.035 0.07 0.14 Miles

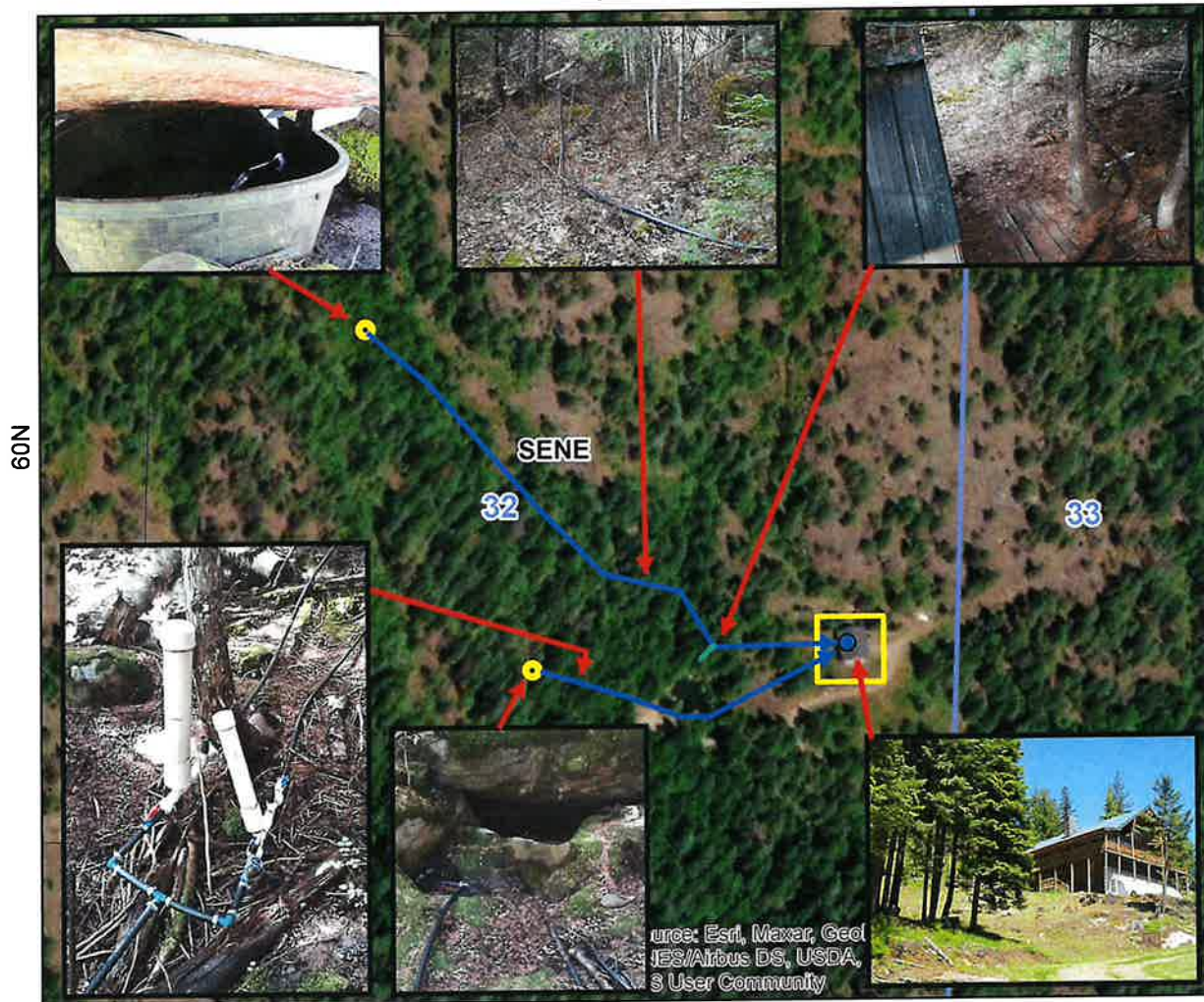
NOTE: WATER RIGHT'S 2ND SPRING POD IS NOT ASSOCIATED WITH THE HYDRO POWER SYSTEM.



State of Idaho
Department of Water Resources
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DOMESTIC system diagram.

01W



- 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:

$$\text{Dynamic Head (ft)} \times \text{Flow (GPM)} \times 0.18 \times \text{Turbine Efficiency (use 0.40)} = \text{Output Watts}$$

$$250 \text{ ft} \times 16 \text{ gpm} \times 0.18 \times 0.48 = 345.6 \text{ output Watts}$$

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.

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

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		

$$\left[\frac{15 \text{ gpm}}{0.45} = \frac{16 \text{ gpm}}{X} \right] = X = \frac{16(0.45)}{15} = 0.48 \text{ Pipe Friction Loss}$$

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

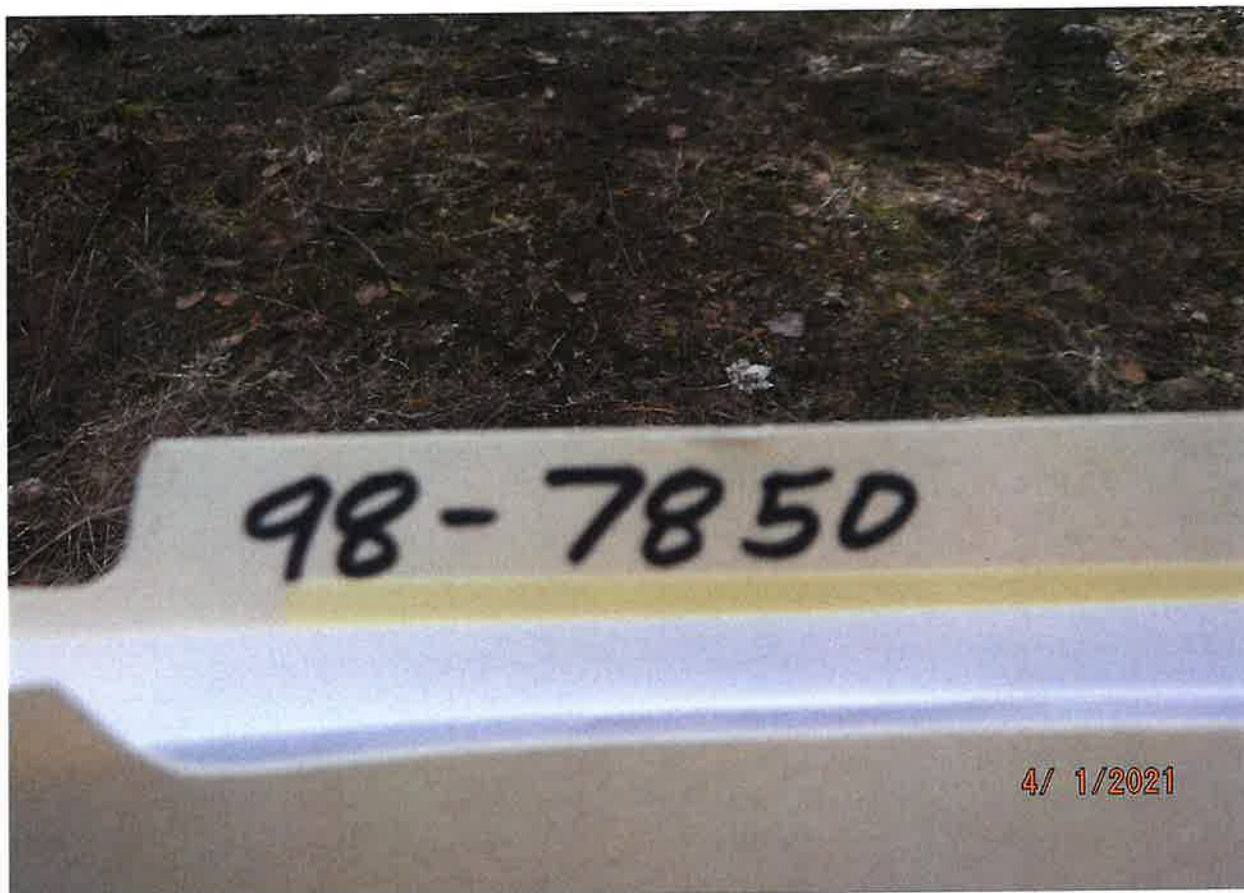
- Head Range: 50 to 500 feet
- Flow range: 3 to 30 gpm
- Max Power: 350 watts
- Voltage from 12 to 48 VDC



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



FOLLOW-UP FIELD EXAM DATE 4/1/2021



POD – SPRING



POD – SPRING BASIN



AT POD – 1 INCH BURIED SPRING BOX TO RUBBER & CONCRETE CISTERN



2 INCH POLY PIPE ROUTED FROM POD-TO-POWER HOUSE





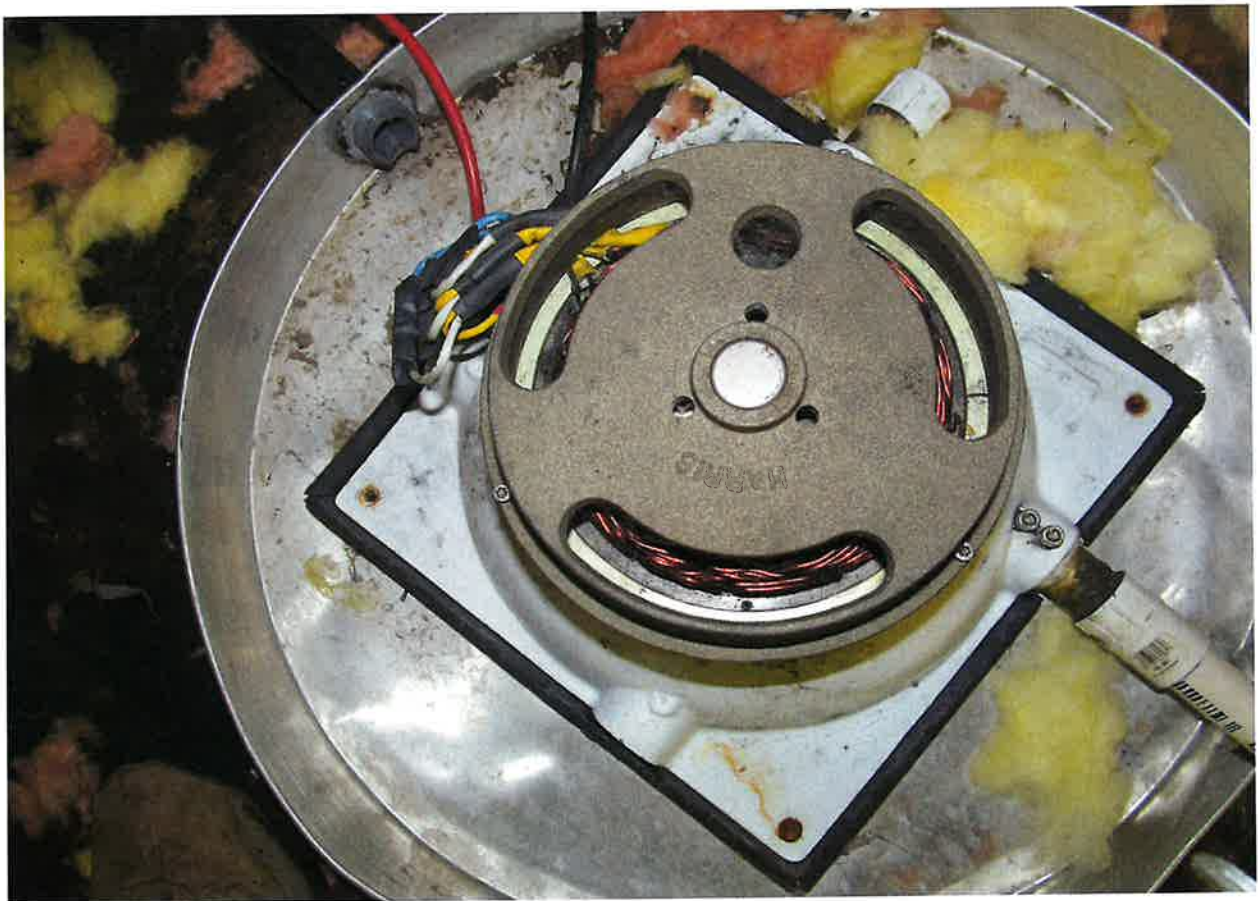
POWER HOUSE CONTAINING HARRIS HYDRO UNIT



OVERFLOW DISCHARGE FROM HARRIS HYDRO UNIT



POU - HYDRO POWER SYSTEM



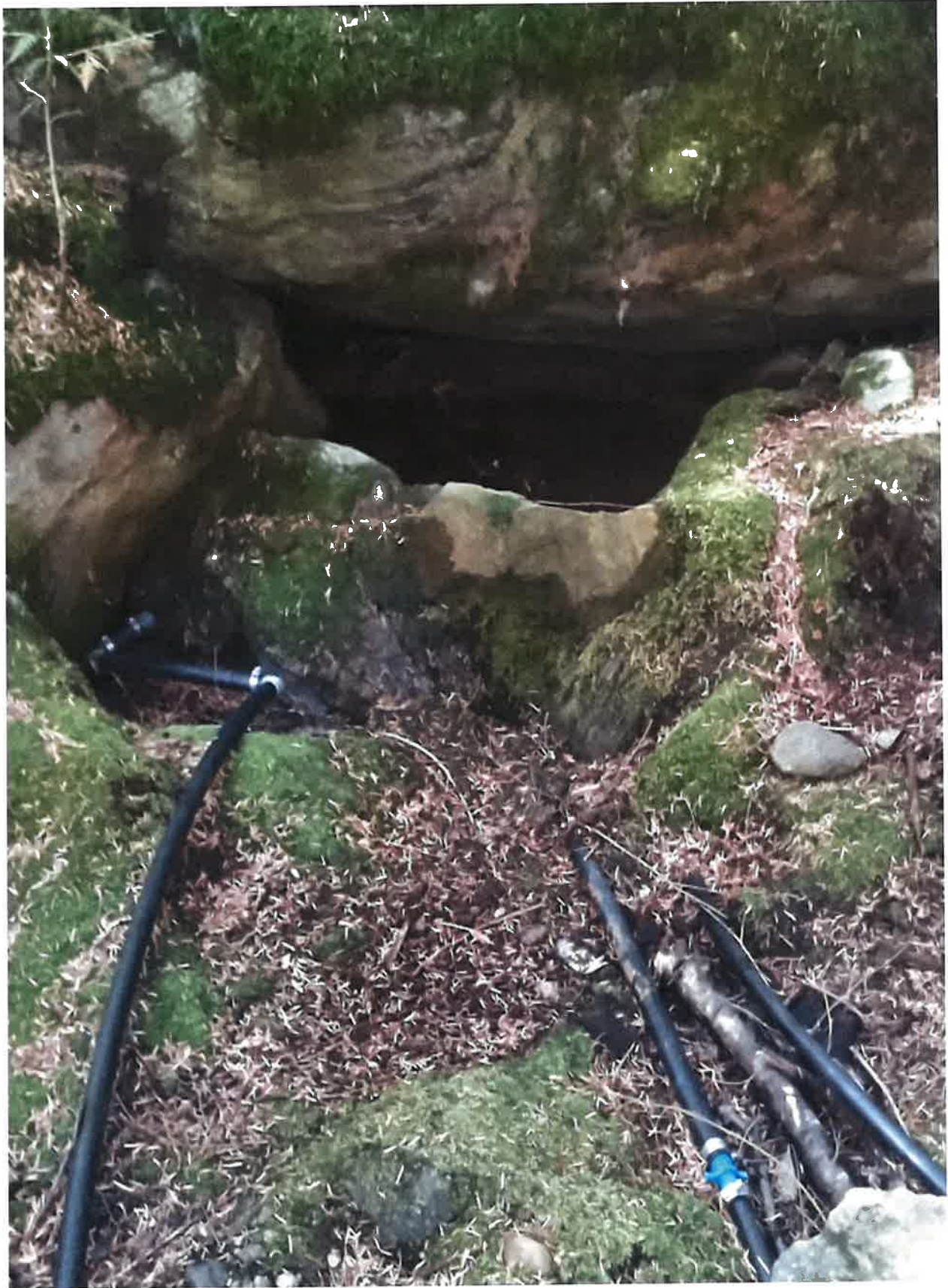
HARRIS HYDRO POWER PELTON WHEEL WITH SINGLE 5/16 HEAD



"T" IN POLY LINE ALLOWING FLOW INTO POWER STATION AND FLOW TO HOME FOR DOMESTIC USE



2 INCH POLY PIPE INFLOW TO HYDRO POWER STATION



2nd SPRING POD (SW¼SE¼NE¼, SEC 32)



- L/H PUMP - $\frac{3}{4}$ INCH POLY PIPE TO RAM PUMP FROM 2ND SPRING SOURCE – USED DURING HIGH SPRING PRODUCTIVITY PERIODS
- R/H PUMP- $\frac{1}{2}$ POLY PIPE TO RAM PUMP FROM 2ND SPRING SOURCE – USED DURING LOW SPRING PRODUCTIVITY PERIODS
- 1 INCH POLY PIPE SERVICE LINE FROM RAM PUMPS TO POU



DOMESTIC POU WITH SMALL GREEN HOUSE

