Spaghetti Hole Passive Treatment System
SRI O&M TAG Project #58 Request #1
OSM PTS ID: PA-64

Requesting Organization: Altoona Water Authority
Requesting Organization Representative: Amy Sipes
Municipality/County: Altoona, Blair County
Dates of work performed: 5/10/2019 to 7/11/2019

Initial Request: On 9/10/2018, the Altoona Water Authority (AWA) requested assistance to evaluate and make recommendations about properly maintaining the Spaghetti Hole passive treatment. They indicated that a portion of the water was bypassing the system. The evaluation and recommendations were to be conducted in conjunction with Saint Francis University staff and students.

Observations and Identified Needs: Water quality passing through the Successive Alkalinity Producing System (SAP) (aka Vertical Flow Pond (VFP)) outlet was good. The inlet to the SAP was eroded but stable, likely due to ATV activity. All stop logs for the SAP outlet were in place. It appeared that the SAP outlet weir had been reconfigured and the staff gauge had not been adjusted to the new weir height. Access road repair including erosion control is an ongoing maintenance need at this site as the road is very long. Overflow from the SAP bypassing treatment was the primary water quality related concern.

Work Completed: SAP stop logs were removed from the Agri Drain box to determine if adjusting head pressure would allow an increased amount of flow to pass through the SAP. After two days, there was no longer an overflow at the treatment system bypass. To further assess the media, test pits were dug in four locations throughout the pond. Most of the organic media appeared to be in good condition. Much of the limestone was clean enough to have void space, with only a few places close to appearing impermeable due to iron and aluminum precipitates. The tests pits were filled and some of the stop logs were re-installed to allow water to fill the pond.

Current Recommendations: Confirm the elevation of the staff gauge at the SAP outlet is adjusted to the proper elevation relative to the new weir height for flow measurements. Continue to monitor the SAP water level to determine the proper amount of stop logs required to maintain water levels on top of the media but not bypassing the SAP overflow pipe. Based on available data, even when the current system is net alkaline, aluminum solids are usually present at the system effluent.

Future Considerations: When the stop logs in the Agri Drain box are configured to direct flow through the SAP treatment media, the overall water chemistry is typically alkaline with low iron and aluminum concentrations. The system effluent chemistry (Point SHSEDOUT) indicates that the system can neutralize all the acidity (e.g., the effluent typically has a circumneutral pH and negative acidity) but has difficulty settling sufficient aluminum solids to consistently result in concentrations below 1 mg/L. This system was constructed in 2002 and for a system of this age, typically alkaline effluent is a noteworthy success. However, the test pits did document that plugging of the limestone layer with aluminum (whitish) solids is occurring to a degree. In order to provide the most cost-effective enhancement of the existing system, a proposed conceptual design has been developed to rehabilitate the system using the existing components in their current configuration with improvements that will continue to neutralize acidity and precipitate aluminum while providing enhanced solids removal. The improvements discussed below are noted on the Conceptual Design prepared as part of this report.

The sedimentation pond is relatively small and is essentially filled with sediment and vegetation. To provide additional settling capacity, it is recommended that the pond be cleaned to restore at least the original water volume and if no liner is present and soil conditions indicate that leakage would not be anticipated, the bottom should be excavated to provide additional solids storage volume. In order to help increase settling effectiveness, two floating widowed baffle curtains should be installed. Material removed from the sedimentation pond will be placed in the proposed dewatering basin.

The existing SAP pond has a compost layer approximately one foot to two feet thick with overlying sediment. The purpose of a compost layer in a SAP of this vintage is to cause ferric iron (Fe^{+3}) to be reduced to the ferrous form (Fe^{+2}) to keep iron from precipitating within the underlying limestone layer. Since 2016, the average total iron concentration in the raw (influent) water has been less than 1 mg/L which does not justify the presence of organic material. The test pits excavated in 2019 show a notable accumulation of aluminum solids in the limestone, which is not unexpected as the presence of organic material does not prevent the precipitation of aluminum solids. It is recommended that the compost be removed and placed as a soil amendment in the area around the treatment system and that the first 1-2 feet of limestone be washed to remove as much of the aluminum solids as feasible. The underdrain piping is PVC and, if exposed, would likely be broken and need significant repairs. Several temporary wash basins could be constructed within the SAP to facilitate cleaning of the limestone that appears to be AASHTO #3 size aggregate. Care should be taken during the washing process to capture the precipitate in the wash basins and transfer the material into the dewatering basin as possible and avoid concentrating the material in the lower portion of the limestone and around the underdrain pipes. The cleaned limestone would be placed back into the SAP and leveled. The limestone cleaning is expected to remove the majority of metal precipitates but some metal solids would remain. Geochemical modeling using PHREEQ-n-AMDTreat beta v6.0 indicate the presence of metal solids enhances metal removal through sorption. Any underdrain pipes that may be damaged during limestone cleaning should be repaired using flexible rubber couplers and pipe of similar size and type. Over time it is expected that the solids formed by the proposed automatic flushing limestone-only vertical flow pond upstream of the SAP pond will clog the limestone in the SAP and that the SAP will function primarily as a settling pond. The size of the existing SAP pond is conducive for this purpose it will provide over four times the settling capacity as the existing sedimentation pond. The existing SAP pond emergency spillway would then function as a primary spillway.

Raw mine drainage entering the stabilization pond has moderate acidity (69 mg/L average) and aluminum (8 mg/L) with iron and manganese typically less than 1 mg/L and 4 mg/L, respectively. As there is typically no appreciable change in chemistry from the influent (Point SHRAW/STB) to the outlet of the stabilization pond (Point SHSTB/STB), and there is not a flow control device or sufficient volume to stabilize flow rate, it is proposed to reconfigure the initial treatment component, Stabilization Pond, to function as an automatic-flushing vertical flow pond (AFVFP). This will require minimal excavation as the elevation and size of current stabilization pond is conducive for gravity flushing to the SAP pond. Installing an AFVFP upstream of the SAP pond will result in accumulation of aluminum solids on top of the SAP limestone, however, the limestone layer will help to filter solids and allow equipment access for future maintenance activities. With limited excavation and grading, the existing stabilization pond should be able to accommodate approximately 4,000 tons of limestone. This would enhance system performance and extend the projected system life over 20 years.

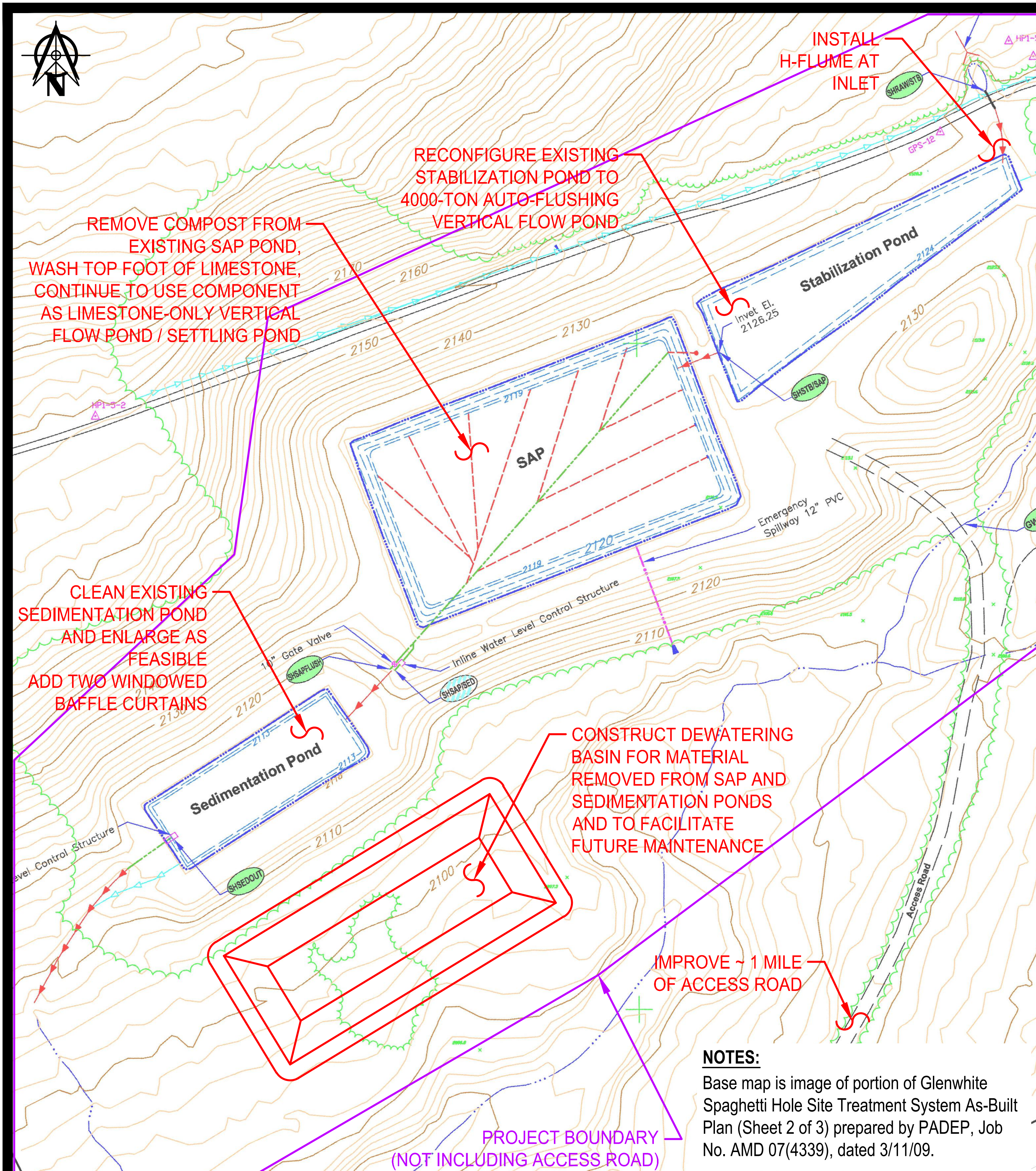
The proposed maintenance activities will result in excess material. As noted above, organic material may be spread around the treatment system as a soil amendment. Other material removed from the existing treatment components will be placed in a newly constructed dewatering basin that will have sufficient capacity to facilitate the proposed improvements as well as future maintenance work. Flow measurements taken downstream of the proposed AFVFP will not accurately represent the actual inflow rate, therefore a H-flume is proposed at the inlet of the treatment system. The access road is about one mile long and needs significant drainage improvements, grading, and surfacing. There are other passive treatment systems located between the Spaghetti Hole system and the public road that will benefit from improving the existing access road. The existing system is over 20 years old (constructed in 2002), therefore, the proposed improvements are recommended to be implemented in the near future to avoid a degradation of effluent water quality.

Attachments: Conceptual Design Site Plan, Site Overview Photo, AMDTreat Cost Calculations.

Photo Log

Top Left: Water level of the SAP dropped after lowering the stop logs.
Top Right: Stop logs removed from SAP outlet to lower the water level in the SAP pond.
Bottom Left: Much of the limestone was observed to still have void space, with only a few places appearing to be impermeable due to Fe and Al precipitates.
Bottom Right: The staff gauge was improperly set for the new weir elevation at the SAP outlet.

Top Left: 10” PVC valve requires valve tool to open (standard 2” handle).
Top Right: Top of limestone layer with compost removed shows aluminum precipitates.
Bottom Left: Test pits revealed a 1” = 8” layer of precipitates overlaying 1.0’ – 1.5’ layer of compost with relatively clean limestone for a 20-year-old system.
Bottom Right: Close up of limestone layer with aluminum precipitates below compost layer.



NOTES:

Base map is image of portion of Glenwhite Spaghetti Hole Site Treatment System As-Built Plan (Sheet 2 of 3) prepared by PADEP, Job No. AMD 07(4339), dated 3/11/09.

mining & reclamation services
434 SPRING STREET EXT.
MARS, PA 16046
www.biomost.com

SCALE: 1" = 100'

0 50' 100'

CONCEPTUAL DESIGN

DATE: Dec. 2022

SPAGHETTI HOLE

SITE PLAN

Logan Township — Blair County

DRAWING NUMBER: 1 of 1

NOTES:

2018 PEMA aerial photograph obtained from www.pasda.psu.edu

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SCALE: 1" = 100'

0 50' 100'

CONCEPTUAL DESIGN

DATE: Dec. 2022

SPAGHETTI HOLE

AERIAL MAP

Logan Township

Blair County

DRAWING NUMBER: 1 of 1

Printed on 01/19/2023

Company Name Stream Restoration Inc.

Project O&M TAG

Site Name Spaghetti Hole

AMD TREAT

AMD TREAT MAIN COST FORM

Costs

Passive Treatment	A	S	
Vertical Flow Pond			$0
Anoxic Limestone Drain			$0
Anaerobic Wetlands			$0
Aerobic Wetlands			$0
Manganese Removal Bed			$0
Oxic Limestone Channel			$0
Limestone Bed	1	0	$264,400
BIO Reactor			$0
Passive Subtotal:			**$264,400**
Active Treatment			
Caustic Soda			$0
Hydrated Lime			$0
Pebble Quick Lime			$0
Ammonia			$0
Oxidants			$0
Soda Ash			$0
Active Subtotal:			**$0**
Ancillary Cost			
Ponds	1	0	$58,235
Roads	1	0	$39,583
Land Access			$0
Ditching			$0
Engineering Cost	1	0	$99,644
Ancillary Subtotal:			**$197,462**
Other Cost (Capital Cost)			$136,000
Total Capital Cost:			**$597,862**
Annual Costs			
Sampling			$0
Labor			$0
Maintenance			$0
Pumping			$0
Chemical Cost			$0
Oxidant Chem Cost			$0
Sludge Removal			$0
Other Cost (Annual Cost)			$0
Land Access (Annual Cost)			$0
Total Annual Cost:			**$0**
Other Cost	1	0	

Water Quality

Design Flow	500.00	gpm
Typical Flow	122.30	gpm
Total Iron	0.70	mg/L
Ferrous Iron	0.20	mg/L
Aluminum	7.50	mg/L
Manganese	3.30	mg/L
pH	3.80	su
Alkalinity	0.40	mg/L
TIC	1.20	mg/L

- ○ Calculate Net Acidity
- ● Enter Hot Acidity manually

Acidity 68.60 mg/L

Sulfate	495.40	mg/L
Chloride	0.00	mg/L
Calcium	0.00	mg/L
Magnesium	0.00	mg/L
Sodium	0.00	mg/L
Water Temperature	10.00	C
Specific Conductivity	0.00	uS/cm
Total Dissolved Solids	0.00	mg/L
Dissolved Oxygen	0.01	mg/L
Typical Acid Loading	18.3	tons/yr

Total Annual Cost: per 1000 Gal of H2O Treated **$0.000**

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COMMENTS:

Raw water characteristics are based on monitoring 1/11/2016 through 10/12/2021 downloaded from www.datashed.org (accessed December 2022).

Chemistry is raw (Point SHRAW/STB) n=18

Flow measured at SAP (Point SHSAP/SED) n=14

Typical flow = Average

Design flow = Maximum

9.9 inch pipe used for AFVFP for 12 inch pipe.

Access road improvements representative, some areas will need more grading and/or aggregate than others.

Engineering Costs set at 20% (10% design, 6% permitting, 4% construction oversight)

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AMD TREAT
LIMESTONE BED (LSB)

AMDTREAT

Limestone Bed Name: Convert Stabilization Pond to AFVFP

☐ **Opening Screen Water Parameters**

Influent Water Parameters that Affect LSB

Calculated Acidity	56.93	mg/L
Alkalinity	0.40	mg/L

- ○ Calculate Net Acidity (Acid-Alkalinity)
- ◉ Enter Net Acidity manually

Net Acidity (Hot Acidity)	68.60	mg/L
Design Flow	500.00	gpm
Typical Flow	122.30	gpm
Total Iron	0.70	mg/L
Aluminum	7.50	mg/L
Manganese	3.30	mg/L

Record Number
1 of 1

SIZING METHODS Select One

1. Tons of Limestone Needed	2,943	LSB Based on Acidity Neutralization
2. Tons of Limestone Needed	7,035	○ LSB Based on Retention Time
3. Tons of Limestone Needed	11,386	○ LSB Based on Alkalinity Generation Rate
4. Tons of Limestone Needed	4,000	◉ LSB Based on Tons Limestone Entered
5. Tons of Limestone Needed	1,297	○ LSB Based on Dimensions

6. Retention Time		hours
7. Alkalinity Generation Rate		g/m2/day
8. Limestone Needed	4,000	tons
9. Length at Top of Freeboard		ft
10. Width at Top of Freeboard		ft

11. % Void Space of LS. Bed	43.00	%
12. System Life		years
13. Limestone Purity	85.00	%
14. Limestone Efficiency		%
15. Density of Loose Limestone	94.30	lbs/ft3
16. Limestone Unit Cost	40.00	$/ton
17. LS Placement Unit Cost	5.00	$/yd3
18. Slope of Pond Sides (Run of Slope : Rise of Slope)	2.0 : 1	
19. Freeboard Depth	3.00	ft
20. Free Standing Water Depth	2.0	ft
24. Limestone Depth	3.0	ft
25. Excavation Unit Cost	10.00	$/yd3
23. Siphon System Cost	18000.0	$

Liner Cost

- ○ No Liner
- ○ Clay Liner

11. Clay Liner Unit Cost		$/yd3
12. Thickness of Clay Liner		ft

- ○ Synthetic Liner

13. Synthetic Liner Unit Cost		$/yd2

☐ 29. Clearing and Grubbing?

○ 30a. Land Multiplier		ratio
○ 30b. Clear/Grub Acres		acres
31. Clear and Grub Unit Cost		$/acre
32. Nbr. of Valves	0	nbr
33. Unit Cost of Valves	3500.00	$ ea.

○ AMDTreat Piping Costs

34. Total Length of Effluent / Influent Pipe		ft
35. Pipe Install Rate		ft/hr
36. Labor Rate		$/hr
37. Segment Len. of Trunk Pipe		ft/pipe seg.
38. Trunk Pipe Cost		$/ft
39. Trunk Coupler Cost		$/coupler
40. Spur Cost		$/ft
41. Spur Coupler Cost		$/spur
42. "T" Connector Cost		$/T coupler
43. Segment Len. of Spur Pipe		ft/pipe seg.
44. Spur Pipe Spacing		ft

○ Custom Piping Costs

	Length (ft)	Diameter (in)	Unit Cost ($)
45. Pipe #1			
46. Pipe #2			
47. Pipe #3			

LSB Sizing Summaries

48. Length at Top of Freeboard	266.78	ft
49. Width at Top of Freeboard	143.39	ft
50. Freeboard Volume	3,982	yd3
51. Water Surface Area	33,477	ft2
52. Total Water Volume	2,366	yd3
54. Limestone Surface Area	30,451	ft2
55. Limestone Volume	3,142.06	yd3
56. Excavation Volume	5,508.9	yd3
57. Clear and Grub Area	0.0	acr.
58. Liner Area	5,535.0	ft2
59. Theoretical Retention Time	9.09	hrs

LSB Cost Summaries

60. Siphon System Cost	18,000	$
61. Limestone Cost	160,000	$
62. Limestone Placement Cost	15,710	$
63. Excavation Cost	55,090	$
64. Liner Cost	0	$
65. Clear and Grub Cost	0	$
66. Valve Cost	0	$
67. Pipe Cost	15,600	$
68. Total Cost	264,400	$

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Project O&M TAG

Site Name Spaghetti Hole

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AMDTREAT

AMD TREAT

PONDS

Pond Name: Dewatering Basin

Opening Screen Water Parameters

Influent Water Parameters that Affect Ponds

Calculated Acidity	56.93	mg/L
Alkalinity	0.40	mg/L

- ○ Calculate Net Acidity (Acid-Alkalinity)
- ◉ Enter Net Acidity manually

Net Acidity (Hot Acidity)	68.60	mg/L
Design Flow	500.00	gpm
Typical Flow	122.30	gpm
Total Iron	0.70	mg/L
Aluminum	7.50	mg/L
Manganese	3.30	mg/L

Record Number 1 of 1

Pond Design Based On:

○ Retention Time

1. Desired Retention Time		hours
3. Sludge Removal Frequency		times/year
4. Titration? ☐		
5. Sludge Rate		gal sludge/ gal H2O
6. Percent Solids		%
7.Sludge Density		lbs./gal

◉ Pond Size

8. Pond Length at Top of Freeboard	235.000	ft
9. Pond Width at Top of Freeboard	96.000	ft
10. Slope Ratio of Pond Sides (Run : Rise)	2.0 : 1	
11. Freeboard Depth	2.0	ft
12. Water Depth	10.0	ft
13. Excavation Unit Cost	10.00	$/yd3
14. Total Length of Effluent / Influent Pipe	100.00	ft
15. Unit Cost of Pipe	25.00	$/ft

Liner Cost

- ◉ No Liner
- ○ Clay Liner

16. Clay Liner Unit Cost		$/yd3
17. Thickness of Clay Liner		ft

- ○ Synthetic Liner

18. Synthetic Liner Unit Cost		$/yd2

☑ 19. Clearing and Grubbing?

◉ 20. Land Multiplier	1.50	ratio
○ 21. Clear/Grub Acres		acres
22. Clear and Grub Unit Cost	3000.00	$/acre

23. Revegetation Cost	3000.00	$/acre
24. Cost of Baffles	0	$

Calculated Pond Dimensions per Pond

25. Length at Top of Freeboard	235	ft
26. Width at Top of Freeboard	96	ft
27. Freeboard Volume	6,837	yd3
28. Water Volume	5,262	yd3
29. Estimated Annual Sludge	0	yd3/yr
30. Volume of Sludge per Removal	0	yd3/ removal
31. Excavation Volume	3.26	acre ft
32. Excavation Volume	5,262	yd3
33. Clear and Grub Area	0.77	acres
34. Liner Area	0	yd2
35. Calculated Retention Time	35	hours

Ponds Sub-Totals per Pond

36. Excavation Cost	52,627	$
37. Pipe Cost	2,500	$
38. Liner Cost	0	$
39. Clearing and Grubbing Cost	2,330	$
40. Revegetation Cost	776	$
41. Baffle Cost	0	$
42. Estimated Cost	58,235	$

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Site Name Spaghetti Hole

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AMD TREAT

ROADS

Road Name: Access Road Improvements

1. Road Length	5300	ft
2. Road Width	12	ft
3. Road Depth	0.33	ft
4. Aggregate Unit Cost	35.00	$/yd3
5. GeoTextile Length	0	ft
6. GeoTextile Unit Cost	0.00	$/yd2
7. Length of Silt Fence	500	ft
8. Unit Cost of Silt Fence	3.00	$/ft
☐ 9. Surveying?		
10. Survey Rate		acres/day
11. Survey Unit Cost		$/day
☐ 12. Clearing and Grubbing?		
13. Clear and Grub Cost		$/acre

Record Number 1 of 1

14. Reveg Unit Cost	3000.00	$/acre
15. Culvert Unit Cost	50.00	$/ft
16. Culvert Length	200	ft

Roads Sub-Totals

17. Road Surface Cost	27,207	$
18. GeoTextile Cost	0	$
19. Silt Fence Cost	1,500	$
20. Culvert Cost	10,000	$
21. Revegetation Cost	876	$
22. Survey Cost	0	$
23. Clear and Grub Cost	0	$
24. Total Cost	39,583	$

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AMDTREAT

AMD TREAT

ENGINEERING COST

1. Capital Cost *	498,218	$
(•) 2. Per Cent of Capital Cost	20.00	%
( ) 3. Actual Engineering Cost		$
4. Total Engineering Cost	99,644	$

*** Total Capital Cost minus Engineering and Land Access Capital Cost**

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Company Name Stream Restoration Inc.

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Site Name Spaghetti Hole

AMD TREAT

OTHER COST

AMDTREAT

Oher Cost Name Spaghetti Hole Improvements

	A. Description of Item	B. Unit Cost Per Item	C. Quantity	D. Total Item Cost	E. Capital Cost Annual Cost
1.	Clean sediment pond (CY)	10.00	1000	10,000	(•) Capital Cost ( ) Annual Cost
2.	Excavate sediment pond (CY)	10.00	800	8,000	(•) Capital Cost ( ) Annual Cost
3.	Remove SAP sediment (CY)	10.00	1000	10,000	(•) Capital Cost ( ) Annual Cost
4.	Remove SAP compost (CY)	10.00	2000	20,000	(•) Capital Cost ( ) Annual Cost
5.	Clean SAP Limestone (T)	8.00	3500	28,000	(•) Capital Cost ( ) Annual Cost
6.	Inlet flume with approach (EA)	1.00	7000	7,000	(•) Capital Cost ( ) Annual Cost
7.	Misc pipe and materials (JOB)	1.00	10000	10,000	(•) Capital Cost ( ) Annual Cost
8.	Mob/Demob (JOB)	20,000.00	1	20,000	(•) Capital Cost ( ) Annual Cost
9.	E&S Controls (JOB)	23,000.00	1	23,000	(•) Capital Cost ( ) Annual Cost
10.		0.00	0	0	(•) Capital Cost ( ) Annual Cost
11.		0.00	0	0	(•) Capital Cost ( ) Annual Cost
12.		0.00	0	0	(•) Capital Cost ( ) Annual Cost
13.		0.00	0	0	(•) Capital Cost ( ) Annual Cost
14.		0.00	0	0	(•) Capital Cost ( ) Annual Cost
15.		0.00	0	0	(•) Capital Cost ( ) Annual Cost

Record Number
1 of 1

Curent Capital Cost 136,000 $
Current Annual Cost 0 $

Total Capital Cost 136,000 $
Total Annual Cost 0 $