PROJECT TITLE: Little Cottonwood Creek Limestone Channel & Erosion Control for Zinc Reduction

LEAD PROJECT SPONSOR/SUBGRANTEE:
Wasatch Legacy Project (WLP)

Represented by:
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The Wasatch Legacy Project (WLP) leverages private and public support to undertake creative and effective actions that conserve and sustain critical resources, create resilient ecosystems, and enrich the quality of life for the region, its residents, businesses, and canyon visitors.

STATE CONTACT PERSON:
Hilary Arens, Utah Division of Water Quality
Phone: (801) 536-4332 Fax: (801) 536-4301

STATE: Utah **WATERSHED:** Upper Little Cottonwood Creek
HYDROLOGIC UNIT CODE: Little Cottonwood UT16020204-022

PROJECT TYPES	WATERBODY TYPES	NPS CATEGORY
[ ]Staffing & Support	[ ] Groundwater	[ ] Agriculture
[X] Watershed	[ ] Lakes/Reservoirs	[ ] Urban Runoff
[ ]Groundwater	[X] Rivers	[ ] Silviculture
[ ] I&E	[X] Streams	[ ] Construction
	[ ] Other	[X] Resource

PROJECT LOCATION: The project location was in an area referred to as the Phone Lot north of (above) the Goldminer's Daughter Parking Lot in the Town of Alta. This area is owned by Alta Ski Area. The actual location of the site is approximately 40°35'22.41"N and 111°38'30.04"W.

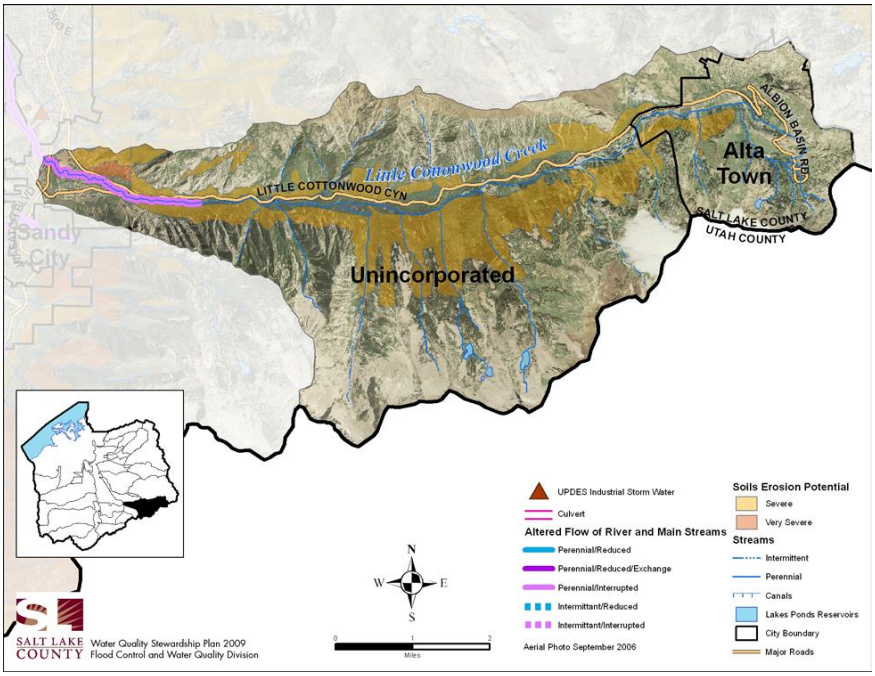

Figure 1: Upper Little Cottonwood Creek Watershed.

1.0 EXECUTIVE SUMMARY

In 2000, Little Cottonwood Creek was placed on the Utah State 303(d) list of impaired waters for high levels of Zinc in the upper reaches and TDS in the lower reaches. A TMDL study was completed in 2002. The Utah Division of Water Quality has classified Little Cottonwood Creek as a Class 3A beneficial use which states the creek is protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain. The TMDL study reported that dissolved zinc concentrations exceeded the water quality criteria established for this classification and beneficial use. Toxic levels of Zinc cause adverse changes in the morphology and physiology of fish and can adversely impact macro-invertebrate populations in a stream. This grant provided financial aid to implement three identified goals for reducing the Zinc loading and meeting the water quality standard and beneficial uses for Little Cottonwood Creek.

In 2013, on behalf of the Wasatch Watershed Project, Friends of Alta, a local land trust applied for and then administered this EPA 319 non-point source grant through the State of Utah Department of Environmental Quality. Over the course of nearly two years (8/28/2013 – 10/31/2014), $24,806 in grant funds were matched with $32,542.42 in cash and in-kind donations from stakeholders; additionally $20,886.78 was contributed from the US Forest Service and Cottonwood Canyons Foundation for a total project budget of $78,235.20. These funds were used to accomplish the following 3 goals: 1) construct two channels to isolate the Howland flow from surface runoff so that the Howland Tunnel water could be treated 2) study the use of limestone and Sodium Hydroxide as potential treatments to reduce Zinc in the creek and 3) continue on-the-ground sampling for determination of successful Zinc removal in Little Cottonwood Creek. The construction of the two channels was completed by Alta Ski Area in 2013. Salt Lake County Service Area 3 managed the operation of the treatment site and conducted the water sampling, reporting results back to the working group of stakeholders. Both Sodium Hydroxide and limestone are common agents used to remove heavy metals from water. Also known as caustic soda, Sodium Hydroxide is used commercially in the manufacturing of pulp and paper, drinking water, antacids, soaps and detergents. Limestone occurs naturally in the environment and has the advantage of abundance, but was not found to be as effective as Sodium Hydroxide.

2.0 BACKGROUND

Little Cottonwood Creek and the project site are located in the Uinta-Wasatch-Cache (UWC) National Forest. With 2.1 million acres of canyons, alpine peaks and streams, the UWC is vitally important to the ecology, sustainability, and economy of the region. The UWC is Salt Lake City's "backyard" forest, attracting millions of recreational visits annually and supplying 60 percent of Salt Lake City's drinking water. In addition to drinking water, the over 1,000 miles of perennial streams and rivers in the Wasatch Range provide critical habitat to fish and other aquatic life.

The 2002 TMDL identified two significant sources of Zinc loading to Little Cottonwood Creek, the Howland Tunnel and the Wasatch Drain Tunnel. Both the Howland Tunnel and the Wasatch Drain Tunnels drain a large network of mine tunnels in the Little Cottonwood Mining District. Prior to the 2002 TMDL, Salt Lake County applied for EPA 319 Project Funding to construct the Alta Fen Project. The goal of the Alta Fen Project was to improve water quality by constructing an engineered fen to precipitate and filter out metal loads from abandoned mines in the headwaters region of the sub-basin before the water entered Little Cottonwood Creek. However, a small landslide in the spring of 2010 temporarily blocked the outflow from the Howland Tunnel, when it began flowing again it had been directed away from the fen site. The Alta Fen Project operated from 1997 to 2002, and was removed in 2012.

In the spring of 2010 a landslide occurred in the Cardiff, Toledo Bowl area of Alta, caused by a heavy snowpack and high spring temperatures. The unusually fast melt overloaded the hillside and a large landslide started above the Phone Lot, burying the culvert mouth of the surface runoff culvert crossing the Phone Lot, threatening to wash out the road. It also buried and crushed the culvert at the mouth of the Howland Tunnel. A new culvert was promptly installed across the highway to stop the flooding. After the landslide the stakeholder group (as defined in Section 5.0) started to design a channeling system for the water to cross the Phone Lot to allow for a permanent repair of the culvert.

As required by 26-11-6 of the Utah Code Annotated 1953, Utah State waters are classed to protect against controllable pollution. Little Cottonwood Creek has been identified as a "High Priority" watershed, 303(d) list Unified Assessment Category IA (July 2013 QAPP Table 1). A TMDL was written and finalized in 2002. Please see "Attachment 1: Analysis of Zinc Impairment in Little Cottonwood Canyon" for details on the water quality issues related to this project.

The Utah Division of Water Quality has classified Little Cottonwood Creek as a Class 3A beneficial use which states the creek is protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.

Table 1: Beneficial Use Classifications

3A - Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
3B - Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
3C - Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.
3D - protected for waterfowl, shore birds and other water oriented wildlife including the necessary aquatic organisms in their food chain.

3.0 GOALS

Goal #1: Alta Ski Area contracted with Brown and Caldwell for an engineering design to construct two channels to isolate the Howland Tunnel stream from surface runoff.

> **Status:** Engineering design was successfully completed by Brown and Caldwell and lead to Alta Ski Area construction work that separated the surface water from the Howland Tunnel stream; this work was beneficial and necessary to treat the impaired water from the Howland Tunnel.

Goal #2: Implement a small scale pilot test to construct a limestone channel and Sodium Hydroxide pH adjustment capable of removing adequate Zinc from the Howland Tunnel stream and provide design testing of the project for larger scale future construction.

> **Status:** Service Area #3 constructed a scalable lined pond on the Howland Tunnel stream with 2 treatment trains to test the two treatments. The information derived from the pilot testing proved critical in developing the technical memo by Brown and Caldwell which has provided quantifies the full scale plant.

Goal #3: Continuation of on-the-ground sampling for determination of successful Zinc removal in Little Cottonwood Creek.

> **Status:** Service Area #3 completed and monitored the pilot plant for 366 days. On the ground sampling was conducted for 13 months and the data was compiled to prove that the Sodium Hydroxide treatment was more effective at reducing the Zinc. Additionally, these results were confirmed through the Brown and Caldwell technical memo (attached) which was completed in August 2013 with data from the pilot plant. The funding for this technical memo was the result of a grant from Tiffany and Company Foundation to the National Forest Foundation. National Forest Foundation became involved with the stakeholder group through the WLP, their goal is to help the group secure funding for a full scale treatment plant to reduce the Zinc loading in Little Cottonwood Creek.

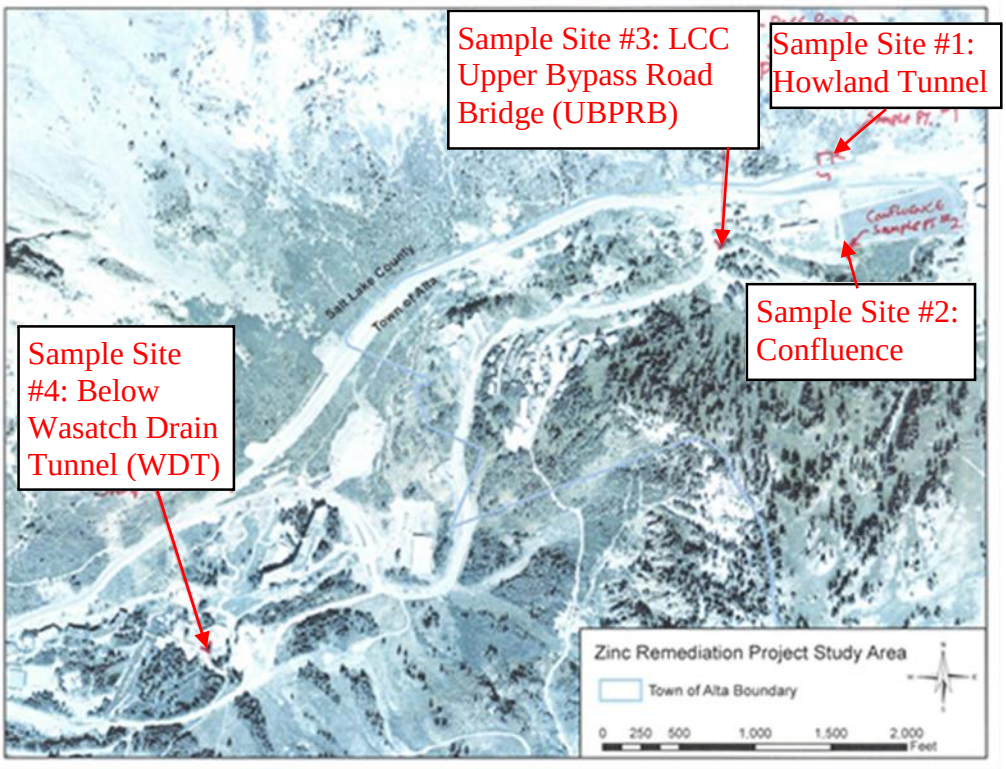

Figure 2: Sample Sites

Goal #4: Provide administrative services to project sponsors.

Status: The work of Friends of Alta and Service Area #3 has provided a forum for the stakeholder group to meet and review the project, provide input and help move the project to full scale.

4.0 ACTIVITIES

Goal #1

Task 1 – Final design for Goal #1 and construct the two channels after the 2013 surface run off season has ceased.

Summary: Final design for Goal #1 was completed by Brown and Caldwell and the construction of the two channels was completed by the Alta Ski Area. A concrete intake structure and 60" concrete pipe was installed to handle the surface runoff flows. A diversion berm was constructed to prevent surface runoff water from co-mingling with the Howland Tunnel stream flow. The in-kind excavation work done by Alta Ski Area ended up being more than what was budgeted.

Actual funds used: $64,127.95 (budget $60,735.20, $15,437.60 from 319)

Goal #2

Task 2 – Construction and installation of a small scale pilot limestone contactor, and slow sand filter on the Howland Tunnel stream to include a temporary diversion structure, and poly drum limestone contactor and sand filter to treat 1-3 gpm from the Howland Tunnel stream. Operate the pilot through 2014.

Photo by Keith Hanson 10/31/2013

Summary: Service Area #3 and Alta Ski Area staff constructed a lined pond on the Howland Tunnel stream with a 3" parshal flume and an intake pipe into the pilot plant. Service Area #3 staff constructed two treatment trains (limestone and Sodium Hydroxide treatments) using borrowed materials from Snowbird, Alta Ski Area and Service Area #3 to construct the contactors and filters. The chemicals were provided through this NPS grant. The pilot was operated through October 2014.

Service Area #3 officially started the 2 treatment trains on October 21, 2013. They ran the pilot for 366 days. They actually had the limestone train running by itself on September 15, 2013. The limestone train has 2-55 gallon drums that are filled about ¾ full of crushed limestone. The raw water enters through a diffuser system in the bottom of the barrels. The water travels up through the first reaction barrel and is then piped to the bottom of the second reaction barrel where it in turn up flows through the limestone and discharges through the outlet pipe at the top of the barrel. Our target flow rate is 1 gpm. There is about 100 minutes of contact time in the limestone reactors. The reactor water then flows into the top of a third barrel that has 18" of sand in it where the water flows through the sand, is collected in the barrel underdrain system and flows through a rotometer set at 1 gpm into a sample bucket. The limestone train has run for 366 days and treated 357,950 gallons averaging 978 gallons per day or about 0.7 gpm. The raw water average 5.31 pH while the Limestone reactor average was 6.07 pH. According to the Service Area it became apparent very early in the study that the Limestone was not effective enough to raise the water pH high enough to precipitate out the Zinc. The crushed limestone became coated with what appeared to be iron deposits early in the process and only slightly raised the pH.

Task 3 – Install a pilot Sodium Hydroxide pH adjustment (active or mechanical treatment) contactor and slow sand filter on the Howland Tunnel stream with a temporary diversion structure and poly drum NaOH reactor and sand filter to treat 1-3 gpm from the Howland stream. Operate the pilot through 2014.

Summary: The pilot treatment train for the Sodium Hydroxide adjustment was essentially the same system as the limestone contactor (described above) but using Sodium Hydroxide instead of Limestone. Again, the chemicals were provided through this NPS grant. Upon review of lab analysis, the overall effectiveness of the limestone was not found to be as effective as the results of the Sodium Hydroxide pH adjustment in bringing the concentrations of Zinc below State regulations. The pilot was operated through October 2014.

With the train using the Sodium Hydroxide precipitation, our goal is to have a constant pH of just over 10 in the precipitation barrels. This raising of the pH creates a metal floc that essentially fills the precipitation barrels. The Sodium Hydroxide precipitation train is similar to the limestone contactor in that the raw water enters through a diffuser system in the bottom of the first barrel. A 25% solution of Sodium Hydroxide is dripped into the barrel near the bottom diffuser using a medical IV drip system. We use a stopwatch to time the drips so that we try to maintain pH 10+. The water travels up through the first precipitation barrel where and is then piped to the bottom of the second precipitation barrel where it in turn up flows through the barrel and discharges through the outlet pipe at the top of the barrel. The target flow rate is 1 gpm. There is about 100 minutes of contact time in the precipitation barrels. The reactor water then flows into the top of a third barrel that has 18" of sand in it where the water flows through the sand, is collected in the barrel underdrain system and flows through a rotometer set at 1 gpm into a sample bucket. The Sodium Hydroxide train has run for 366 days and treated 404,913 gallons averaging 1106 gallons per day or about 0.8 gpm. Raw water average ph = 5.31 Sodium Hydroxide precipitation average pH = 9.32.

Actual Funds Used for Goal #2 Task 2 & 3: $5,132.67 (budget $5,000.00, $2,800.00 from 319)

Goal #3

Task 4 – Monthly sampling of a total of 6 points, the 4 mentioned and the effluent from the two pilots. Sample for: Flow rate, pH, Conductivity, Alkalinity, Hardness, TDS, DO, Cu, Fe, Mn, Zn, Ca, and Mg.

Summary: Monthly samples were successfully taken for a 13 month period and analyzed by Chemtech Ford Laboratories.

Task 5 – Additional sampling: At pilot start up and pilot conclusion additional sampling of total and dissolved metals and sampling of precipitated sludge.

Summary: The sludge produced through the pilots was sampled for TCLP as well as metals concentration at the conclusion of the project. The Brown and Caldwell technical memo details the sludge quantities and provides guidance for full scale construction. The sludge passed the TCLP test and is considered a non-hazardous waste which can be disposed of locally, through EP Technologies. It is yet to be determined if it will be delivered as a solid or liquid, as there may be opportunities to evaporate off some of the liquid at the treatment site. Annual sampling of the sludge will take place for continued proper disposal.

Actual Funds Used for Goal #3 Task 4 & 5: $10,193.14 (Budget $10,000.00, $6,568.40 from 319)

Goal # 4

Task 5 - Track match **($1,000)**

Summary: On behalf of Wasatch Legacy Project, Friends of Alta document matching contributions, tracked project progress, coordinated team efforts, and provided Technical

Assistance. WWLP/FOA has prepared this annual progress evaluation report for the project and the Project Final Report according to separate contract with DWQ.

Actual Funds Used: $1,000 (Budget $1,000, $0 from 319)

Task 6 - Technical Assistance **($1,500)**

Summary: Salt Lake County Service Area #3 conducted sampling and transported samples to the lab as well as made operational adjustments based on sampling results.

Actual Funds Used: $1,500.00 (Budget $1,500, $0 from 319)

5.0 PARTNERS

Since the operation of the Alta Fen Project from 1997 -2002, and the TMDL study in 2002 the following group of stakeholders has been meeting and working collaboratively and as good Samaritans to reduce heavy metal loading from mining history in Little Cottonwood Creek: the Town of Alta, Salt Lake County Service Area #3, Salt Lake City, Salt Lake County, Alta Ski Area, Snowbird Ski and Summer Resort, Cottonwood Canyons Foundation, Friends of Alta, the U.S. Forest Service, the Utah Division of Water Quality.

The Wasatch Legacy Partnership (WLP), began in 2011 as a public-private partnership formed to enhance watershed conditions and sustainable outdoor recreation in the watersheds feeding the Salt Lake Valley by implementing projects that improve long-term watershed health. The WLP has a diverse membership made up of representatives from federal, state, county and municipal governments, nongovernmental organizations, and ski resorts which had added additional resources to the group of stakeholder which had been working on this project. WLP membership includes: the Town of Alta, Salt Lake City, Salt Lake County, Save Our Canyons, Alta Ski Area, Snowbird Ski and Summer Resort, Solitude Mountain Resort, Brighton Ski Resort, Cottonwood Canyons Foundation, Friends of Alta, the U.S. Forest Service, the Utah Department of Natural Resources, the Utah Division of Water Quality, the Wasatch Front Regional Council, Salt Lake Climbers Alliance, Wasatch Mountain Club, and Salt Lake County Parks and Recreation.

Table 2: Major NPS Project Partners and a Summary of their Contributions	
Alta Ski Area	Inkind labor and equipment as well as property access for the treatment site located on their property
Cottonwood Canyons Foundation	Financial support for the match and financial support that was not included in the match
Friends of Alta	Inkind services to administer this NPS grant as well as cash to cover expenses that went over budget
Salt Lake City Public Utilities	Technical support for pilot and full scale design
Salt Lake County Service Area 3	Construction, technical and operational inkind support
Salt Lake County Flood Control and Engineering	Technical support
Snowbird Ski and Summer Resort	Labor and material for pilot construction
U.S. Forest Service	Contributed financial support that was part of this grant but not included in the match

Table 3: 319 Grant Actuals by Agency	**Inkind Actual**	**Cash Actual**	**Total Actual**
319 Funds		$24,806.00	$24,806.00
Alta Ski Area	$27,803.57		$27,803.57

USFS	$235.40	$10,000.00	$10,235.40
Friends of Alta	$1,000.00	$325.81	$1,325.81
Service Area #3	$6,700.00		$6,700.00
Cottonwood Canyons Foundation		$11,082.98	$11,082.98
Total	**$35,738.97**	**$46,214.79**	**$81,953.76**

For documentation of matching funds and sources see the Finances 9.0.

6.0 COMPLICATIONS

The winter is harsh at 8600' in the Wasatch Mountains. Service Area #3 tried to keep the pilot system running all winter with weekly visits. Occasionally during sampling, they would experience a system upset for any number of reasons including: freezing, a plugged drip line, or particles in a sample. The biggest challenge was attributed to project being at the pilot level – ie low flows and a small site. They enclosed the pilot plant to try and keep it from freezing. However, the sub-zero weather created problems in keeping the system flowing and twice during the winter the system froze but they were able to get it restarted. The winter storms and increasing snowpack were certainly a challenge. Keeping the pilot site accessible with 500" of snow meant for lots of shoveling and added plowing. Service Area #3 was only able to access the plant three times in December, three times in January and once in February. If something plugged up or the caustic ran out, etc., it could be more than a week or two before they could correct it. The snow was 15 feet deep at the entryway. This was one factor that could disrupt the data. Additionally, they did not filter the samples so sometimes floc like particles would flow into sample bottle, if these things happened, they would still sample but these results would sometimes reflect the upset and have thus been removed in the averaging process for that site. The freezing problem could be avoided through proper construction of the full scale plant with electricity to keep the system from freezing.

Sludge generation is also an issue we must still address. The floc created is light and is slow to settle. A 55 gallon sludge barrel will settle out to about 33% sludge and 66% clear water. Service Area #3 generated 345 gallons of sludge in treating 405,000 gallons of water. That is without settling and decanting the clear water off, so we believe that we can reduce the 345 to around 100. They have had limited success bench testing with Thatcher chemical's t-floc b-135 in a dilute state to help consolidate or thicken the sludge. They are also trying Sodium Bisulfite instead of Sodium Hydroxide to see if they can reduce the amount of sludge generated but it requires pH adjustment and does not work as well as we had hoped.

7.0 RECOMMENDATIONS

With the DEQ's lead with NPS program has kept stakeholders on track in reducing the Zinc loading and allowed the stakeholder to test different mediums. The stakeholder group learned that we can effectively work together and leverage individual expertise and resources. Through this NPS grant the stakeholder group has found a viable solution in Sodium Hydroxide. We have also learned more about what each stakeholder has to contribute such as technical expertise, financing, operations and maintenance support.

In addition to this grant, and through its partnership with the WLP, the National Forest Foundation (NFF) received a planning grant to finalize engineering and operation and maintenance plans for remediation based on the results of the work completed through this NPS grant. Funds were granted to draft a long-term agreement regarding roles and responsibilities to achieve improved water quality. The stakeholder group is still working on this effort.

The stakeholder group continues to working on the following goals: 1) to sufficiently continue reducing zinc in Little Cottonwood Creek to improve water quality and meet State of Utah water quality standards; 2) to help

Little Cottonwood Creek regain its Class 3A coldwater fishery status; and 3) to engage as many stakeholders as possible through the Wasatch Legacy Project (WLP). To achieve this we are working on the following tasks:

- Develop agreement/s that lay out long-term roles and responsibilities of the interested parties;
- Design the final engineered plan that will scale up the pilot tests to full-scale implementation;
- Implement Sodium Hydroxide treatments to reduce zinc in Little Cottonwood Creek;
- Ensure the Columbus Rexall Mine remediation is part of the "Wasatch Legacy Project" priorities
- Use this as a public education opportunity on successful remediation strategies.

8.0 ENVIRONMENTAL RESULTS

This NPS grant allowed for the testing of two treatments to reduce Zinc loading in Little Cottonwood Creek. The results and analysis of these tests indicate that Sodium Hydroxide is the preferred treatment in bringing the creek into compliance with State of Utah class 3A beneficial use which protects for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.

Table 4: LCC Zinc Results Processed by Chemtech Ford

	Site # 1			Site # 1: after limstone reactor	Site # 1: after limestone reactor and filter	Site #1: after Sodium Hydroxide reactor	Site #1: after Sodium Hydroxide reactor and filter	Site #2			Site #3			Site #4		
	zinc mg/L				zinc mg/L	zinc mg/L	zinc mg/L	zinc mg/L			zinc mg/L			zinc mg/L		
Date	Howland Tunnel / portal	hardness	pH	limestone reactor	limestone filter	Caustic reactor	Caustic filter	Confluence *	hardness	pH	UBPRB	hardness	pH	Below WDT	hardness	pH
10/31/2012	5.75	128	6	n/a	n/a	n/a	n/a	1.12	150	7.7	0.13	171	8.1	0.29	185	8.3
11/21/2012	5.22	117	6	n/a	n/a	n/a	n/a	4.39	112	6.7	0.13	161	8.2	0.25	173	8.3
12/12/2012	5.08	119	6	n/a	n/a	n/a	n/a	5.14	127	6.4	0.17	178	8.2	0.22	156	8.3
1/10/2013	6.27	147	6.1	n/a	n/a	n/a	n/a	5.13	130	6.6	0.13	178	8.1	0.19	164	8.2
2/19/2013	5.62			n/a	n/a	n/a	n/a				0.1			0.22		
3/21/2013	4.01			n/a	n/a	n/a	n/a				0.09			0.21		
4/15/2013	3.8			n/a	n/a	n/a	n/a				0.18			0.31		
5/21/2013	0.57			n/a	n/a	n/a	n/a	0.45			0.07			0.13		
6/18/2013	14			n/a	n/a	n/a	n/a	2.02			0.14			0.14		
7/17/2013	7.88			n/a	n/a	n/a	n/a	0.99			0.16			0.22		
8/20/2013	6.89			n/a	n/a	n/a	n/a							0.25		
PILOT																
9/20/2013	6.5			n/a	3.91	n/a	n/a									
10/16/2013	6.39			n/a	5.64	n/a	n/a				0.19			0.26		
10/24/2013	6.34			n/a	5.93		0.64									
11/18/2013	4.81			4.8	4.8	0.79	1.77							0.18		
12/12/2013	5.27			n/a	5.16	3.01	0.04							0.21		
1/21/2014	5.26			n/a	5.27	2.51	21.2									
2/18/2014	5.47				4.45	1.76	0.1							0.26		
3/5/2014	5.25					5.06	3.93									
3/18/2014	5.32	122			5.24	0.44	1.79							0.26	205	
4/1/2014	3.98	103	6.1		4.03	0.47	3.11							0.25	214	8.1
4/16/2014	2.74	75.7	6.1		2.15	5.61	0.02							0.24	224	8.1
5/20/2014	0.52	56	7		0.38	0.4	0.58				0.19	116	7.8	0.32	129	7.9
6/17/2014	11.5	110	3.5		14.2	1.15	0.65				0.15	98.6	7.8	0.17	103	7.9
7/17/2014	6.92	116	5.4		6.93	9.9	6.27				0.12	139	8	0.17	135	8.1
8/20/2014	4.16	102	5.2		4.26	0.1	0.46				0.09	146	7.9	0.14	140	8.1
9/17/2014	4.01	101	6		4.41	3.98	1.88				0.1	170	8.1	0.18	148	8.2
10/22/2014	3.69				3.27	0.97	0.43				0.09			0.14		
PILOT AVG	**5.18**	**98.2**	**5.61**		**4.39**	**1.41**	**1.18**				**0.12**	**134**	**7.9**	**0.21**	**162**	**8**

Spreadsheet Notes:

Results removed from average because outlyer readings due to particulate matter. occasionally we would have a system upset for any number of reasons; freezing, plugged drip line, particles in our sample(we did not filter the samples so sometimes floc like particles would flow into sample bottle) if these things happened, we would still sample but these results would sometimes reflect the upset so I removed them from the average.

* Service Area #3 Note: We they actually started the pilots, it made more sense to not sample at the confluence as the State identified the compliance point as the UBPRB

9.0 DELIVERABLES AND FINANCES

For the Budget vs. Actual – see Attachment 2

Table 5: Task	Deliverables	319/NPS Funding	Additional Funding	Total

Goal 1/Task 1 – Final engineering design and construction of the two channels	engineering design by Brown and Caldwell. construction of 2 channels and materials needed to preform such work, construction of a diversion berm.	$15,437.60	$48,690.35	$64,127.95
Goal 2/Task 2 – Construction and installation of a small scale pilot limestone contactor, and slow sand filter on the Howland Tunnel stream to include a temporary diversion structure, and poly drum limestone contactor and sand filter to treat 1-3 gpm from the Howland Tunnel stream.	construction of a treatment train to test a Limestone	$1,588.99	Service Area #3 Inkind $1,100 & FOA cash $132.67	$2,821.66
Goal 2/Task 3 – Install a pilot Sodium Hydroxide pH adjustment (active or mechanical treatment) contactor and slow sand filter on the Howland Tunnel stream with a temporary diversion structure and poly drum NaOH reactor and sand filter to treat 1-3 gpm from the Howland stream.	construction of a treatment train to test Sodium Hydroxide, which proved to be the favorable treatment for a full scale treatment plant	$1,211.01	$1,100.00	$2,311.01
Goal 3/Task 4 – Monthly sampling of a total of 6 points, the 4 mentioned and the effluent from the two pilots. Sample for: Flow rate, pH, Conductivity, Alkalinity, Hardness, TDS, DO, Cu, Fe, Mn, Zn, Ca, and Mg.	sampling results	$5,265.00	Service Area #3 Inkind $2,280	$7,545.00
Goal 3/Task 5 – Additional sampling: At pilot start up and pilot conclusion additional sampling of total and dissolved metals and sampling of precipitated sludge.	sampling results and TCLP sludge assessment	$1,735.00	Service Area #3 Inkind $720 & FOA cash $193.14	$2,648.14
Goal 4/Task 5 - Track match	FOA tracked matches and compiled this final report		$1,000.00	$1,000.00
Goal 4/Task 6 - Technical Assistance	Service Area #3 provided technical assistance and the pilot plant update		$1,500.00	$1,500.00
Total				**$81,953.76**

10.0 CONCLUSIONS

The Sodium Hydroxide is very effective at removing the zinc as well as other metal contaminants. Keeping the system operating with the proper pH is critical. Excursions below 9 pH cause upset to the floc process.

Service Area #3 began sampling in front of the sand filter on the caustic train because the water looks very clear when the pH is above 10. In an upset, when we do get carry over from the precipitation process, it tends to plug the sand off rapidly. I believe we do not want a sand filter in the future. Also occasionally the sample results are believed to be inaccurate because there were precipitated particle(s) in the sample. We have not yet tried a paper filter for the samples but plan to so that we are not skewing the data. When running in ideal circumstances, we remove nearly all the zinc.

During the test period, the precipitation process has lowered the Zinc from an average of 5.18 mg/L to 1.31 mg/L after the precipitation process and to 1.26 mg/L after the sand. The limestone only reduced it to an average of 4.49 mg/L.

At this point, Service Area #3 feels strongly that we can design and operate a 50 gpm precipitation process that is not too labor intensive and will greatly improve Little Cottonwood Creek water quality. Funding opportunities are actively being pursued by the partners (see section 5.0) with the intent of using the Brown and Caldwell Technical Memo (attachment #9) for construction guidelines.

Loading Reductions Predicted:

The predicted load reductions from the 50 GPM treatment facility will sufficiently meet the water quality standards for Little Cottonwood Creek.
Using the Zinc conversion factor from “Rule R317-2 Standards for Quality for Waters of the State" Table 2.14.3a, the conversion factor (CF) for Zinc is Cf * e^(0.8473(ln(hardness))+0.884) where CF = 0.986. To figure out, kg/day, the following equation was used: Kilograms/Day = Conc., mg/L × Flow, MGD × 3.785 lbs/MG/mg/L.

The average concentration from the Howland Tunnel Portal at 1 GPM pilot program from 9/20/2013 to 10/22/2014 was 5.18 mg/L which equals 0.03 kg/day. The average concentration from below the Sodium Hydroxide reactor and filter at 1 GPM pilot program from 9/20/2013 to 10/22/2014 was 1.18 mg/L which equals 0.01 kg/day, with a resultant actual loading reduction of 0.02 kg/day.

When we upscale the results from the pilot to 50 GPM being treated, the kg/day from the Howland Tunnel Portal is 1.41 kg/day and below the Sodium Hydroxide reactor is 0.32 kg/day. The results indicate a predicted loading reduction at 50 GPM of 1.09 kg/day.

The compliance point for Little Cottonwood Creek is Above Alta Bridge. At this point, the average hardness from 2002-2014 is 151.1mg/L, the average flow from 2002-2006 is 15 cfs, and the average Zinc concentration from 2002-2014 at is 0.146 mg/L (see Excel spreadsheet for details.) Using these averages, the estimated kg/day of Zinc at the compliance point is 5.35 kg/day. Assuming that 50 GPM is treated above the confluence, the predicted loading reduction is 1.09 kg/day (see above), resulting in a predicted instream loading of 4.26 kg/day. Using this instream loading, the predicted Zinc concentration in mg/L at 15 cfs with reduced load reduction would be 0.116 mg/L, or 116.2 ug/L. Using the conversion factor equation (above), the predicted dissolved Zinc concentration is 113.64 ug/L which is less than the dissolved Zinc standard at this location (using the averaged hardness of 151.1 mg/L) which is 147.06 ug/L. The Zinc Standard is greater than Zinc Dissolved (Predicted), so achievement of standard is predicted.

11.0 ATTACHMENTS

The following have been attached in this order:

1. Actual Budget
2. Update by Service Area #3, Keith Hanson - pilot project operator
3. Photos
4. Zinc Pilot Sheet with Data

5. LCC Zinc Results
6. Friends of Alta - 12/1/2014 Inkind Support Letter
7. Service Area #3 - 12/15/2014 Inkind Support Letter
8. Contract 141014 Reimbursement Requests: Includes Chemtech Ford Reports
9. Brown and Caldwell Technical Memo
10. Analysis of Zinc Impairment in Little Cottonwood Canyon, Dec 2012
11. QAPP, July 2013