

Final
FY2013/2015 Annual Sand Creek Stream Monitoring
Within
RVAAP-004-R-01 Open Demolition Area #2 MRS
For the Rocket Ridge Project
Letter Reports

(Ohio EPA ID# 267-000859-089)

October 7, 2015

Prepared for:



U.S. Army Corps of Engineers, Louisville District
600 Dr. Martin Luther King, Jr. Place
Louisville, KY 40202-2232

Prepared by:



295 S. Water St. #300
Kent, OH 44240

For:





NATIONAL GUARD BUREAU
111 SOUTH GEORGE MASON DRIVE
ARLINGTON VA 22204-1373

October 7, 2015

Ohio Environmental Protection Agency
DERR-NEDO
Attn: Mr. Drew Kocher
2110 East Aurora Road
Twinsburg, OH 44087-1924

Subject: Ravenna Army Ammunition Plant Restoration Program
Rocket Ridge (Sand Creek Stream Relocation) Project Summaries for 2013, 2014
and 2015
RVAAP-004-R-01 Open Demolition Area 2 MRS
Ohio EPA ID #267-000859-089
Camp Ravenna, Portage/Trumbull Counties, Ohio

Dear Mr. Kocher:

Enclosed for your records are the following Final project summaries for the Sand Creek relocation at the Rocket Ridge site at Camp Ravenna (RVAAP-004-R-01 Open Demolition Area 2 MRS, Ohio EPA ID#267-000859-089):

- *Rocket Ridge Project Summary – Sand Creek Stream Relocation, Ravenna, Portage County, Ohio*, prepared by Davey Resource Group and dated September 6, 2013.
- *Rocket Ridge Project Summary – Sand Creek Stream Relocation, Year 1 Monitoring, Camp Ravenna Joint Military Training Center, Paris Township, Portage County, Ohio*, prepared by Davey Resource Group and dated September 25, 2014.
- *Rocket Ridge Project Summary – Sand Creek Stream Relocation, Year 3 Monitoring, Camp Ravenna Joint Military Training Center, Paris Township, Portage County, Ohio*, prepared by Davey Resource Group and dated September 17, 2015.

These project summaries were required by the Ohio EPA to document the stream relocation project. The project has been completed as required and is considered closed. The enclosed documents are being provided to you for your records and do not require Ohio EPA review.



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Please contact the undersigned at (703) 607-7955 or Mark.S.Leeper.civ@mail.mil if there are issues or concerns with this submission.

Sincerely,

A handwritten signature in black ink, appearing to read "Mark Leeper".

Mark Leeper P.G., MBA
RVAAP Restoration Program Manager
Army National Guard Directorate

cc: Justin Burke, Ohio EPA, DERR (one [1] electronic copy)
Eric Cheng, USACE – Louisville (one [1] electronic copy)
Greg Moore, USACE – Louisville (one [1] electronic copy)
Katie Tait/Kevin Sedlak, Camp Ravenna (one [1] electronic copy)
Gail Harris, Vista Science Corp. (two [2] electronic copies, two [2] hard copies)

Enclosures: Two (2) hard copies, one (1) electronic copy of Project Summaries



A Division of The Davey Tree Expert Company

September 17, 2015

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Ms. Colleen Loredo
Project Manager
Independence Excavating, Inc.
5720 Schaaf Road
Independence, Ohio 44131

RE: *Rocket Ridge Project Summary*—Sand Creek Stream Relocation, Year 3
Monitoring, Camp Ravenna Joint Military Training Center, Paris Township,
Portage County, Ohio

Dear Ms. Loredo:

The relocation of Sand Creek in the Rocket Ridge area within the former Ravenna Ammunition Plant (RVAAP) occurred in May 2013. The relocation of the stream and re-grading of the adjacent area was implemented by Independence Excavating. Davey Resource Group, a division of The Davey Tree Expert Company, planted and seeded banks of the relocated stream as well as the re-graded area adjacent to, and north of, the relocated stream on May 22, 2013 (Appendix A). As a requirement of Year 3 monitoring for Sand Creek, Davey Resource Group performed stream assessments on July 17 and August 31, 2015 that included a Qualitative Habitat Evaluation Index (QHEI) and a Fish Index of Biotic Integrity (IBI). Photographs showing the status of the restoration and aquatic life can be found in Appendix B.

MONITORING METHODOLOGY

QHEI

Post-construction riparian development and in-stream habitat improvements within the relocated segment of Sand Creek were evaluated using the QHEI, as developed by the Ohio Environmental Protection Agency (OEPA). The QHEI protocol provides a quantitative evaluation of the physical characteristics within a stream reach that are important to fish communities. The QHEI protocol designates waterways as Coldwater Habitat (CWH), Exceptional Warmwater Habitat (EWH), Warmwater Habitat (WWH), Modified Warmwater Habitat (MWH), or Limited Resource Water (LRW).

Streams designated as having CWH are capable of supporting native cold water fish. Streams that are designated EWH are waterways with unique assemblages of aquatic life. A stream that is designated as WWH is capable of supporting warm water aquatic organisms. MWH applies to extensively modified habitats that may be capable of supporting warm water aquatic organisms. A designation of LRW for aquatic life use is used for streams with an extremely limited physical habitat.

The QHEI scoring methodology takes into account six metrics which evaluate channel substrate, channel morphology, in-stream cover, riparian zone, pool/glide and riffle-run quality, and drainage area/gradient characteristics. Scores range from 1 to 100 with higher scores reflecting better quality streams.

Fish IBI

Sampling methodology followed guidelines provided in the Ohio EPA publication *Biological Criteria for the Protection of Aquatic Life: Volume II: User's Manual for Biological Field Assessment of Ohio Surface Waters* (October 30, 1987; updated January 1 1988 and January 13, 2013). The IBI measures the health of a stream based on multiple attributes of the fish population. Scoring is based on deviation from reference conditions in the Erie/Ontario Drift and Lake Plain (EOLP) for this study. Narrative descriptions of fish community condition are correlated with varying levels and types of environmental perturbation. IBI scores range from 0 (lowest) to 60 (highest) with the following narrative descriptions (ranks) for the scoring ranges: No Fish, Very Poor, Poor, Marginally Fair, Fair, Marginally Good, Good, Marginally Exceptional, and Exceptional. One IBI score was determined for the relocated stream.

SAMPLING RESULTS

QHEI

The QHEI stream assessment for Sand Creek was conducted by Davey Resource Group biologists on July 17, 2015. The QHEI sampling area included the original channel, the relocated channel, and an additional 50 feet of channel extending west from the relocated channel (as indicated on the map in Appendix A). Davey Resource Group biologists found a diversity of substrate types present within the sampling area with cobble and sand being dominant. In the previous year, gravel and sand had been the dominant substrates. This change in substrate dominance is likely due to heavy water loading during June 2015. Exposed, broken bedrock within the channel provides some high quality reaches of riffle habitat. The original stream channel is still connected to the relocated stream but does not have continual through-flow, thereby functioning as a backwater. This backwater has the potential to develop into an oxbow in the future. The moderate amount of in-stream cover is attributed mostly to the habitat features in the original channel. The relocated reach has some areas of shallows and in-stream cover and root wads continue to develop. The stream benefits from a wide, forested floodplain.

Sand Creek attained a QHEI score of 76 for 2015, compared to a score of 73 for 2014. This high QHEI score meets the scoring requirements to be classified as a WWH stream. However, more time will be required for vegetation and fish communities to develop in order to achieve the full biotic assemblages typical for a stream with this classification. See Appendix C for complete QHEI results.

Fish IBI

Fish IBI data were collected by Davey Resource Group biologists on July 17 and August 31, 2015. Fish were collected using a Smith-Root® LR-24 backpack electrofisher. The stream sampling reach was fished thoroughly for three (3) hours and all captured fish were counted and identified before being released. The sampling reach is shown on the map included in Appendix A.

During the IBI survey, fourteen (14) total fish species were identified within the stream sampling area (Appendix D). The IBI score for 2015 is 38 (Good), compared to 31 for 2014 (Fair). For

Ms. Colleen Loreda
Project Manager
Independence Excavating, Inc.
September 17, 2015
Page 3.

reference, streams that score 45 are ranked as Marginally Exceptional. Table 3 in Appendix E lists the scoring metrics used to calculate the IBI score within the Sand Creek sampling area.

During the Sand Creek fish IBI survey, the majority of the fish found were pioneer and tolerant fish species, with insectivores dominating the remaining fish species. These results reflect the early level of succession in the current fish population. In general, higher percentages of insectivores, top carnivores, and intolerant species trend towards higher IBI scores while higher percentages of omnivores, anomalies (DELTS), and tolerant species trend towards lower IBI scores.

Summary of Results

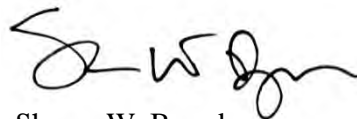
In this final monitoring year, the relocated stream reach received a QHEI score of 76, which falls within the range of WWH. For the Sand Creek stream to attain such a high score so soon after its construction reflects the excellent quality of restoration efforts implemented. The diversity of substrate types, the creation of riffles, and the connection to the original stream channel has enhanced the habitat potential for fish in this recently relocated stream reach. The moderate amount of current in-stream cover present is predominantly due to the existing cover in the original channel. However, some high-quality areas of shallow water habitat have also been created. The habitat potential of the relocated stream reach is expected to improve as aquatic macrophytes, root mats and root wads, and overhanging vegetation increase.

The IBI score for 2015 is 38 (Good), indicative of WWH headwater streams. It is possible that the fish population has been somewhat negatively affected by the recent restoration, the low amount of high-quality vegetative cover, and the continuing re-establishment of benthic macroinvertebrate populations. With the continued growth of the vegetation and re-establishment of benthic macroinvertebrates and in-stream cover features, it is expected that the quality of the fish population will continue to improve.

It is also possible that heavy amounts of rain experienced in June and low amounts of rain experienced in August during summer 2015 had negative impacts on the assemblage of species prior to each sampling event, even though the required amount of time passed before each IBI fish survey occurred in the field.

Thank you for the opportunity to provide you with these consulting services. In the event you have any questions or need further information, please do not hesitate to call me at 330-673-5685, ext. 8026.

Sincerely,



Shawn W. Bruzda
Biologist / Urban Forester
Ecological Services
Natural Resource Consulting

Appendix A
As-built Restoration Map

Seed Mixes Applied May 22, 2013

Ohio Prairie Nursery (Woodland Edge (modified) Seed Mix):

- Asclepias tuberosa* - Butterfly Weed
- Aster novae-angliae* - New England Aster
- Aster* sp. - Aster species
- Chamaecrista fasciculata* - Partridge Pea
- Echinacea purpurea* - Purple Coneflower
- Elymus virginicus* - Virginia Wild Rye
- Eupatorium purpureum* - Sweet Joe Pye
- Heliopsis helianthoides* - Ox Eye Sunflower
- Hystrix patula* - Bottlebrush Grass
- Monarda fistulosa* - Wild Bergamot
- Ratibida pinnata* - Grey-Headed Coneflower
- Rudbeckia hirta* - Black-eyed Susan
- Rudbeckia triloba* - Brown-eyed Susan
- Solidago* sp. - Goldenrod species

Ohio Prairie Nursery (Ohio Floodplain (modified) Seed Mix):


- Grasses and Grass-like**
- Carex crinita* - Fringed Sedge
 - Carex lurida* - Shallow/Lurid Sedge
 - Elymus canadensis* - Nodding Wild Rye
 - Elymus virginicus* - Virginia Wild Rye
 - Glyceria grandis* - Reed Manna Grass
 - Scirpus atrovirens* - Dark Green Bulrush
 - Scirpus validus* - Great/Soft-stemmed Bulrush


Forbs

- Actinomeris alternifolia* - Wingstem
- Asclepias incarnata* - Swamp Milkweed
- Eupatorium perfoliatum* - Common Boneset
- Lobelia cardinalis* - Cardinal Flower
- Mimulus ringens* - Monkey Flower
- Rudbeckia laciniata* - Green-headed Coneflower
- Verbena hastata* - Blue Vervain
- Veronicastrum virginicum* - Culver's Root

As-built Restoration Map

Restoration areas

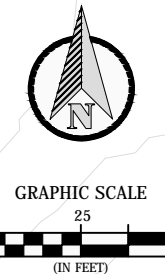
 = Bank restoration area was seeded with a floodplain seed mix and stabilized with erosion control blanket (0.16 acre). After seeding and blanket installation, this area was planted with 110, 3-gallon shrubs, approximately 4-8 foot on center. Shrubs included *Cornus amomum* (silky dogwood), *Salix discolor* (pussy willow), *Salix exigua* (sandbar willow), and *Salix sericea* (silky willow). The toe of the restored channel area was installed with 400 live stakes. Live stake species included native willow species listed above.








 = This re-graded open area was seeded with a woodland edge seed mix (0.30 acre). This area was re-shaped and roughly re-graded. Grading was done to create a flatter mound while keeping soils away from existing trees and wet areas. After shaping, this area was planted with ten 1 1/2" to 2-inch caliper trees. Trees included five *Quercus rubra* (northern red oak), three *Q. bicolor* (swamp white oak), and two *Tilia americana* (American linden). After tree planting, this area was seeded and straw mulch was applied at the appropriate rate.

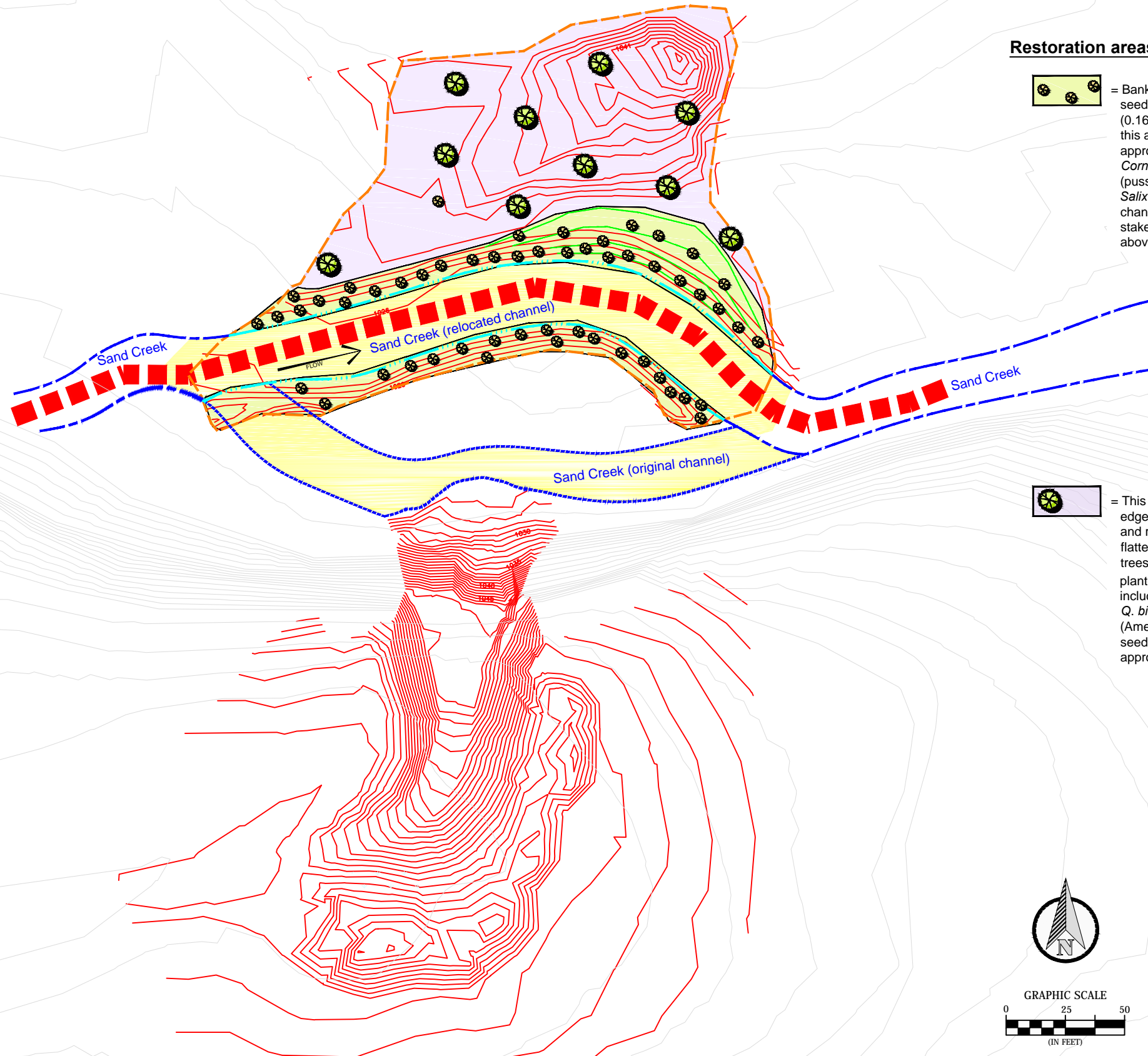
Plant locations are NOT TO SCALE

NOTE: Seeding rates were 10 lbs. per acre for both the native seed mixes. In addition to the native seed mixes: *Lolium multiflorum* (annual rye grass) at a rate of 20 lbs. per acre and/or *Secale cereale* (winter rye) at rate of 1-bushel (56 lbs.) per acre was broadcast over all the restored areas prior to mulching.

As noted on the September 1, 2011 site visit, the existing seed bank is very viable as evidenced by the current vegetation regeneration observed. Herbaceous plants, as well as numerous tree seedlings, were seen. It is anticipated that the viability of the native seed bank will readily colonize the entire restoration area.



-  = Approximate project area (0.6 acre)
-  = Sand Creek stream (existing)
-  = Relocated stream channel
-  = Original stream channel is now a floodplain-engaged backwater
-  = Bank shaping contour
-  = Approximate IBI reach (425 linear feet)
-  = Approximate QHEI reach (550 linear feet; includes restored channel and backwater)



Prepared by:
DAVEY
 RESOURCE GROUP
A Division of The Davey Tree Expert Company

Prepared for:
 Independence
 Excavating, Inc.
A DiGeronimo Company

Sand Creek Stream
 Relocation

May 22, July 2 and
 August 13, 2013

Sheet 1
 of 1

Appendix B

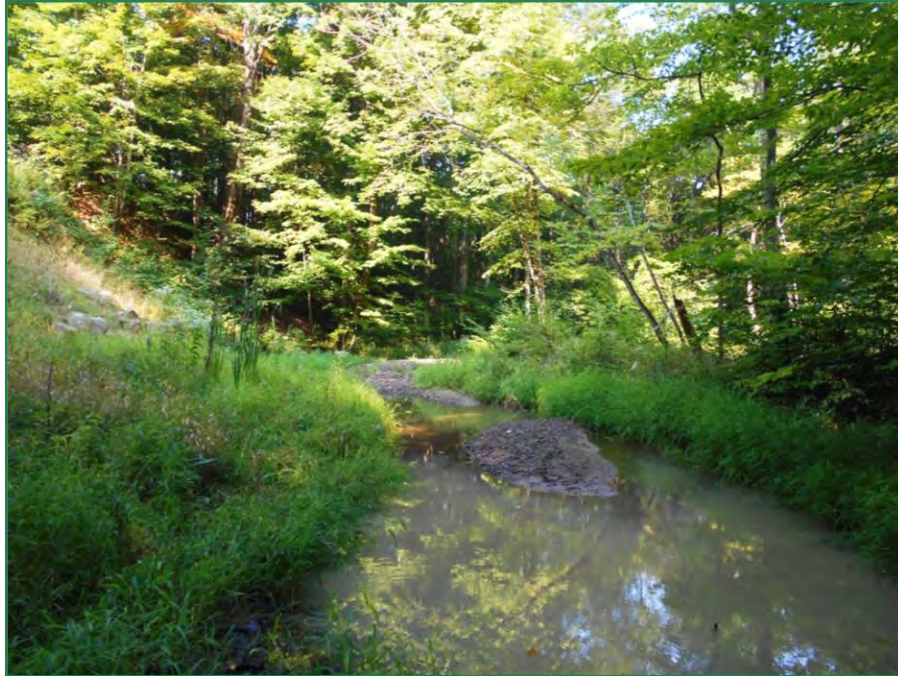
Photographs



Photograph 1 (August 31, 2015). The eastern limit of the relocated stream channel looking upstream toward the western limit.



Photograph 2 (August 31, 2015). The western limit of the relocated stream channel looking downstream toward the eastern limit.



Photograph 3 (August 31, 2015). Upstream view of the original stream channel which has now become a functional backwater.



Photograph 4 (August 31, 2015). The bluntnose minnow (*Pimephales notatus*) was the most common fish species captured during the 2015 IBI fish survey. Of the 1,043 total fish captured, 437 (41.8%) were bluntnose minnows.

Appendix C
QHEI Form



Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 76

Stream/Location Sand Creek - Rocket Ridge, Ravenna Arsenal RM: 15 Date: 7/17/2015
STORE#: Scorer's Full Name & Affiliation: Brandon Beck - Davey Resource Group
River Code: Lat/Long.: 41.1954, -81.0929 Office verified location

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES: estimate % or note every type present

Check ONE (Or 2 & average)
BEST TYPES: BLDR /SLABS [10], BOULDER [9], COBBLE [8], GRAVEL [7], SAND [6], BEDROCK [5]
OTHER TYPES: HARDPAN [4], DETRITUS [3], MUCK [2], SILT [2], ARTIFICIAL [0]
ORIGIN: LIMESTONE [1], OUTWASH [1], WETLANDS [0], HARDPAN [0], SANDSTONE [0], RIP/RAP [0], LACUSTRINE [0], SHALE [-1], COAL FINES [-2]
QUALITY: HEAVY [-2], MODERATE [-1], NORMAL [0], FREE [1], EXTENSIVE [-2], MODERATE [-1], NORMAL [0], NONE [1]
Substrate Maximum 20

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts

AMOUNT: EXTENSIVE >75% [11], MODERATE 25-75% [7], SPARSE 5-<25% [3], NEARLY ABSENT <5% [1]
1 UNDERCUT BANKS [1], 0 POOLS >70CM [2], 2 OXBOWS/BACKWATERS [1]
1 OVERHANGING VEGETATION [1], 1 ROOTWADS [1], 1 AQUATIC MACROPHYTES [1]
1 SHALLOWS (IN SLOW WATER) [1], 1 BOULDERS [1], 1 LOGS or WOODY DEBRIS [1]
0 ROOTMATS [1]
Cover Maximum 20

3] CHANNEL MORPHOLOGY Check ONE in each category (Or 2 & average)

SINUOSITY: HIGH [4], MODERATE [3], LOW [2], NONE [1]
DEVELOPMENT: EXCELLENT [7], GOOD [5], FAIR [3], POOR [1]
CHANNELIZATION: NONE [6], RECOVERED [4], RECOVERING [3], RECENT OR NO RECOVERY [1]
STABILITY: HIGH [3], MODERATE [2], LOW [1]
Channel Maximum 20

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for EACH BANK (Or 2 per bank & average)

EROSION: NONE / LITTLE [3], MODERATE [2], HEAVY / SEVERE [1]
RIPARIAN WIDTH: WIDE > 50 M [4], MODERATE 10-50m [3], NARROW 5-10m [2], VERY NARROW <5m [1], NONE [0]
FLOOD PLAIN QUALITY: Forest, Swamp [3], Shrub or Old Field [2], Fenced Pasture [1], Residential, Park, New Field [1], Open Pasture, Rowcrop [0]
Conservation Tillage [1], URBAN or INDUSTRIAL [0], Mining/Construction [0]
Riparian Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH: > 1m [6], 0.7-<1m [4], 0.4-<0.7m [2], 0.2m-<0.4m [1], < 0.2m [0]
CHANNEL WIDTH: POOL WIDTH > RIFFLE WIDTH [2], POOL WIDTH = RIFFLE WIDTH [1], POOL WIDTH < RIFFLE WIDTH [0]
CURRENT VELOCITY: TORRENTIAL [-1], VERY FAST [1], FAST [1], MODERATE [1], SLOW [1], INTERSTITIAL [-1], INTERMITTENT [-2], EDDIES [1]
Pool/Current Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

RIFFLE DEPTH: BEST AREAS > 10CM [2], BEST AREAS 5-10 CM [1], BEST AREAS < 5 CM [metric=0]
RUN DEPTH: MAXIMUM > 50CM [2], MAXIMUM < 50CM [1]
RIFFLE / RUN SUBSTRATE: STABLE (e.g., Cobble, Boulder) [2], MOD. STABLE (e.g., Large Gravel) [1], UNSTABLE (e.g. Fine Gravel, Sand) [0]
RIFFLE / RUN EMBEDDEDNESS: NONE [2], LOW [1], MODERATE [0], EXTENSIVE [-1]
Riffle/Run Maximum 8

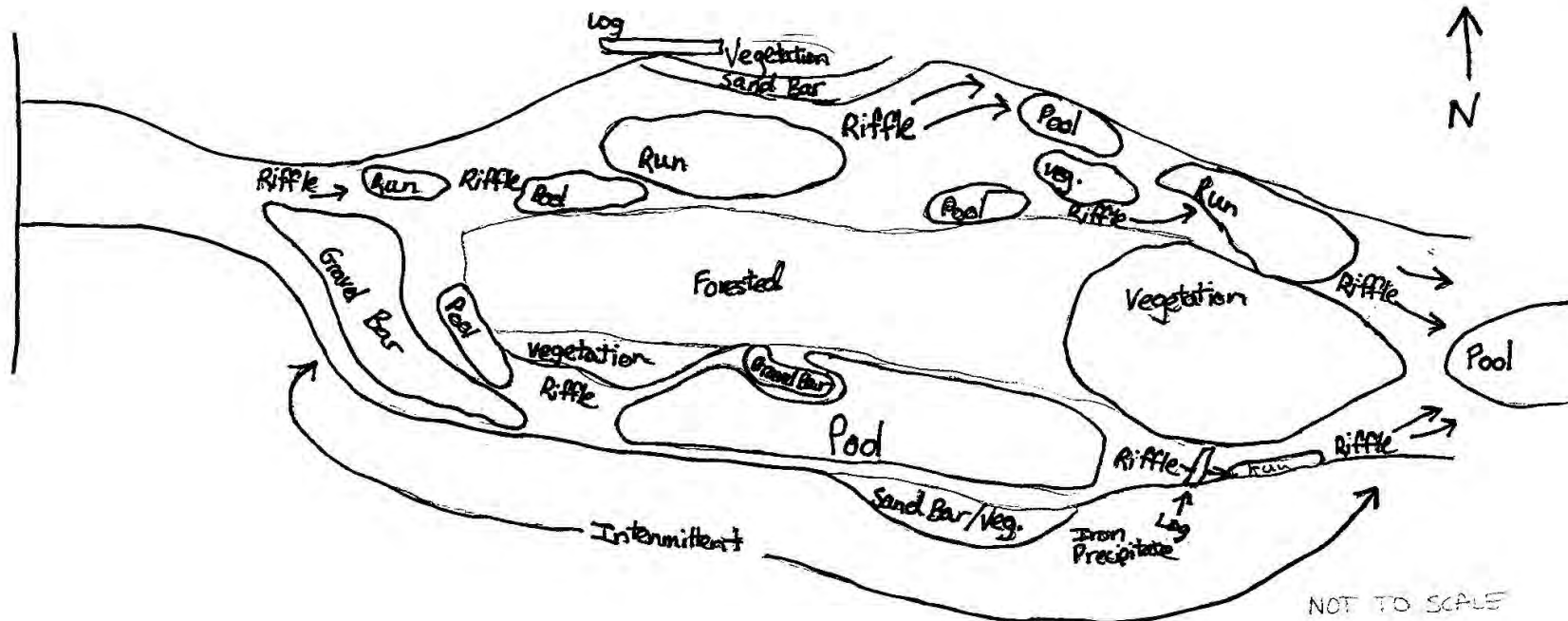
6] GRADIENT

DRAINAGE AREA (14 ft/mi) (3.74 mi²)
%POOL: 30 %GLIDE:
%RUN: 25 %RIFFLE: 45
Gradient Maximum 10

Stream & Location: 0

METHOD	SECCHI DEPTH	Comment RE: Reach consistency/ Is reach typical of stream?, Recreation/ Observed - Inferred, Other/ Sampling observations, Concerns, Access directions.
<input type="checkbox"/> BOAT <input type="checkbox"/> WADE <input type="checkbox"/> L. LINE <input type="checkbox"/> OTHER	1st _____ cm pass 2nd _____ cm	
DISTANCE	CANOPY	
<input type="checkbox"/> 0.5 Km <input type="checkbox"/> 0.2 Km <input type="checkbox"/> 0.15 Km <input type="checkbox"/> 0.12 Km <input type="checkbox"/> OTHER	<input type="checkbox"/> >85%-OPEN <input type="checkbox"/> 55%-<85% <input type="checkbox"/> 30%-<55% <input type="checkbox"/> 10%-<30% <input type="checkbox"/> <10%-CLOSED	
_____ meters	Consider maintenance status and basin issues. Write something to aide understanding of overall QHEI score.	

Stream Drawing:



Appendix D

Comprehensive Species Lists for IBI Data

Table 1. First IBI Dataset

Species Name	IBI Group	Feed Guild	Breed Guild	Pollution Tolerance	# of Fish	DELT
bluntnose minnow (<i>Pimephales notatus</i>)	N	O	C	T	151	0
central stoneroller (<i>Campostoma anomalum</i>)	N	H	N	-	11	0
creek chub (<i>Semotilus atromaculatus</i>)	N	G	N	T	15	0
fantail darter (<i>Etheostoma flabellare</i>)	D	I	C	-	3	0
grass pickerel (<i>Esox americanus</i>)	-	P	M	P	2	0
johnny darter (<i>Etheostoma nigrum</i>)	D	I	C	-	36	0
northern hog sucker (<i>Hypentelium nigricans</i>)	R	I	S	M	14	0
rainbow darter (<i>Etheostoma caeruleum</i>)	D	I	S	M	5	0
silverjaw minnow (<i>Notropis buccatus</i>)	N	I	M	-	11	0
southern redbelly dace (<i>Chrosomus erythrogaster</i>)	N	H	S	-	4	0
suckermouth minnow (<i>Phenacobius mirabilis</i>)	N	I	S	-	18	0
western blacknose dace (<i>Rhinichthys obtusus</i>)	N	G	S	T	31	0
white sucker (<i>Catostomus commersonii</i>)	W	O	S	T	3	0
Total Fish Captured	-	-	-	-	304	0
Total Fish Included in IBI Scoring	-	-	-	-	304	0

Table 2. Second IBI Dataset

Species Name	IBI Group	Feed Guild	Breed Guild	Pollution Tolerance	# of Fish	DELT
bluntnose minnow (<i>Pimephales notatus</i>)	N	O	C	T	286	0
central stoneroller (<i>Campostoma anomalum</i>)	N	H	N	-	32	0
creek chub (<i>Semotilus atromaculatus</i>)	N	G	N	T	9	0
green sunfish (<i>Lepomis cyanellus</i>)	S	I	C	T	1	
johnny darter (<i>Etheostoma nigrum</i>)	D	I	C	-	124	0
northern hog sucker (<i>Hypentelium nigricans</i>)	R	I	S	M	14	0
silverjaw minnow (<i>Notropis buccatus</i>)	N	I	M	-	10	0
southern redbelly dace (<i>Chrosomus erythrogaster</i>)	N	H	S	-	35	0
suckermouth minnow (<i>Phenacobius mirabilis</i>)	N	I	S	-	32	0
western blacknose dace (<i>Rhinichthys obtusus</i>)	N	G	S	T	195	0
white sucker (<i>Catostomus commersonii</i>)	W	O	S	T	1	0
Total Fish Captured	-	-	-	-	739	0
Total Fish Included in IBI Scoring	-	-	-	-	739	0

Appendix E IBI Scoring

Table 3. IBI Results

Metric	Score			
	7-17-2015		8-31-2015	
	Value	Score	Value	Score
Total Number of Species (minus exotics and hybrids)	13	5	11	5
Number of Darter/Sculpin Species	3	5	1	1
Number of Headwater Species	3	3	2	3
Number of Minnow Species	7	5	7	5
Number of Sensitive Species	2	3	1	1
% Tolerant Species	66	1	67	1
% Omnivores	51	1	39	1
% Insectivores	29	1	24	3
% Pioneering Species	70	3	58	5
Number of Individuals Per 300 meters	702	3	1,705	1
Number of Simple Lithophiles Species	6	5	5	5
% DELT Anomalies	0	5	0	5
Individual IBI Scores	-	40	-	36
Average IBI Score		38		



A Division of The Davey Tree Expert Company

September 25, 2014

Corporate Headquarters

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Ms. Colleen Loredo
Project Manager
Independence Excavating, Inc.
5720 Schaaf Road
Independence, Ohio 44131

RE: *Rocket Ridge Project Summary*—Sand Creek Stream Relocation, Year 1
Monitoring, Camp Ravenna Joint Military Training Center, Paris Township,
Portage County, Ohio

Dear Ms. Loredo:

The relocation of Sand Creek in the Rocket Ridge area within the Former Ravenna Ammunition Plant (RVAAP) occurred in May 2013. The relocation of the stream and re-grading of the adjacent area was implemented by Independence Excavating. Davey Resource Group, a division of The Davey Tree Expert Company, planted and seeded banks of the relocated stream as well as the re-graded area adjacent to, and north of, the relocated stream on May 22, 2013 (Appendix A). As a requirement of Year 1 monitoring for Sand Creek, Davey Resource Group performed stream assessments on July 2 and August 19, 2014 that included a Qualitative Habitat Evaluation Index (QHEI) and a Fish Index of Biotic Integrity (IBI). Photographs showing the status of the restoration and aquatic life can be found in Appendix B.

MONITORING METHODOLOGY

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Ms. Colleen Loreda
Project Manager
Independence Excavating, Inc.
September 25, 2014
Page 2.

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The QHEI sampling area included the original channel, the relocated channel, and an additional 50 feet of channel extending west from the relocated channel (as indicated on the map in Appendix A). Davey Resource Group biologists found a diversity of substrate types present within the sampling area with gravel and sand being dominant. Exposed, broken bedrock within the channel provides some high quality reaches of riffle habitat. The original stream channel is still connected to the relocated stream but does not have through flow, thereby functioning as an oxbow. The moderate amount of in-stream cover is attributed mostly to the habitat features in the original channel. The relocated reach has some areas of shallows in slow water but was restored too recently to benefit from vegetative cover.

This stream attained a QHEI score of 73 and was calculated on July 2, 2014. This high QHEI score meets the scoring requirements to be classified as a WWH stream. However, more time will be required for plant and fish communities to develop in order to achieve the full biotic assemblages typical for a stream with this classification. See Appendix C for complete QHEI results.

FISH IBI

Sampling methodology followed guidelines provided in the Ohio EPA publication *Biological Criteria for the Protection of Aquatic Life: Volume II: Users Manual for Biological Field Assessment of Ohio Surface Waters* (October 30, 1987; updated January 1 1988 and January 13, 2013). The IBI measures the health of a stream based on multiple attributes of the fish population. Scoring is based on deviation from reference conditions and is classified in the Erie/Ontario Drift and Lake Plain as Fair, Marginally Good, or Good. One IBI score was determined for the relocated stream.

Fish survey data were collected by Davey Resource Group biologists on July 2 and August 19, 2014. Fish were collected using a specialized shore-based electrofisher with a long-line setup. All fish were counted and identified before being released. The sampling reach is shown on the map included in Appendix A.

During the IBI survey, 10 fish species were identified within the stream sampling area (Appendix D). The IBI score for 2014 was 31, which is ranked as Fair and indicative of MWH headwater streams in the Erie/Ontario Drift and Lake Plain. For reference, streams that score 40 achieve a ranking of Good. Table 3 in Appendix E lists the scoring metrics used to calculate the IBI score within the Sand Creek sampling area.

A high percentage of pioneer fish species and a low percentage of insectivore fish species were found during this biological survey, which reflects the early level of succession in the fish population. It is probable that the fish population has been negatively affected by the recent restoration and the lack of high quality vegetative cover and re-establishment of benthic macroinvertebrate populations. With the growth of the vegetation and the stabilization of the soils, it is expected that the fish population will improve.

It is also probable that the heavy amounts of rain experienced during summer 2014 had negative impacts on the assemblage of species prior to each sampling event, even though the correct amount of time was permitted to pass before each fish survey occurred in the field.

Ms. Colleen Loreda
Project Manager
Independence Excavating, Inc.
September 25, 2014
Page 3.

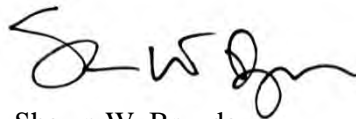
SUMMARY OF RESULTS

The relocated stream reach received a QHEI score of 73, which falls within the range of WWH. For this stream to attain such a high classification so soon after its construction reflects the excellent quality of restoration efforts implemented. The diversity of substrate types, the creation of riffles, and the connection to the original stream channel has enhanced the habitat potential for fish in this newly relocated stream reach. The moderate amount of in-stream cover currently present is predominantly due to the existing cover in the original channel. However, some high quality areas of shallow water habitat have also been created. The habitat potential of the relocated stream reach is expected to improve as aquatic macrophytes, root mats, and overhanging vegetation increase.

The fish IBI score was in the middle of the Fair range. It is expected that the IBI score will improve as the fish population of this stream reach continues to develop.

Thank you for the opportunity to provide you with these consulting services. In the event you have any questions or need further information, please do not hesitate to call me at 330-673-5685, ext. 8026.

Sincerely,

A handwritten signature in black ink, appearing to read "Shawn W. Bruzda". The signature is fluid and cursive, with a large initial "S" and "W".

Shawn W. Bruzda
Biologist / Urban Forester
Ecological Services
Natural Resource Consulting

Appendix A
As-built Restoration Map

Seed mixes applied May 22, 2013

Ohio Prairie Nursery (Woodland Edge (modified) Seed Mix)


- Elymus virginicus* - Virginia Wild Rye
- Hystrix patula* - Bottlebrush Grass
- Chamaecrista fasciculata* - Partridge Pea
- Heliopsis helianthoides* - Ox Eye Sunflower
- Echinacea purpurea* - Purple Coneflower
- Ratibida pinnata* - Grey-Headed Coneflower
- Rudbeckia hirta* - Black-eyed Susan
- Rudbeckia triloba* - Brown-eyed Susan
- Asclepias tuberosa* - Butterfly Weed
- Solidago* sp - Goldenrod species
- Monarda fistulosa* - Wild Bergamot
- Eupatorium purpureum* - Sweet Joe Pye
- Aster novae-angliae* - New England Aster
- Aster* sp - Aster species


Ohio Prairie Nursery (Ohio Floodplain (modified) Seed Mix)

- Grasses and grass-like**
- Elymus canadensis*-Nodding Wild Rye
 - Elymus virginicus*-Virginia Wild Rye
 - Carex crinita*-Fringed Sedge
 - Carex lurida*-Shallow/Lurid Sedge
 - Glyceria grandis*-Reed Manna Grass
 - Scirpus atrovirens*-Dark Green Bulrush
 - Scirpus validus*-Great/Soft-stemmed Bulrush
- Forbs**
- Actinomeris alternifolia*-Wingstem
 - Asclepias incarnata*-Swamp Milkweed
 - Eupatorium perfoliatum*-Common Boneset
 - Lobelia Cardinalis*-Cardinal Flower
 - Mimulus ringens*-Monkey Flower
 - Rudbeckia laciniata*-Green-headed Coneflower
 - Verbena hastata*-Blue Vervain
 - Veronicastrum virginicum*-Culver's Root

As-built Restoration Map

Restoration areas

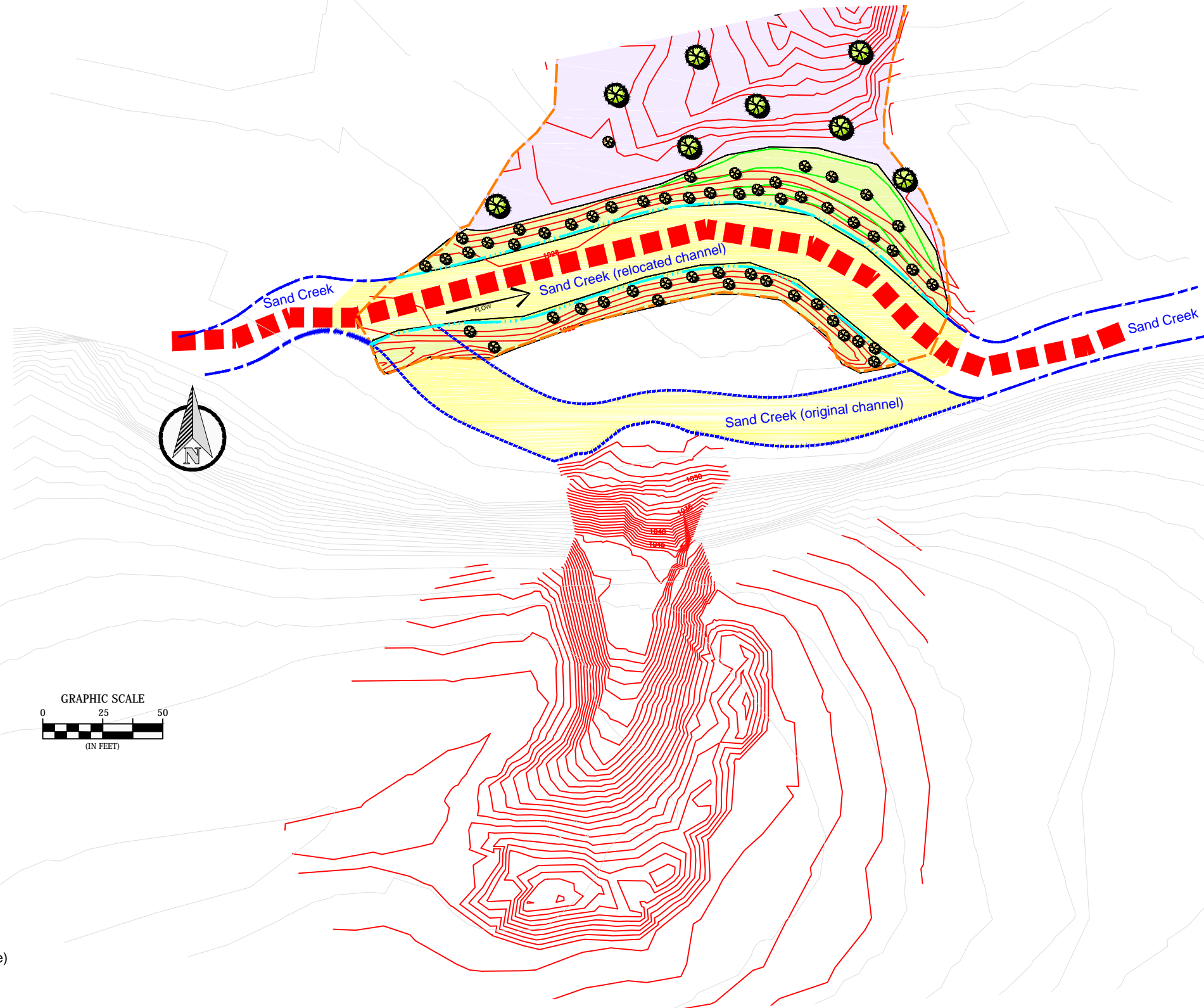
 = Bank restoration area was seeded with a floodplain seed mix and stabilized with erosion control blanket (0.16 acre). After seeding and blanket installation, this area was planted with 110, 3-gallon shrubs, approximately 4-8 foot on center. Shrubs included *Cornus amomum* (silky dogwood), *Salix discolor* (pussy willow), *Salix exigua* (sandbar willow), and *Salix sericea* (silky willow). The toe of the restored channel area was installed with 400 live stakes. Live stakes species included native willow species listed above.








 = This re-graded open area was seeded with a woodland edge seed mix (0.30 acre). This area was re-shaped and roughly re-graded. Grading was done to create a flatter mound while keeping soils away from existing trees and wet areas. After shaping this area was planted with ten 1 1/2 to 2-inch caliper trees. Trees included five *Quercus rubra* (northern red oak), three *Q. bicolor* (swamp white oak), and two *Tilia americana* (American linden). After tree planting this area was seeded and straw mulch was applied at the appropriate rate.

Plant locations are NOT TO SCALE

NOTE: Seeding rates were 10 lbs. per acre for both the native seed mixes. In addition to the native seed mixes; *Lolium multiflorum* (annual rye grass) at a rate of 20 lbs. per acre and/or *Secale cereale* (winter rye) at rate of 1-bushel (56 lbs.) per acre was broadcast over all the restored areas prior to mulching.

As noted on the September 1, 2011 site visit, the existing seed bank is very viable as evidenced by the current vegetation regeneration observed. Herbaceous as well as numerous tree seedlings were seen. It is anticipated that the viability of the native seed bank will readily colonize the entire restoration area.



-  = Approximate project area (0.6 acre)
-  = Sand Creek stream (existing)
-  = Relocated stream channel
-  = Original stream channel is now a floodplain engaged ox-bow
-  = Bank shaping contour
-  = Approximate IBI reach (425 linear feet)
-  = Approximate QHEI reach (550 linear feet; includes restored channel and ox-bow)

Prepared by
DAVEY
 RESOURCE GROUP
A Division of The Davey Tree Expert Company

Prepared for
 Independence
 Excavating, Inc.
A DiGeronimo Company

Sand Creek Stream
 Relocation

May 22, July 2, and
 August 13, 2013

Sheet 1
 of 1

Appendix B

Photographs



Photograph 1 (July 2, 2014). Eastern edge of restoration area looking at downstream habitat.



Photograph 2 (July 2, 2014). Eastern edge of restoration area looking upstream toward western edge.



Photograph 3 (July 2, 2014). The original stream channel, now an oxbow, before redirection.



Photograph 4 (July 2, 2014). Western blacknose dace (*Rhinichthys obtusus*), a fish species indicative of good water quality.

Appendix C
QHEI Form

Stream/Location Sand Creek - Rocket Ridge, Camp Ravenna **RM:** 15 **Date:** 7/2/2014

River Code: _____ **Scorers Full Name & Affiliation:** Adam Benshoff - Davey Resource Group

STORET #: _____ **Lat/Long.:** 41.1954, -81.0929 Office verified to

1] SUBSTRATE Check **ONLY Two** substrate **TYPE BOXES:**
estimate % or note every type present

Check ONE (Or 2 & average)

BEST TYPES		POOL	RIFFLE	OTHER 1		POOL	RIFFLE		
<input type="checkbox"/>	<input type="checkbox"/>	BLDR /SLABS [10]			<input type="checkbox"/>	<input type="checkbox"/>	HARDPAN [4]	X	X
<input type="checkbox"/>	<input type="checkbox"/>	BOULDER [9]	X	X	<input type="checkbox"/>	<input type="checkbox"/>	DETRITUS [3]	X	X
<input type="checkbox"/>	<input type="checkbox"/>	COBBLE [8]	X	X	<input type="checkbox"/>	<input type="checkbox"/>	MUCK [2]		
<input type="checkbox"/>	<input type="checkbox"/>	GRAVEL [7]	X	X	<input type="checkbox"/>	<input type="checkbox"/>	SILT [2]	X	X
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	SAND [6]	X	X	<input type="checkbox"/>	<input type="checkbox"/>	ARTIFICIAL [0]		
<input type="checkbox"/>	<input type="checkbox"/>	BEDROCK [5]	X	X	(Score natural substrates; ignore sludge from point-sources)				

ORIGIN		QUALITY	
<input type="checkbox"/>	LIMESTONE [1]	<input type="checkbox"/>	HEAVY [-2]
<input type="checkbox"/>	TILLS [1]	<input type="checkbox"/>	MODERATE [-1]
<input type="checkbox"/>	WETLANDS [0]	<input checked="" type="checkbox"/>	NORMAL [0]
<input type="checkbox"/>	HARDPAN [0]	<input type="checkbox"/>	FREE [1]
<input checked="" type="checkbox"/>	SANDSTONE [0]	<input checked="" type="checkbox"/>	EXTENSIVE [-2]
<input type="checkbox"/>	RIP/RAP [0]	<input checked="" type="checkbox"/>	MODERATE [-1]
<input type="checkbox"/>	LACUSTRINE [0]	<input checked="" type="checkbox"/>	NORMAL [0]
<input type="checkbox"/>	SHALE [-1]	<input type="checkbox"/>	NONE [1]
<input type="checkbox"/>	COAL FINES [-2]		

Substrate
15.5
Maximum

NUMBER OF BEST TYPES 4 or more [2]
 3 or less [0]

Comments

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep/fast water, or deep, well-defined, functional pools.

AMOUNT
Check ONE (Or 2 & Average)

0	UNDERCUT BANKS [1]	0	POOLS >70CM [2]	3
1	OVERHANGING VEGETATION [1]	1	ROOTWADS [1]	1
2	SHALLOWS (IN SLOW WATER) [1]	0	BOULDERS [1]	0
0	ROOTMATS [1]			

<input type="checkbox"/>	EXTENSIVE >75% [11]
<input checked="" type="checkbox"/>	MODERATE 25-75% [7]
<input type="checkbox"/>	SPARSE 5-<25% [3]
<input type="checkbox"/>	NEARLY ABSENT <5% [1]

Cover
12
Maximum 20

Comments

3] CHANNEL MORPHOLOGY Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
<input type="checkbox"/> HIGH [4]	<input type="checkbox"/> EXCELLENT [7]	<input checked="" type="checkbox"/> NONE [6]	<input type="checkbox"/> HIGH [3]
<input checked="" type="checkbox"/> MODERATE [3]	<input checked="" type="checkbox"/> GOOD [5]	<input type="checkbox"/> RECOVERED [4]	<input checked="" type="checkbox"/> MODERATE [2]
<input type="checkbox"/> LOW [2]	<input type="checkbox"/> FAIR [3]	<input type="checkbox"/> RECOVERING [3]	<input type="checkbox"/> LOW [1]
<input type="checkbox"/> NONE [1]	<input type="checkbox"/> POOR [1]	<input type="checkbox"/> RECENT OR NO RECOVERY [1]	

Channel
16
Maximum 20

Comments

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for EACH BANK (Or 2 per bank & average)

EROSION		RIPARIAN WIDTH		FLOOD PLAIN QUALITY	
L	R	L	R	L	R
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Riparian
10
Maximum 10

Comments

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH	CHANNEL WIDTH	CURRENT VELOCITY
Check ONE (ONLY!)	Check ONE (Or 2 & average)	Check ALL that apply
<input type="checkbox"/> > 1m [6]	<input checked="" type="checkbox"/> POOL WIDTH > RIFFLE WIDTH [2]	<input type="checkbox"/> TORRENTIAL [-1]
<input type="checkbox"/> 0.7-<1m [4]	<input type="checkbox"/> POOL WIDTH = RIFFLE WIDTH [1]	<input checked="" type="checkbox"/> SLOW [1]
<input type="checkbox"/> 0.4-<0.7m [2]	<input type="checkbox"/> POOL WIDTH < RIFFLE WIDTH [0]	<input type="checkbox"/> INTERSTITIAL [-1]
<input checked="" type="checkbox"/> 0.2m-<0.4m [1]		<input type="checkbox"/> INTERMITTENT [-2]
<input type="checkbox"/> < 0.2m [0]		<input checked="" type="checkbox"/> MODERATE [1]
		<input type="checkbox"/> EDDIES [1]

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Pool/Current
6
Maximum 12

Comments

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

Check ONE (Or 2 & average)

NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
<input checked="" type="checkbox"/> BEST AREAS > 10CM [2]	<input type="checkbox"/> MAXIMUM > 50CM [2]	<input checked="" type="checkbox"/> STABLE (e.g., Cobble, Boulder) [2]	<input type="checkbox"/> NONE [2]
<input type="checkbox"/> BEST AREAS 5-10 CM [1]	<input checked="" type="checkbox"/> MAXIMUM < 50CM [1]	<input checked="" type="checkbox"/> MOD. STABLE (e.g., Large Gravel) [1]	<input checked="" type="checkbox"/> LOW [1]
<input type="checkbox"/> BEST AREAS < 5 CM [metric=0]		<input type="checkbox"/> UNSTABLE (e.g. Fine Gravel, Sand) [0]	<input type="checkbox"/> MODERATE [0]
			<input type="checkbox"/> EXTENSIVE [-1]

Riffle/Run
5.5
Maximum 8

Comments

4 cm

6] GRADIENT

14 ft/mi	<input type="checkbox"/> VERY LOW - LOW [2-4]	%POOL: <u>25</u>	%GLIDE: <u>0</u>
DRAINAGE AREA	<input type="checkbox"/> MODERATE [6-10]	%RUN: <u>20</u>	%RIFFLE: <u>55</u>
3.74 sq mi	<input checked="" type="checkbox"/> HIGH - VERY HIGH [10-6]		

Gradient
Maximum 10
8

Stream & Location: 0

A) SAMPLED REACH

Comment RE: Reach consistency/ Is reach typical of stream?, Recreation/ Observed - Inferred, Other/ Sampling observations, Concerns, Access directions.

See map in Appendix A to see IBI length and QHEI survey area. Unexploded ordinance surrounds entire area.

Check ALL that apply

METHOD

BOAT

WADE

L. LINE

OTHER

DISTANCE

0.5 Km

0.2 Km

0.15 Km

0.12 Km

OTHER

METHOD

1st --sample pass-- 2nd

HIGH

UP

NORMAL

LOW

DRY

CLARITY

1st --sample pass-- 2nd

<20 cm

20-<40 cm

40-70 cm

> 70 cm/ CTB

Secchi Dpth

meters

CANOPY

1st pass _____ cm

2nd pass _____ cm

> 85% OPEN

55%-<85%

30%-<55%

10%-<30%

<10%-CLOSED

BJ AESTHETICS

NUISANCE ALGAE

INVASIVE MACROPHYTES

EXCESS TURBIDITY

DISCOLORATION

FOAM / SCUM

OIL SHEEN

TRASH / LITTER

NUISANCE ODOR

SLUDGE DEPOSITS

CSOs/SSOs/OUTFALLS

DJ MAINTENANCE

PUBLIC / PRIVATE / BOTH / NA

ACTIVE / HISTORIC / BOTH / NA

YOUNG-SUCCESSION-OLD

SPRAY / SNAG / REMOVED

MODIFIED / DIPPED OUT / NA

LEVEED / ONE SIDED

RELOCATED / CUTOFFS

MOVING-BEDLOAD-STABLE

ARMoured / SLUMPS

ISLANDS / SCoured

IMPOUNDED / DESICCATED

FLOOD CONTROL / DRAINAGE

Circle some & COMMENT

EJ ISSUES

WWTP / CSO / NPDES / INDUSTRY

HARDENED / URBAN / DIRT&GRIME

CONTAMINATED / LANDFILL

BMPs-CONSTRUCTION-SEDIMENT

LOGGING / IRRIGATION / COOLING

BANK / EROSION / SURFACE

FALSE BANK / MANURE / LAGOON

WASH H₂O / TILE / H₂O TABLE

ACID / MINE / QUARRY / FLOW

NATURAL / WETLAND / STAGNANT

PARK / GOLF / LAWN / HOME

ATMOSPHERE / DATA PAUCITY

FJ MEASUREMENTS

\bar{x} width

\bar{x} depth

max. depth

\bar{x} bankfull width

bankfull \bar{x} depth

W/D ratio

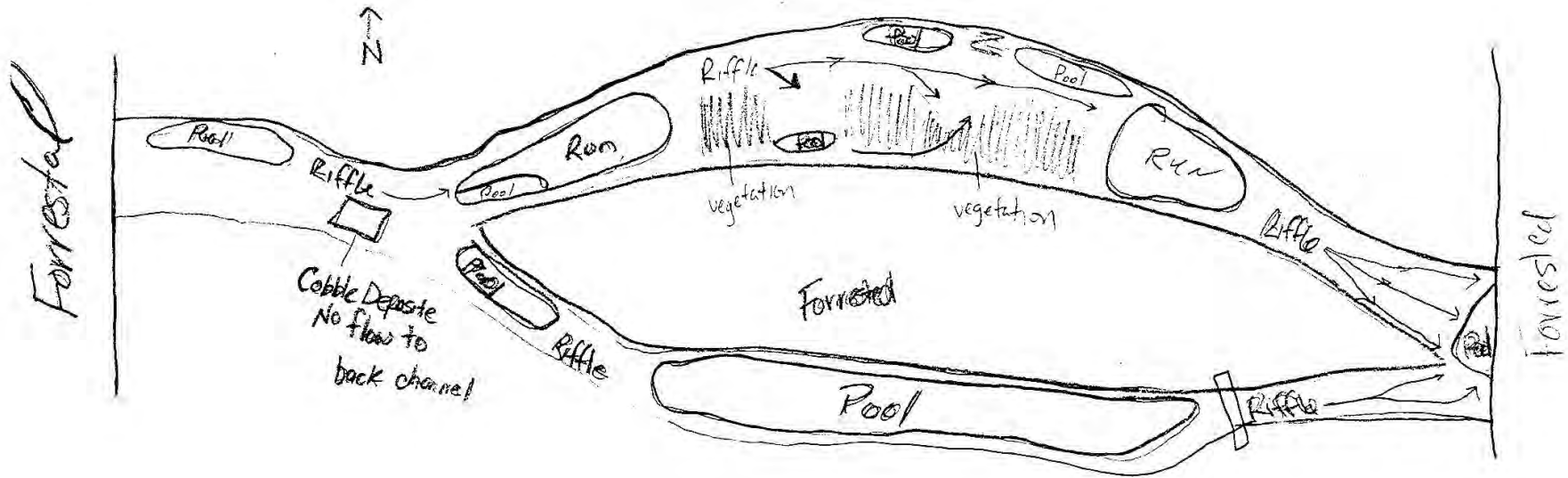
bankfull max. depth

floodprone \bar{x}^2 width

entrench. ratio

Legacy Tree:

Stream Drawing:



Appendix D

Comprehensive Species Lists for IBI Data

Table 1. First IBI Dataset

River Code: N/A	Stream: Sand Creek	Drainage Area:				
River Mile: 15	Gradient: 14 ft/mile	3.7 mi ²	Sample Date: 07-02-2014			
Ecoregion: EOLP	Sampling Area: Mitigation	No. of Passes: 1	Sampler Type: F			
Basin: Mahoning	Area- Downstream	Dist. Fished: 520 ft				
Species Name	IBI Group	Feed Guild	Breed Guild	Pollution Tolerance	# of Fish	DELT
bluntnose minnow (<i>Pimephales promelas</i>)	N	O	C	T	121	0
creek chub (<i>Semotilus atromaculatus</i>)	N	G	N	T	13	0
fantail darter (<i>Etheostoma flabellare</i>)	D	I	C	-	32	0
johnny darter (<i>Etheostoma nigrum</i>)	D	I	C	-	58	0
silverjaw minnow (<i>Notropis buccatus</i>)	N	I	M	-	1	0
southern redbelly dace (<i>Chrosomus erythrogaster</i>)	N	H	S	-	7	0
western blacknose dace (<i>Rhinichthys obtusus</i>)	N	G	S	T	43	0
Total Fish Captured	-	-	-	-	275	0
Total Fish Included in IBI Scoring	-	-	-	-	275	0

Table 2. Second IBI Dataset

River Code: N/A	Stream: Sand Creek	Drainage Area:				
River Mile: 15	Gradient: 14 ft/mile	3.7 mi ²	Sample Date: 08-19-2014			
Ecoregion: EOLP	Sampling Area: Mitigation	No. of Passes: 1	Sampler Type: F			
Basin: Mahoning	Area- Downstream	Dist. Fished: 520 ft				
Species Name	IBI Group	Feed Guild	Breed Guild	Pollution Tolerance	# of Fish	DELT
bluntnose minnow (<i>Pimephales promelas</i>)	N	O	C	T	59	0
central mudminnow (<i>Umbra limi</i>)	-	I	C	T	1	0
creek chub (<i>Semotilus atromaculatus</i>)	N	G	N	T	31	0
fantail darter (<i>Etheostoma flabellare</i>)	D	I	C	-	17	0
johnny darter (<i>Etheostoma nigrum</i>)	D	I	C	-	27	0
northern hog sucker (<i>Hypentelium nigricans</i>)	R	I	S	M	5	0
silverjaw minnow (<i>Notropis buccatus</i>)	N	I	M	-	8	0
western blacknose dace (<i>Rhinichthys obtusus</i>)	N	G	S	T	43	0
white sucker (<i>Catostomus commersonii</i>)	W	O	S	T	1	0
Total Fish Captured	-	-	-	-	157	0
Total Fish Included in IBI Scoring	-	-	-	-	157	0

Appendix E IBI Scoring

Table 3. IBI Results

Metric	Score			
	7-2-2014		8-19-2014	
	Value	Score	Value	Score
Total Number of Species (minus exotics and hybrids)	7	3	9	3
Number of Darter/Sculpin Species	2	3	2	3
Number of Headwater Species	3	3	2	3
Number of Minnow Species	4	3	3	3
Number of Sensitive Species	1	1	1	1
% Tolerant Species	64	1	86	1
% Omnivores	44	1	38	1
% Insectivores	33	5	37	5
% Pioneering Species	70	1	80	1
Number of Individuals Per 300 meters	138	3	79	3
Number of Simple Lithophiles Species	1	1	3	3
% DELT Anomalies	0	5	0	5
Individual IBI Scores	-	30	-	32
Average IBI Score		31		



A Division of The Davey Tree Expert Company

Corporate Headquarters

1500 North Mantua Street

PO Box 5193

Kent, Ohio 44240-5193

330.673.5685

Toll Free 1.800.828.8312

Fax 330.673.0860

September 6, 2013

Ms. Colleen Loredo
Project Manager
Independence Excavating, Inc.
5720 Schaaf Road
Independence, Ohio 44131

RE: *Rocket Ridge Project Summary*—Sand Creek Stream Relocation, Ravenna Arsenal, Ravenna, Portage County, Ohio

Dear Ms. Loredo:

The relocation of Sand Creek in the Rocket Ridge area within the Ravenna Arsenal occurred in May 2013. The relocation of the stream and re-grading of the adjacent area was implemented by Independence Excavating. Davey Resource Group, a division of The Davey Tree Expert Company, planted and seeded banks of the relocated stream as well as the re-graded area adjacent to and north of the relocated stream on May 22, 2013. Davey Resource Group performed stream assessments on July 2 and August 13, 2013 which included a Qualitative Habitat Evaluation Index (QHEI) and a Fish Index of Biotic Integrity (IBI).

PLANTING

The restoration plan for the Sand Creek Stream Relocation involved the stabilization of the stream banks and adjacent area as shown in the Appendix A map. The stream banks were planted with an Ohio Floodplain Seed Mix and the adjacent area to the north was seeded with a Woodland Edge Seed Mix, as shown on the Appendix A map. After seeding, the stream banks were stabilized with erosion control blankets. One hundred and ten 3-gallon shrubs were planted in the stream bank restoration area with an additional 400 live stakes installed at the toe of the stream bank. This density of planting will provide bank stabilization and erosion control for the long term. Ten 1.5- to 2-inch caliper trees were planted in the adjacent area to the north. Photographs of these areas are located in Appendix B.

MONITORING METHODOLOGY

QHEI

Post-construction riparian development and in-stream habitat improvements within the relocated segment of Sand Creek were evaluated using the QHEI, as developed by the Ohio Environmental Protection Agency (EPA). The QHEI protocol provides a quantitative evaluation of the physical characteristics within a stream reach that are important to fish communities. The QHEI protocol designates waterways as either Coldwater Habitat (CWH), Exceptional Warmwater Habitat (EWH), Warmwater Habitat (WWH), Modified Warmwater Habitat (MWH) or Limited Resource Water (LRW).

Streams designated as having CWH are capable of supporting native cold water fish. Streams that are designated EWH are waterways with unique assemblages of aquatic life. A stream that is designated as WWH is capable of supporting warm water aquatic organisms. MWH applies to extensively modified habitats that may be capable of supporting warm water aquatic organisms. A designation of LRW for aquatic life use is used for streams with an extremely limited physical habitat. The QHEI scoring methodology takes into account six metrics which evaluate channel substrate, channel morphology, in-stream cover, riparian zone, pool/glide and riffle-run quality, and drainage area/gradient characteristics. Scores range from 1 to 100 with higher scores reflecting better quality streams.

The QHEI sampling area included the original channel, the relocated channel, and an additional fifty feet of channel extending west from the relocated channel (as indicated on the map in Appendix A). Davey Resource Group biologists found a diversity of substrate types present within the sampling area with gravel and sand being dominant. Exposed, broken bedrock within the channel is providing some high quality reaches of riffle habitat. The original stream channel is still connected to the relocated stream but does not have through flow, thereby functioning as an oxbow. The moderate amount of in-stream cover is attributed mostly to the habitat features in the original channel. The relocated reach has some areas of shallows in slow water but is too recently restored to benefit from vegetative cover.

This stream attained a QHEI score of 72.5. This high QHEI score meets the scoring requirements to be classified as a WWH stream. However, it requires more time for plant and fish communities to develop in order to achieve the full biotic assemblages typical for a stream with this classification. See Appendix C for complete QHEI results.

Fish IBI

Sampling methodology followed guidelines provided in the Ohio EPA *Biological Criteria for the Protection of Aquatic Life, Volume II* manual. The IBI measures the health of a stream based on multiple attributes of the fish population. Scoring is based on deviation from reference conditions and is classified in the Erie/Ontario Drift and Lake Plain as Fair, Marginally Good, or Good. One IBI score was determined for the relocated stream.

Survey data were collected by Davey Resource Group biologists on July 2 and August 13, 2013. Fish were collected using a specialized electroshocker long-line setup. All fish were counted and identified before being released. The sampling reach is shown on the map included in Appendix A.

During the IBI survey, a total of 12 fish species were identified within the stream sampling area (Appendix D). The IBI score for 2013 was 39, which is within the range of Marginally Good for headwater streams in the Erie/Ontario Drift and Lake Plain. For reference, streams that score 40 achieve a ranking of Good. Table 3 in Appendix E lists the scoring metrics within the Sand Creek sampling area

A high proportion of pioneer fish species were found during this biological survey, which reflects the early level of succession in the fish population. It is probable that the fish population has been negatively affected by the recentness of the restoration and the lack of vegetative cover. With the growth of the vegetation and the stabilization of the soils, it is expected that the fish population will improve.

Summary of Results

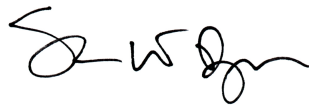
Photographs 1 and 3 (Appendix B) show the planted trees, shrubs, and seedlings that are beginning to establish on the banks of Sand Creek. These plants will provide erosion control and shade along the relocated stream reach and will improve habitat for macroinvertebrates and fish.

The relocated stream reach received a QHEI score of 72.5, which falls within the range of WWH. For this stream to attain such a high classification so recently after its construction reflects the excellent quality of restoration efforts implemented. The diversity of substrate types, the creation of riffles, and the connection to the original stream channel has enhanced the habitat potential for fish in this newly relocated stream reach. The moderate amount of in-stream cover currently present is predominately due to the existing cover in the original channel but some high quality areas of shallow water habitat have been created. The habitat potential of the relocated stream reach is expected to improve as aquatic macrophytes, root mats, and overhanging vegetation increase.

The fish IBI score was at the top of the Marginally Good range, bordering the highest possible range of Good. It is expected that the IBI score will improve as the fish population of this stream reach develops.

Thank you for the opportunity to provide you with these restoration and consulting services. In the event you have any questions or need further information, please do not hesitate to call me at 330-673-5685, ext. 8026.

Sincerely,

A handwritten signature in black ink, appearing to read "S. Bruzda", written in a cursive style.

Shawn Bruzda
Biologist / Urban Forester
Ecological Services
Natural Resource Consulting

Appendix A
As-built Restoration Map

Seed mixes applied May 22, 2013

Ohio Prairie Nursery (Woodland Edge (modified) Seed Mix)


- Elymus virginicus* - Virginia Wild Rye
- Hystrix patula* - Bottlebrush Grass
- Chamaecrista fasciculata* - Partridge Pea
- Heliopsis helianthoides* - Ox Eye Sunflower
- Echinacea purpurea* - Purple Coneflower
- Ratibida pinnata* - Grey-Headed Coneflower
- Rudbeckia hirta* - Black-eyed Susan
- Rudbeckia triloba* - Brown-eyed Susan
- Asclepias tuberosa* - Butterfly Weed
- Solidago* sp - Goldenrod species
- Monarda fistulosa* - Wild Bergamot
- Eupatorium purpureum* - Sweet Joe Pye
- Aster novae-angliae* - New England Aster
- Aster* sp - Aster species


Ohio Prairie Nursery (Ohio Floodplain (modified) Seed Mix)

- Grasses and grass-like**
- Elymus canadensis* - Nodding Wild Rye
 - Elymus virginicus* - Virginia Wild Rye
 - Carex crinita* - Fringed Sedge
 - Carex lurida* - Shallow/Lurid Sedge
 - Glyceria grandis* - Reed Manna Grass
 - Scirpus atrovirens* - Dark Green Bulrush
 - Scirpus validus* - Great/Soft-stemmed Bulrush
- Forbs**
- Actinomeris alternifolia* - Wingstem
 - Asclepias incarnata* - Swamp Milkweed
 - Eupatorium perfoliatum* - Common Boneset
 - Lobelia Cardinalis* - Cardinal Flower
 - Mimulus ringens* - Monkey Flower
 - Rudbeckia laciniata* - Green-headed Coneflower
 - Verbena hastata* - Blue Vervain
 - Veronicastrum virginicum* - Culver's Root

As-built Restoration Map

Restoration areas

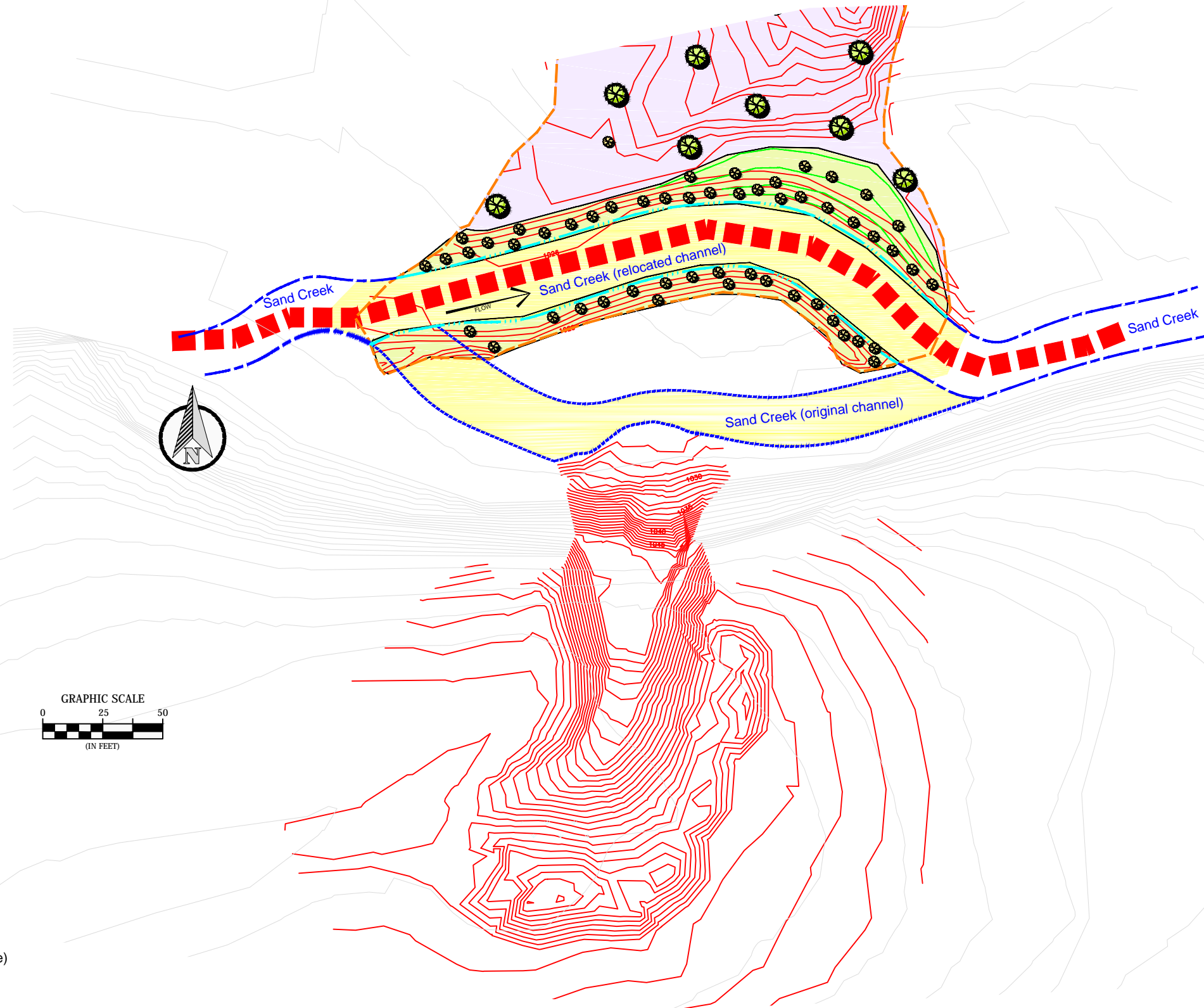
 = Bank restoration area was seeded with a floodplain seed mix and stabilized with erosion control blanket (0.16 acre). After seeding and blanket installation, this area was planted with 110, 3-gallon shrubs, approximately 4-8 foot on center. Shrubs included *Cornus amomum* (silky dogwood), *Salix discolor* (pussy willow), *Salix exigua* (sandbar willow), and *Salix sericea* (silky willow). The toe of the restored channel area was installed with 400 live stakes. Live stakes species included native willow species listed above.








 = This re-graded open area was seeded with a woodland edge seed mix (0.30 acre). This area was re-shaped and roughly re-graded. Grading was done to create a flatter mound while keeping soils away from existing trees and wet areas. After shaping this area was planted with ten 1 1/2 to 2-inch caliper trees. Trees included five *Quercus rubra* (northern red oak), three *Q. bicolor* (swamp white oak), and two *Tilia americana* (American linden). After tree planting this area was seeded and straw mulch was applied at the appropriate rate.

Plant locations are NOT TO SCALE

NOTE: Seeding rates were 10 lbs. per acre for both the native seed mixes. In addition to the native seed mixes; *Lolium multiflorum* (annual rye grass) at a rate of 20 lbs. per acre and/or *Secale cereale* (winter rye) at rate of 1-bushel (56 lbs.) per acre was broadcast over all the restored areas prior to mulching.

As noted on the September 1, 2011 site visit, the existing seed bank is very viable as evidenced by the current vegetation regeneration observed. Herbaceous as well as numerous tree seedlings were seen. It is anticipated that the viability of the native seed bank will readily colonize the entire restoration area.



-  = Approximate project area (0.6 acre)
-  = Sand Creek stream (existing)
-  = Relocated stream channel
-  = Original stream channel is now a floodplain engaged ox-bow
-  = Bank shaping contour
-  = Approximate IBI reach (425 linear feet)
-  = Approximate QHEI reach (550 linear feet; includes restored channel and ox-bow)

Prepared by
DAVEY
 RESOURCE GROUP
A Division of The Davey Tree Expert Company

Prepared for
 Independence
 Excavating, Inc.
A DiGeronimo Company

Sand Creek Stream
 Relocation

May 22, July 2, and
 August 13, 2013

Sheet 1
 of 1

Appendix B Photographs



Photograph 1 (August 13, 2013) The open area adjacent to the relocated channel has been seeded and planted with young trees.



Photograph 2 (August 13, 2013) The substrate of the relocated portion of Sand Creek is composed primarily of sand and gravel. Large proportions of bedrock also occur.



Photograph 3 (August 13, 2013) This is a view of the relocated stream channel facing upstream. Good quality riffle habitat can be seen in this photograph.



Photograph 4 (July 2, 2013) This is a view of the relocated stream channel facing downstream. Shrubs and aquatic macrophytes are beginning to establish.



Photograph 5 (July 2, 2013) As can be seen to the right of this photograph, the original channel has been modified so that it does not have through flow, thereby functioning as an oxbow. The relocated channel is to the left.



Photograph 6 (July 2, 2013) The riparian zone around the original stream channel has not been disturbed during the restoration and relocation. The habitat in this reach accounts for most of the in-stream cover in the QHEI assessment.

Appendix C
QHEI Form

Stream & Location: Sand Creek – Rocket Ridge, Ravenna Arsenal

A) SAMPLED REACH

Comment RE: Reach consistency/ Is reach typical of stream?, Recreation/ Observed - Inferred, Other/ Sampling observations, Concerns, Access directions.

Check ALL that apply

See map in Appendix A to see IBI length and QHEI area surveyed. Unexploded ordinances were common in the surrounding area.

METHOD	METHOD
<input type="checkbox"/> BOAT	1st -sample pass- 2nd
<input type="checkbox"/> WADE	<input type="checkbox"/> HIGH
<input checked="" type="checkbox"/> L. LINE	<input type="checkbox"/> UP
<input type="checkbox"/> OTHER	<input checked="" type="checkbox"/> NORMAL
DISTANCE	<input type="checkbox"/> LOW
<input type="checkbox"/> 0.5 Km	<input type="checkbox"/> DRY
<input type="checkbox"/> 0.2 Km	
<input checked="" type="checkbox"/> 0.15 Km	
<input type="checkbox"/> 0.12 Km	
<input type="checkbox"/> OTHER	

CLARITY

1st -sample pass- 2nd

<20 cm

20-<40 cm

40-70 cm

> 70 cm/ CTB

Secchi Dpth

CANOPY

1st pass _____ cm

2nd pass _____ cm

≥ 85% OPEN

55%-<85%

30%-<55%

10%-<30%

≤10%-CLOSED

CJ RECREATION

POOL: AREA >100ft² DEPTH >3ft

BJ AESTHETICS

NUISANCE ALGAE

INVASIVE MACROPHYTES

EXCESS TURBIDITY

DISCOLORATION

FOAM / SCUM

OIL SHEEN

TRASH / LITTER

NUISANCE ODOR

SLUDGE DEPOSITS

CSOs/SSOs/OUTFALLS

DJ MAINTENANCE

PUBLIC / PRIVATE / BOTH / NA

ACTIVE / HISTORIC / BOTH / NA

YOUNG-SUCCESSION-OLD

SPRAY / SNAG / REMOVED

MODIFIED / DIPPED OUT / NA

LEVEED / ONE SIDED

RELOCATED / CUTOFFS

MOVING-BEDLOAD-STABLE

ARMoured / SLUMPS

ISLANDS / SCoured

IMPOUNDED / DESICCATED

FLOOD CONTROL / DRAINAGE

Circle some & COMMENT

EJ ISSUES

WWTP / CSO / NPDES / INDUSTRY

HARDENED / URBAN / DIRT&GRIME

CONTAMINATED / LANDFILL

BMPs-CONSTRUCTION-SEDIMENT

LOGGING / IRRIGATION / COOLING

BANK / EROSION / SURFACE

FALSE BANK / MANURE / LAGOON

WASH H₂O / TILE / H₂O TABLE

ACID / MINE / QUARRY / FLOW

NATURAL / WETLAND / STAGNANT

PARK / GOLF / LAWN / HOME

ATMOSPHERE / DATA PAUCITY

FJ MEASUREMENTS

\bar{x} width

\bar{x} depth

max. depth

\bar{x} bankfull width

bankfull \bar{x} depth

W/D ratio

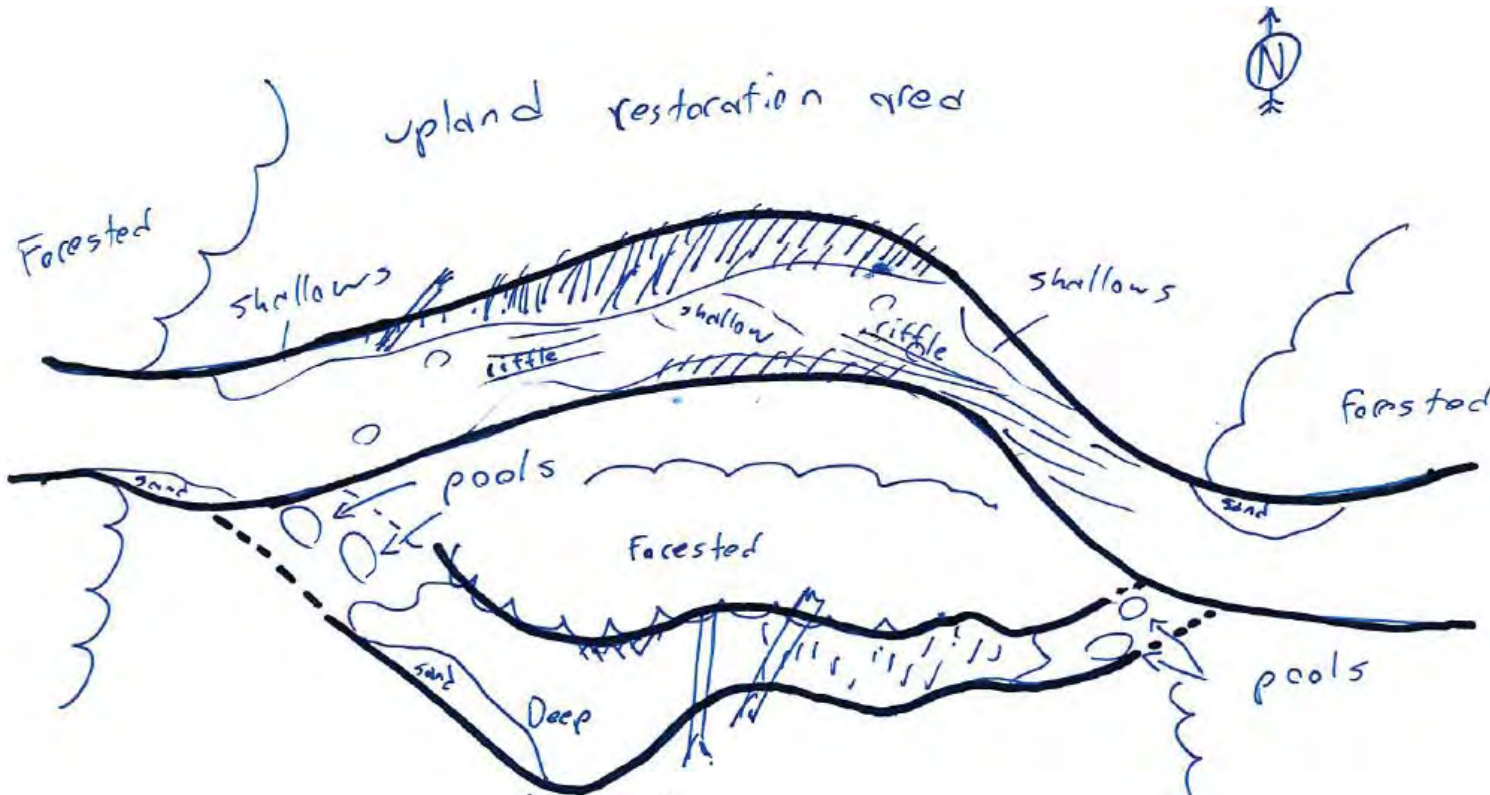
bankfull max. depth

floodprone \bar{x}^2 width

entrench. ratio

Legacy Tree:

Stream Drawing:



Appendix D Comprehensive Species Lists for IBI Data

Table 1. Day One IBI Data

Species Name	IBI Group	Feed Guild	Breed Guild	Pollution Tolerance	# of Fish	DELT
bluntnose minnow (<i>Pimephales promelas</i>)	N	O	C	T	147	0
central stoneroller (<i>Campostoma anomalum</i>)	N	H	N	-	13	0
creek chub (<i>Semotilus atromaculatus</i>)	N	G	N	T	21	0
fantail darter (<i>Etheostoma flabellare</i>)	D	I	C	-	19	0
green sunfish (<i>Lepomis cyanellus</i>)	S	I	C	T	3	0
greenside darter (<i>Etheostoma blennioides</i>)	S	I	C	T	23	0
johnny darter (<i>Etheostoma nigrum</i>)	D	I	C	-	5	0
northern hog sucker (<i>Hypentelium nigricans</i>)	R	I	S	M	9	0
redside dace (<i>Clinostomus elongatus</i>)	N	I	S	I	1	0
silverjaw minnow (<i>Notropis buccatus</i>)	N	I	M	-	14	0
suckermouth minnow (<i>Phenacobius mirabilis</i>)	N	I	S	-	5	0
western blacknose dace (<i>Rhinichthys obtusus</i>)	N	G	S	T	9	0
Total Fish Captured	-	-	-	-	269	0
Total Fish Included in IBI Scoring	-	-	-	-	269	0

Table 2. Day Two IBI Data

Species Name	IBI Group	Feed Guild	Breed Guild	Pollution Tolerance	# of Fish	DELT
bluntnose minnow (<i>Pimephales promelas</i>)	N	O	C	T	242	0
central stoneroller (<i>Campostoma anomalum</i>)	N	H	N	-	46	0
creek chub (<i>Semotilus atromaculatus</i>)	N	G	N	T	51	0
fantail darter (<i>Etheostoma flabellare</i>)	D	I	C	-	29	0
green sunfish (<i>Lepomis cyanellus</i>)	S	I	C	T	4	0
greenside darter (<i>Etheostoma blennioides</i>)	S	I	C	T	72	0
johnny darter (<i>Etheostoma nigrum</i>)	D	I	C	-	2	0
northern hog sucker (<i>Hypentelium nigricans</i>)	R	I	S	M	15	0
redside dace (<i>Clinostomus elongatus</i>)	N	I	S	I	6	0
silverjaw minnow (<i>Notropis buccatus</i>)	N	I	M	-	5	0
suckermouth minnow (<i>Phenacobius mirabilis</i>)	N	I	S	-	1	0
western blacknose dace (<i>Rhinichthys obtusus</i>)	N	G	S	T	20	0
Total Fish Captured	-	-	-	-	493	0
Total Fish Included in IBI Scoring	-	-	-	-	493	0

Appendix E IBI Scoring

Table 3. IBI Results

Metric	Score			
	7-2-2013		8-13-2013	
	Value	Score	Value	Score
Total Number of Species (minus exotics and hybrids)	12	5	12	5
Number of Darter/Sculpin Species	3	5	3	5
Number of Headwater Species	3	3	3	3
Number of Minnow Species	7	5	7	5
Number of Sensitive Species	3	3	3	3
% Tolerant Species	67	1	64	1
% Omnivores	55	0	49	0
% Insectivores	29	3	27	3
% Pioneering Species	71	1	61	1
Number of Individuals	269	3	493	3
Number of Simple Lithophiles	5	5	5	5
% DELT Anomalies	0	5	0	5
Individual IBI Scores	-	39	-	39
Average IBI Score		39		