Conservation Agreement and Strategy for Graham's Beardtongue (*Penstemon grahamii*) and White River Beardtongue (*P. scariosus* var. *albifluvis*)

SEED MANAGEMENT STRATEGY

Prepared by the Penstemon Conservation Team

State of Utah School and Institutional Trust Lands Administration
Uintah County, Utah
Utah Public Lands Policy Coordination Office
Utah Division of Wildlife Resources
Rio Blanco County, Colorado
Bureau of Land Management
U.S. Fish and Wildlife Service

May 2017

CONSERVATION AGREEMENT AND STRATEGY FOR GRAHAM'S BEARDTONGUE (*PENSTEMON GRAHAMII*) AND WHITE RIVER BEARDTONGUE (*P. SCARIOSUS* VAR. *ALBIFLUVIS*):

SEED MANAGEMENT STRATEGY

Prepared by

The Penstemon Conservation Team

State of Utah School and Institutional Trust Lands Administration
Uintah County, Utah
Utah Public Lands Policy Coordination Office
Utah Division of Wildlife Resources
Rio Blanco County, Colorado
Bureau of Land Management
U.S. Fish and Wildlife Service

May 30, 2017

CONTENTS

APPENDICES

TABLES

FIGURES

This page intentionally blank

INTRODUCTION AND PURPOSE

The purpose of this Seed Management Strategy (hereafter, Strategy) is to guide the development and implementation of an ex situ seed bank conservation strategy for Graham's and White River beardtongues in accordance with the requirements outlined in the Penstemon Conservation Agreement (hereafter, Agreement) (PCT 2014). The objectives of this Strategy are to 1) describe the importance of an ex situ seed bank for conservation, 2) identify the key principles for developing a seed bank, 3) develop a strategic approach for future collections, and 4) provide the logistical details required for implementation of this plan.

This Strategy fulfills the commitment to develop a seed bank, as described in Table 4 action 16 of the Agreement, and provides standardized procedures for the development and implementation of seed collection and seed storage for Graham's and White River beardtongues.

Adaptive Management

Adaptive management is a strategic approach for meeting management challenges under changing conditions and available information. Implementing adaptive management will be the responsibility of the Penstemon Conservation Team (PCT 2014, section 6.5). The Penstemon Conservation Team will review and use new information gathered from seed collection reports, seed germination tests, restoration studies, and other applicable research in order to revise this seed storage and collection plan as needed. Sources of new information may be studies directly funded through the Agreement or from outside research relevant to the ecology of the species.

Objective 1: Establish Ex situ Seed Banking

'*Ex situ*' refers to actions that take place off site, such as research conducted in a laboratory rather than in the wild. '*In situ*' actions are those that take place in the wild where a species occurs naturally, such as monitoring conducted in the field. Since *ex situ* seed banking is one of the most economical and efficient methods for preserving the genetic diversity of rare species, it is an ideal tool for the Conservation Team to employ.

The ultimate goal of *ex situ* collection and storage of seeds or other plant materials is to make those materials available for the long-term survival and resiliency of populations in the wild. A major benefit of ex situ conservation is the preservation of plant material for research efforts and restoration purposes, without a need to remove plants from wild populations. *Ex situ* plant materials can also be a useful tool to provide public awareness for a species.

Ex situ (off site) conservation of plant genetic material can be achieved through several different methods, such as, seed banks, gene banks, in-vitro storage methods, pollen banks, and DNA genetic banks. Botanical gardens are the most conventional method of ex situ conservation, all of which house specimens (vegetative propagules, tissues, and seed) for reintroduction into nature. Plants may also be preserved in part through seedbanks or germplasm banks. Seed banking is typically the most economical and efficient approach when it comes to ex situ conservation methods.

Most long-term seedbanks have a cryogenic laboratory facility in which the seeds can be preserved for up to a century or more without losing their viability. For plants that cannot be preserved in seedbanks,

germplasm may be conserved as in-vitro storage, where cuttings of plants are kept under strict conditions in glass tubes and vessels.

An important component of seed banking is having two types of seed storage, "black box," and "working" collections. A black box collection can be thought of as an archived genetic collection. The goal is to provide long term seed storage at a specialized facility to help preserve plant genetics in perpetuity. This collection is typically left untouched unless there is a catastrophic event requiring the use of these seed due to the loss of reproductive material from the wild or loss of a working collection.

In contrast, a "working" collection stores seeds that will be used within a shorter time frame for restoration, research, and in situ conservation needs. Seed collected for the working collection will be cleaned, stored, and used later in reclamation seed mixes and/or used for propagation for plant materials. Seeds from the working collection can be used toward habitat restoration and as mitigation for impacts from development activities. Prior to planned development activities, seeds should be collected and placed in both the black box and working collections for genetic conservation and future reclamation activities at the same site.

Seed banking is the preferred ex situ method that the Penstemon Conservation Team will implement to preserve Graham's and White River beardtongue genetics. When developing these seed collections, it is the Team's objective to collect seed from across the entire range of each species, including from each designated conservation area, and repeat these collections over time.

Objective 2: Achieve the Principles of Seed Banking

The following basic principles of ex-situ seed banking are incorporated into the Strategy.

- Collection Purpose – As previously described the two types of collections, black box and working collections, serve different but related purposes (see Objective 1). As part of our seed collection protocol, we will determine the number of individuals, populations, and seeds that need to be collected from wild populations. The final use of the seeds will be determined prior to conducting a wild seed collection.

- Genetic Diversity – Genetic diversity is the key to maintaining a healthy population in the wild. A seed bank, whose purpose is to support wild populations through augmentation and reintroduction, should also represent the diversity of the species in order to ensure successful reintroductions. Genetic diversity of a collection is achieved by collecting seed from many individuals across both place and time (Menges et al. 2004, Walters 2004). Each sub-population has the potential to have unique genetic traits. Therefore, we will target seed collections across the species range, including the edge of the species range where genes favoring adaptability may be more frequent. We will also identify populations across the species range for repeat collections in order to capture the genetic variability across the range and between years.

- Redundancy – Redundancy of seed collections will be accomplished by collecting seed from the same populations over time. Redundancy is also important when considering the storage of the seeds. In order to avoid a loss of valuable seeds, time, effort, and funding the seed collections will not be stored all at the same location. This will offer protection against an emergency event such as loss of power, fire, disease, or other natural disaster. Seeds will be deposited at more than one storage facility to ensure there is no over reliance in one facility, and the collections are protected by implementing the principle of redundancy.

- Resiliency – Resiliency of a seed collection describes the longevity and viability of the seeds after they are placed into storage. The resiliency of the seeds after being taken out of storage depends on many influencing factors, such as the environmental conditions at collection, treatment during handling, storage temperature, relative humidity in storage, seed water content, and the characteristics of the individual taxon (Walters 2004). The resiliency of the seeds will decline as storage time increases, and this varies widely based on the particular species (Walters 2004). In order to determine the seed collections longevity, i.e., how long seeds can be stored before declining beyond a critical threshold, we will determine the health and viability of the seed when they are initially collected. This baseline viability will be used to determine when a collection needs to be replenished.

Objective 3: Develop and Implement a Strategy for Future Collections

EVALUATION OF EXISTING EX SITU SEED BANK MATERIALS

Over the past fifteen years seed of both *Penstemon* species was collected by Red Butte Garden and Arboretum (RBG) at the University of Utah, and placed in long-term conservation storage at the National Center for Genetic Resources Preservation (NCGRP) or kept on-site at RBG to be used as a secondary black box collection and working collection. Storing seeds at more than one location provided redundancy for the seed collections. Seeds stored at the NCGRP are primarily intended for emergency use and NCGRP is considered to be the "black-box" storage facility. All seeds were collected and handled according to protocols established by the Center for Plant Conservation (CPC) and International Union for the Conservation of Nature (IUCN) Guidelines for the Management of Ex-situ Populations.

A complete summary of the seed currently held in storage at RBG and NCGRP for each species is listed in Tables 1 and 2 of Appendix A. A map of current collection locations by species is shown below Appendix C, Figures 1 and 2. A total of 12,174 wild seeds of Graham's beardtongue from 12 general locations have been collected and placed in storage at the RBG and NCGRP facilities. Additionally, 7,936 seeds have been produced from first generation (F1) greenhouse plants. A total of 18,931 wild collected seeds of White River beardtongue from six general locations have been collected and are currently in storage.

The majority of existing seeds in storage were collected near established long-term population monitoring sites, and therefore represent a narrow portion of the populations and genetic diversity for both species. The range and genetic diversity of both species is not thoroughly represented in existing collections.

FUTURE SEED COLLECTION STRATEGY

A planned, strategic approach to collection of seeds and storage locations is necessary to achieve the principles of genetic diversity, redundancy, and resiliency necessary for a robust ex situ seed bank. Additionally, enough seed must be collected to develop a robust "black-box" conservation collection as well as a working collection for restoration research and applied restoration projects.

To achieve an ex-situ seed collection that represents the genetic diversity of the species across the landscape we will collect seeds from as many locations as possible across the extent of the species' range. Seed collections will not be limited to designated conservation areas; however, the conservation areas will be used to assist with identifying areas where collection will occur.

Seed collections may be targeted or opportunistic. Target collections will be strategically planned to insure genetic robustness of the ex-situ collections. Opportunistic collections may be from target or non-target areas and should be conducted when possible. For example, if species' surveys overlap with natural

seed dispersal, seed may be collected during the survey window to maximize efficiency of time and funding, while also increasing the robustness of the seed bank. Additionally, repeated opportunistic collections, such as collections made near monitoring plots adds to the robustness of the overall collection by providing good genetic representation across time.

Who will collect – The targeted collections will be conducted by federal agencies or approved qualified botanists (USFWS 2011) acting as third-party contractors. Prior to conducting any seed collection, the third party must be authorized for access by the land owner or land management agency.

Timing of collections – Within four years the Team aims to have all five beardtongue units, for both species, represented in black box and working collections. See the Collection Timeline – 4 Year Plan section below for a detailed schedule. Annual weather patterns and reproduction activity of populations can affect the ability to collect seeds and may change the collection time line. The Team will adapt this Plan as necessary to account for variability in seasonal reproduction.

Frequency of collections – Viability data from other *Penstemon* species being held in long-term cold storage indicate that seeds maintain a stable viability rate for up to 20 to 30 years before sharp declines in viability occur (personal communication, Christine Walters, NCGRP, 5/15/2016). Therefore, a conservative approach to replenishing a black-box ex situ seed bank for *Penstemon* species is to recollect from the same populations at a maximum of interval every 20 years. More frequent collections may be required to support other uses for seeds, such as reintroduction, where used seeds will require replacement.

How much to collect – The amount of seed needed varies widely based on the intended use for the seeds and the health of the populations. Detailed discussion and worksheets for evaluating the size of a collection can be found in Appendix 1 of Guerrant et al. 2004. In summary, to achieve maximum genetic diversity and have 95% of alleles represented in a collection, we will apply the following general principles;

- For populations that have more than 50 individuals, we will collect seed from at least 50 individuals in order to capture 95% of the alleles.
- For a species with over 50 populations, a minimum of 50 populations should be collected from.
- For populations with 50 or fewer individuals, we will collect seed from each reproductive individual if possible. For a species with 50 or fewer populations, we will collect seed from all populations if possible.

To avoid negatively impacting a population, no more than 10% of the available seed should be collected in one year. More frequent, smaller collections have a less negative impact on sensitive populations than infrequent intense collections.

COLLECTION TIMELINE – 4 YEAR PLAN

This collection timeline will be updated before the field season in the 5th year (before March 2021). The specific collection locations within the target areas will be determined by the field crew leaders. Some flexibility in collection location must be built into the strategy in order to adapt to localized climatic conditions, safety and accessibility, and sub-population health. Seed collection locations within units should prioritize areas where seed was not previously collected.

Year 1

The following areas will be targeted in the first year:

Unit 1 – Sand Wash Unit – Graham's Beardtongue

- Both BLM and SITLA conservation areas will be targeted for collection.
- Up to 10 locations will be collected.
- Collections will range across the unit from east to west.
- The western most sub-population along Wrinkles road will be targeted.
- Special attention will be given to collect from disjunct conservation areas within the unit.

Unit 5 – Raven Ridge Unit – Graham's Beardtongue and White River Beardtongue

- Up to 5 locations will be targeted for each species.
- Both BLM and SITLA Interim B areas will be targeted for collection.
- Northern and western most locations of White River and Graham's beardtongue will be targeted.
- Special attention will be given to collect from disjunct conservation areas within the unit.

Year 2

The following areas will be targeted in the second year:

Unit 4 – White River Unit – Graham's Beardtongue and White River Beardtongue

- Up to 10 locations will be targeted for White River beardtongue.
- Up to 10 locations will be targeted for Graham's beardtongue.
- Collections will be from private conservation areas, private interim areas, SITLA interim, and BLM areas.

Book Cliffs White River Beardtongue Population

- At least one, and up to 3, collections will be made from the book cliffs location discovered in 2014. Number and location of collections will be determined by updated survey and population data.

Year 3

The following areas will be targeted in the third year:

Unit 3 – Evacuation Creek Unit – Graham's Beardtongue and White River Beardtongue

- Up to 10 locations will be targeted for each species.
- Collections will be from private conservation areas, private interim areas, SITLA interim, and BLM areas.

Year 4

The following areas will be targeted in the fourth year:

Unit 2 – Seep Ridge Unit – Graham's Beardtongue and White River Beardtongue

- Up to 5 locations will be targeted for Graham's beardtongue.
- Up to 10 locations will be targeted for White River beardtongue.
- Collections will be from SITLA conservation area, SILTA interim areas, DWR and BLM will be targeted.
- Areas on the eastern portion of the unit and disjunct areas will be prioritized since other areas within the unit are already represented in the seed bank.

Collection Protocols

Seed will be collected, cleaned, and stored according to the guidelines established by the CPC and NCGRP, which are described in detail in Guerrant et al 2004 and Wieland 1993 (Appendix B). As established in the CPC guidelines, no more than 10% of the available seed on a given day will be collected. If the field crew leader determines that removing 10% of the seed will be harmful to the health of the population, fewer seeds will be collected so that the existence of the population is not compromised (Guerrant et al 2004, Appendix 1). Maternal lines will be kept separate during collections, as described in the CPC protocols, in order to carry a population's genetic diversity through to final restoration applications. A seed collection data form (Appendix D) will be filled out for each seed collection and maintained for long-term record keeping. One copy of the data form will be submitted with the seeds for storage (along with additional forms required by the storage facility) and a second copy will be maintained at the BLM, Vernal Field Office.

Seed Viability Testing

Ideally seed collections should be tested to determine baseline viability prior to placement in long-term storage. Baseline viability is used to assess the long-term viability of seeds in storage and replenishment rates. Viability is also necessary to determine how much seed needs to be collected and to plan for reintroduction efforts. Viability testing will be conducted as soon as possible after collection or within 12 months of collection.

Once in long-term storage it is helpful to test a small sample of seeds in order to determine the rate of attrition while in storage and plan replenishment collections. Periodic testing will be conducted after 5 and 10 years post collection, followed by testing at 10 year intervals to determine if attrition is occurring.

Viability testing of collections will be conducted as funding allows.

Seed Cleaning and Storage

Long-term conservation black-box collections will be submitted to Red Butte Garden, where seeds will be cleaned, accessioned, and stored. Seeds going to NCGRP must be submitted by a CPC partner institution, such as Red Butte Garden. Therefore, Red Butte Garden will submit a portion of the seeds for storage at NCGRP and these will be maintained as part of the CPC National Rare Plant Collection. Viability tests will be conducted by either NCGRP or Red Butte Garden upon request of the donating agency.

The Team's records for collection data, storage location, and viability will be stored in a database managed by the BLM, Vernal Field Office. A copy of the seed collection data form will be submitted to the BLM annually in order to maintain records in one location.

Working collections will be cleaned and housed at one of the following facilities depending on available capacity, length of storage, and intended seed use.

1. Red Butte Garden and Arboretum
   C/O Conservation Department
   300 Wakara Way
   Salt Lake City, UT 84108

   Contact Person:
   Bruce Pavlik, Conservation Director
   (801) 585-5853
   bruce.pavlik@redbutte.utah.edu

2. Great Basin Research Center
   494 West 100 South
   Ephraim, UT 84626

   Contact Person:
   Kevin Gunnell
   (435) 283-4441 ext. 2024
   www.greatbasinnpp.org/udwr

REFERENCES

Guerrant E.O., P.L. Fiedler, K. Havens, and M. Maunder. 2004. Appendix 1 Revised genetic sampling guidelines for conservation collections of rare and endangered plants. In Guerrant, E.O., K. Havens, and M. Maunder (Eds.). *Ex situ Plant Conservation: Supporting Species Survival in the Wild*. Washington, D.C.: Island Press.

Menges, E. S., E. O. Guerrant, and S. Hamzè. 2004. Effects of seed collection on the extinction risk of perennial plants. In Guerrant, E.O., K. Havens, and M. Maunder (Eds.). *Ex situ Plant Conservation: Supporting Species Survival in the Wild*. Washington, D.C.: Island Press.

Penstemon Conservation Team. 2014. Conservation Agreement and Strategy for Graham's Beardtongue (*Penstemon grahamii*) and White River Beardtongue (*P. scariosus* var. *albifluvis*). Prepared for the State of Utah School and Institutional Trust Lands Administration; Uintah County, Utah; Utah Public Lands Coordination Office; Utah Division of Wildlife Resources; Rio Blanco County, Colorado; Bureau of Land Management; and U.S. Fish and Wildlife Service. Prepared by SWCA Environmental Consultants, Salt Lake City, Utah. July 22, 2014.

Red Butte Garden and Arboretum. 2013. Red Butte Garden Rare Plant Seed Collection Protocol. Red Butte Garden Conservation Department, Salt Lake City, UT.

U.S. Fish and Wildlife Service (USFWS). 2011. Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed and Candidate Plants. Utah Ecological Services Field Office: U.S. Fish and Wildlife Service.

Wieland, G. 1993. Guidelines for the Management of Orthodox Seeds. St. Louis, MO: Center for Plant Conservation.

APPENDIX A

Tables

This page intentionally blank

Table A-1. White River Beardtongue Seed Currently in Ex situ Storage

RBG Seed Accession Number	Collection Date	Location Name	Location Lat/Long NAD 83	# Individuals	# Seed Collected	Storage Location		Germination %	Germination Date
						RBG	NCGRP		
NA	1992?	Unknown, collected by Denver BG		NA	701	NA	701	88	1992
S-6	8/3/2001	White River	N 39.974975° W109.167569°	25	2000	2000	0	NA	
S-164	6/30/2005	White River	N 39.974975° W109.167569°	14	1170	100	1000	NA	
S-214	6/30/2005	White River	N 39.974975° W109.167569°	13	411	411	0	NA	
S-241	6/25/2006	White River	N 39.974975° W109.167569°	9	70	9	61	NA	
S-247	6/25/2006	White River	N 39.974975° W109.167569°	NA	678	361	317	NA	
S-274	7/6/2007	Bitter Creek	N 39.737309 W109.353458	NA	1161	541	503	26% and 88%	2013 and 2015
S-368	7/9/2009	White River	N 39.974975° W109.167569°	NA	1678	1490	0	98%	2015
S-369	7/10/2009	Watson site	N 39.878986° W109.155692°	NA	1093	993	0	88%	2015
S-407	7/10/2010	White River	N 39.974975° W109.167569°	14	1277	0	1277	41%	2011
S-501	7/18/2013	Watson Site	N 39.878986° W109.155692°	39	316	256	0	87%	2015
S-502	7/19/2013	White River	N 39.974975° W109.167569°	60	2410	804	1206	90%	2015
In process	7/8/2015	White River	N 39.974975° W109.167569°	31	3028	3028	0	NA	

Table A-1. White River Beardtongue Seed Currently in Ex situ Storage

RBG Seed Accession Number	Collection Date	Location Name	Location Lat/Long NAD 83	# Individuals	# Seed Collected	Storage Location		Germination %	Germination Date
						RBG	NCGRP		
In process	7/2/2015	Watson	N 39.878986° W109.155692°	8	114	114	0	NA	
In process	7/2/2015	Hells Canyon	N 39.897730° W109.087712°	17	1351	1351	0	NA	
In process	7/7/2016	BLM [RSR1]	TBD	8	1,896	1,896	0	NA	
In process	8/4/2016	Agency Draw	N 39.732400° W109.590700°	2	209	209	0	NA	
TOTAL					18,931	13,563	6,364		

Table A-2. Graham's Beardtongue Seed Currently in Ex situ Storage

Seed Accession Number	Collection Date	Location Name	Location Lat/Long NAD 83	# Individuals	# Seed Collected	Storage Location		Germination %	Germination Date
						RBG	NCGRP		
S-37	7/1/2004	Buck Canyon	N 39.737546° W109.502966°	2	10	10	0	NA	
S-275	7/6/2007	UNK	N 39.713786° W109.616498°	NA	~268	108	122	30%	2011
S-276	6/26/2007	UNK	N 39.725079° W109.339211°	NA	80	0	70	NA	
S-324	7/22/2008	Blue Knoll East	N 39.730186° W109.466520°	NA	227	206	0	NA	
S-325	7/22/2008	Blue Knoll	N 39.726626° W109.502046°	NA	350	330	0	NA	
S-326	7/22/2008	Buck Canyon	N 39.737546° W109.502966°	NA	418	418	0	NA	
S-354	7/22/2009	Colorado Border site, Park Canyon	N39.841155° W109.049945°	bulk	270	270	0	NA	
S-355	7/22/2009	Park Canyon	N 39.834756° W109.107818°	bulk	2231	2097	0	40%	
S-364	7/15/2009	Park Canyon	N 39.834756° W109.107818°	bulk	331	<331	0	41%	
S-365	7/16/2009	Blue Knoll East	N 39.730186° W109.466520°	NA	289	289	0	NA	
S-366	7/16/2009	Blue Knoll	N 39.726626° W109.502046°	NA	264	0	264	NA	
S-367	7/16/2009	Buck Canyon	N 39.737546° W109.502966°	NA	748	348	400	NA	
S-414	6/1/2010	Blue Knoll	N 39.726626° W109.502046°	NA	19	0	0	0%	12/2/2011

Table A-2. Graham's Beardtongue Seed Currently in Ex situ Storage

Seed Accession Number	Collection Date	Location Name	Location Lat/Long NAD 83	# Individuals	# Seed Collected	Storage Location		Germination %	Germination Date
						RBG	NCGRP		
S-415	6/1/2010	Blue Knoll East	N 39.730186° W109.466520°	NA	10	0	0	0%	12/2/2011
S-416	6/1/2010	Buck Canyon	N 39.737546° W109.502966°	NA	121	0	0	0%	12/2/2011
S-417	6/1/2010	Sunday School Canyon	N 39.663728° W109.435887°	NA	11	0	0	9%	12/2/2011
S-494	7/11/2013	Greenhouse F1 Parent P-324	N/A	1	900	400	450	29%; 16%; 25%; 0%	11/10/2014; 3/5/2015; 11/10/14; 12/8/2014
S-495	7/11/2013	Greenhouse F1 Parent P-317	N/A	1	2,570	1,172	1,285	29%; 16%; 25%; 0%	11/10/2014; 3/5/2015; 11/10/14; 12/8/2014
S-496	7/11/2013	Greenhouse F1 Parent P-316	N/A	1	1500	750	750	NA	
S-497	7/11/2013	Greenhouse F1 Parent P-315	N/A	1	1150	575	575	NA	
S-498	7/11/2013	Greenhouse F1 Parent P-314	N/A	1	356	150	156	29%; 16%; 25%; 0%	11/10/2014; 3/5/2015; 11/10/14; 12/8/2014
S-499	7/11/2013	Greenhouse F1 Parent P-322	N/A	1	307	104	154	29%; 16%; 25%; 0%	11/10/2014; 3/5/2015; 11/10/14; 12/8/2014
S-500	7/11/2013	Greenhouse F1 Parent P-319	N/A	1	575	352	123	NA	
S-520	7/22/2013	Sunday School Canyon	N 39.663728° W109.435887°	15	1106	1006	0	NA	

Table A-2. Graham's Beardtongue Seed Currently in Ex situ Storage

Seed Accession Number	Collection Date	Location Name	Location Lat/Long NAD 83	# Individuals	# Seed Collected	Storage Location		Germination %	Germination Date
						RBG	NCGRP		
S-526	7/22/2013	Blue Knoll site	N 39.726626° W109.502046°	6	238	238	0	NA	
S-527	7/22/2013	Blue Knoll East	N 39.730186° W109.466520°	9	632	632	0	NA	
S-528	7/22/2013	Buck Canyon	N 39.737546° W109.502966°	13	1073	973	0	NA	
S-582	7/22/2014	Blue Knoll East	N 39.730186° W109.466520°	18	1860	1760	0	NA	
S-583	7/22/2014	East of Blue Knoll East Site	N 39.732311 W 109.463065	11	599	599	0	NA	
S-584	7/21/2014	Buck Canyon	N 39.737546° W109.502966°	15	651	551	0	NA	
S-585	7/21/2014	Sunday School Canyon	N 39.663728° W109.435887°	7	171	171	0	NA	
In process	6/17/2016	Seep Ridge	TBD	1	6	6	0	NA	
In process	6/21/2016	Wrinkles Road	N 39.843965 W 110.142345	2	44	44	0	NA	
In process	6/22/2016	Buck Canyon	TBD	1	35	35	0	NA	
In process	7/6/2016	Seep Ridge	TBD	7	104	104	0	NA	
In process	8/4/2016	Seep Ridge	TBD[RSR2]	1	8	8	0	NA	
TOTAL					19,201	13,706	4,349	NA	

This page intentionally blank

APPENDIX B

Beardtongue Rare Plant Seed Collection Protocol

This page intentionally blank

BEARDTONGUE RARE PLANT SEED COLLECTION PROTOCOL

(Revised from Red Butte Garden Rare Plant Seed Collection Protocol 2013)

Based on Center for Plant Conservation methods described in "Ex situ Plant Conservation: supporting species in the wild" Editor Guerrant et al. 2004.

Field Collection Materials

1. Paper coin envelopes or cloth bags.
2. Scotch tape
3. Dry cooler to place bags/envelopes once seed is collected
4. GPS or Map to record location of seed collection
5. Tweezers
6. Magnifying loupe
7. Camera

Field Collection Methods

1. Seed will be assessed for maturity prior to collection. Only mature seeds will be collected.
2. Seeds may be collected at the time of natural dispersal either directly from the plants or from the ground immediately beneath the plant.
3. Only collect from healthy populations without presence of disease.
4. Confirm the species of plant you are collecting with an expert.
5. Take photographs the plant and habitat. Include pictures of the following: habitat, population, the whole plant, floral characteristics, vegetative characteristics, and seeds. Photograph any unusual observations as well, such as fungus, herbivory, habitat destruction, etc. if it is not typical for the species.
6. Fill out a seed collection data form (for the institute that the seed is being sent to) while in the field. Each site or population should get a new field data form.
7. Collect seeds along maternal lines in a separate envelope for each parent plant.
8. Label each envelope with the scientific name of the plant, date collected, approximate number of seeds in the envelope, and population name (Element Occurrence #, common place name, or GPS coordinates).
9. Seal envelopes using scotch tape to seal ALL seam at the top and bottom of the envelope. (Glue on the envelopes will not stick in hot dry conditions and leaves gaps for seeds to escape.)
10. **DO NOT ever use plastic bags for collection or storage** of the seeds as they need to remain dry, cool, and ventilated to remain viable.

Amount of Seed to Collect

1. Populations fewer than 50 individuals: Collect seed from all plants, 10% of available seed per plant.
2. Populations of 50+ individual plants: Collect seed from 50 plants if possible and 10% of available seed per plant.
3. Limit collections to no more than 10% of the seed available at the time of the visit.
4. Do not collect all of the seeds produced by one individual.

*As time and resources allow, collect from as many available populations as feasible, up to 50 populations. With small populations of fewer than 50 plants, it is critical to collect from many populations.

Guidelines for Selecting Populations

1. Keep in mind, we want to collect ecologically significant variation. That means collecting material from distinct individuals, at different times and from different habitats (Husband and Campbell 2004).
2. Do not select only the "best" looking plants for collection. A broad genetic representation is desired for the seed bank.
3. When there are many populations to select from, target the largest populations. Not only can transplant success be higher from propagules of larger populations (Helenurm 1998), but there is more variation, and a lower risk of extinction to the population from the seed collection.
4. **Do not** collect if it is your best judgment that any seed collection will be detrimental to the survival of that population.

Field Storage and Transport

Option 1: Keep seeds in a cooler. The seeds should still remain dry in the cooler so place cold packs or ice in a separate plastic container in the cooler.

Option 2: Keep seeds in a paper or cloth bag in the shade of a vehicle or tree. Keep seeds a parked vehicle with ALL windows open.

- Keep seeds cool and dry.
- **Do not** allow seeds to remain in a closed vehicle in the sun or on a warm day. A closed car can easily reach temperatures of 130+ F in the summer and even 30 minutes in a hot car can reduce seed viability.
- Seeds **cannot** be transported inside of a trunk of a vehicle unless in a cooler.
- While transporting seeds keep the above recommendations in mind. If taking a long rest stop while traveling the seeds must be kept in a cool location such as a cooler, motel room, or a back pack carried with you.

Shipment

1. Send seeds to the designated storage facility as soon as possible after collection.
2. Seeds being sent to NCGRP must be sent to Red Butte Garden first for accession. Mail seeds shipped overnight to the address listed below or hand deliver.
3. Ship to: Red Butte Garden and Arboretum
   Attn: Bruce Pavlik
   Conservation Department
   300 Wakara Way
   Salt Lake City, UT 84108

Questions or concerns should be directed to Bruce Pavlik at bruce.pavlik@redbutte.utah.edu (801) 585-5853.

This page intentionally blank

APPENDIX C

Seed Collection Maps

This page intentionally blank

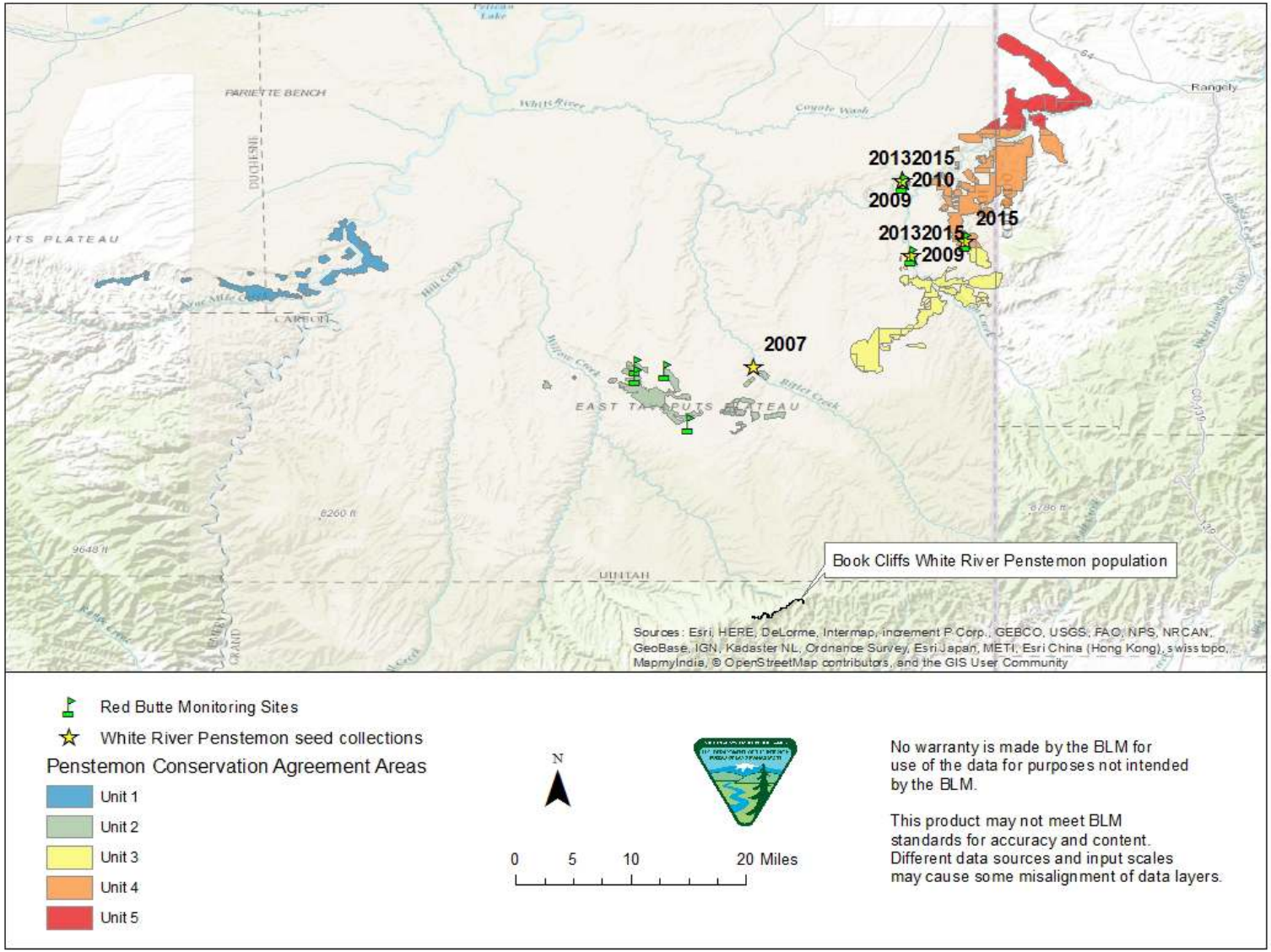

Figure C-1. Map of existing White River beardtongue seed collection locations.

This page intentionally blank

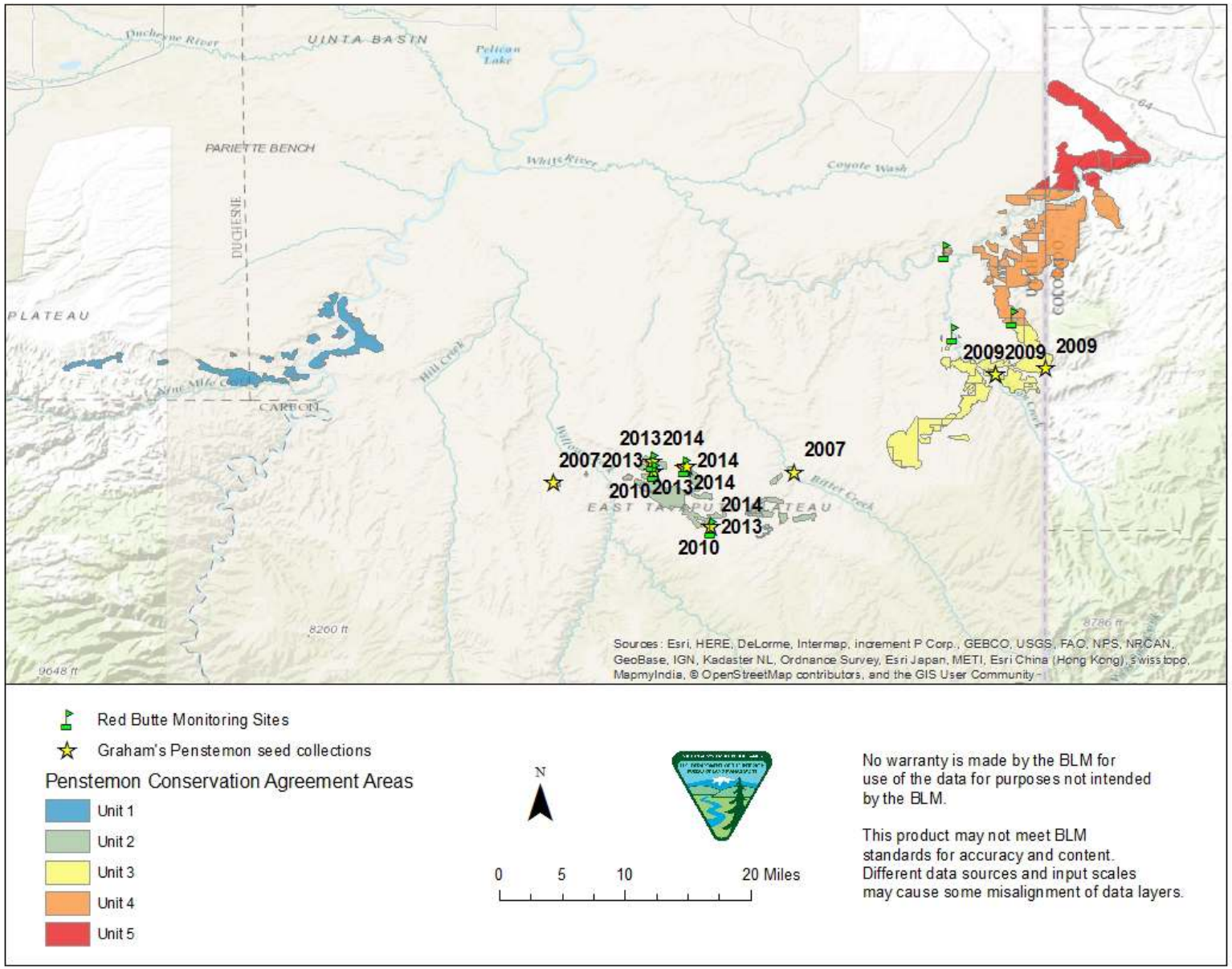

Figure C-2. Map of existing Graham's beardtongue seed collection locations.

This page intentionally blank

Appendix D

Rare Plant Seed Collection Form

This page intentionally blank

RARE PLANT SEED COLLECTION FORM

(Adapted from Red Butte Garden Collection form)

CPC Accession # _____

Date: _____ **Collector:** _____ **Other Accession #** _____

Family: _____ **Genus:** _____ **Species:** _____ **Variety:** _____

State: _____ **County:** _____ **Elevation (m):** _____

Reason Collected: _____

GPS/UTM Datum (NAD 83) N: _____ **E:** _____

Map name & type: _____ **Land Owner:** _____

Location Description: (Directions and Site)

_____

_____

_____

Seeds Collected from (Circle): *Plants Ground Both* **Seeds Collected (Circle):** *Bulk or Maternal Lines* **Collected at (circle)**: *natural dispersal immature Post-dispersal*

No. of Plants Found: _____ **No. of Plants Sampled:** _____ **Flower Date**: _____

 # seeds collected _____ **Area Sampled (m^2):** _____ **Plant Height (cm/m):** _____

Plant Habit (circle): *tree shrub forb grass succulent*

Habitat and Associated Species:

_____

_____

_____

Habitat Information (Circle):

Light:	Open	¼ Shade	½ Shade	¾ Shade	Full Shade
Slope:	0-5	6-10	11-40	41-60	>60
Exposure:	North	South	East	West	

Soil Type: _____ **Soil Color:** _____

Population Threats: _____

Land Use: _____

Additional Comments: _____

This page intentionally blank