February 2015

Cave Rock Community Stormwater Summary

Prepared for:

Cave Rock Estates General Improvement District

Prepared by:

Nevada Tahoe Conservation District

Cave Rock Community Stormwater Summary
February 2015

Prepared and published by the Nevada Tahoe Conservation District.

Funds for this publication were provided by the United States Environmental Protection Agency.

Correspondence regarding this document should be sent to:
Jason Brand, Acting District Manager
Nevada Tahoe Conservation District
400 Dorla Court
PO Box 915
Zephyr Cove, NV 89448-0915

Contents

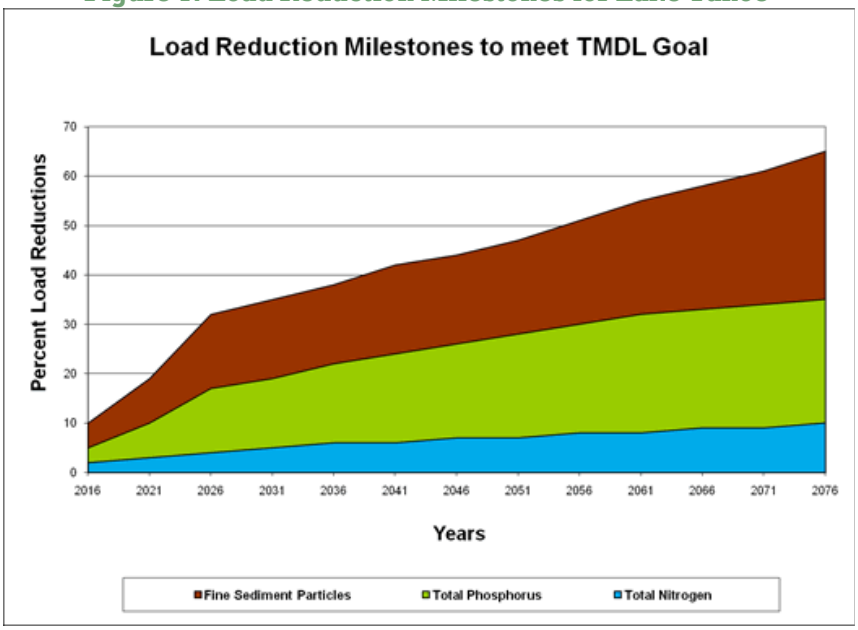
Executive Summary

This document provides information regarding Community Watershed Partnerships in the Cave Rock Estates General Improvement District. It gives an inventory of the watershed and describes water quality issues and stormwater treatments including information on the Cave Rock Estates community stormwater system and private parcel BMP implementation.

Introduction and Background

Lake Tahoe was designated as an impaired water body by the Environmental Protection Agency (EPA) in 1988. One of the requirements after designation is the creation of a Total Maximum Daily Load (TMDL) which set limits on the total amount of pollutants a water body can receive and still meet safe water standards. In 2011, after much research and development, a TMDL for Lake Tahoe was approved. The goal of the Lake Tahoe TMDL is to restore the Lake to its historic water clarity level of 97.4 feet. It established thresholds of pollutants (namely fine sediment, nitrogen and phosphorus) and calculated the load reductions needed from the four largest sources (urban and forest stormwater runoff, stream channel erosion, and atmospheric deposition) to achieve the TMDL by 2076. The Clarity Challenge was created as an interim goal to the TMDL numeric target. This goal is to meet a target of 78 feet of lake clarity by 2026 and considers opportunities for achievable load reductions in all source categories.

Figure 1: Load Reduction Milestones for Lake Tahoe



State Water Resources Control Board in California and Nevada Division of Environmental Protection (NDEP) in Nevada oversee implementation of the TMDL. These agencies work with other basin groups to achieve the thresholds put forth by the TMDL through the Lake Clarity Crediting Program. It uses Lake Clarity Credits to track pollutant load reductions from urban stormwater runoff through a comprehensive tracking system. The Crediting Program aligns policies with ongoing implementation which in turn improves accountability and effectiveness of efforts.

The Tahoe Regional Planning Agency (TRPA)'s Environmental Improvement Program (EIP) was launched in 1997. The program was created to protect and improve the extraordinary natural and recreational resources of Lake Tahoe. It is a cooperative effort that defines the restoration needed to attain the environmental goals of increasing water clarity. Key to this strategy is reliance upon partnerships with all sectors of the community, including private, local, state and federal. Part of the new Regional Plan adopted by the TRPA in 2012 is the option for jurisdictions to create Area Plans.

These plans allow the jurisdictions to be more considerate of the unique properties of their local communities. They describe the implementation of land use goals, policies, and ordinances including how the area will reach the environmental thresholds set forth by the TRPA Regional Plan. Once a plan is found to conform to all TRPA regulations and is adopted by a jurisdiction, the jurisdiction can assume development review authority through a memorandum of understanding (MOU) with the TRPA.

A portion of the TMDL and the EIP is the implementation of Best Management Practices (BMPs). BMP's improve water quality by reducing soil erosion and capturing polluted water before it enters Lake Tahoe. Implementing BMPs on public lands and private parcels is a critical step toward improving Lake Tahoe's water quality.

Community Watershed Partnerships (CWPs) work with jurisdictions and property owners to create community-wide projects that achieve water quality improvement and help stabilize the declining clarity of Lake Tahoe. CWPs help watersheds achieve lake clarity goals by integrating the needs of the jurisdictions with the Best Management Practices (BMP) requirements of private parcels owners.

Cave Rock Estates is an area with steep, rocky slopes and minimal places to infiltrate stormwater runoff. These geographical barriers have made this location an appropriate place to consider larger, area-wide treatments. The Cave Rock Estates Erosion Control Project (1990), Slope Protection Project (2003), and Bed Filter Retrofit (2014) were large capital improvement projects that installed treatments to control the sediment load that comes from this area.

Figure 2: CRE Stormwater System 2011

This Community Watershed Partnership (CWP) plan provides measures that Cave Rock Estates General Improvement District (CREGID) can take to not only help meet TMDL milestones but also to protect and improve native vegetation via invasive weed control.

Inventory of the Watershed

Cave Rock Estates is located on the east shore of Lake Tahoe in Douglas County and is named after the iconic Cave Rock. Starting in 1961, Cave Rock Estates developed during a period of 17 years in three different phases. Approximately 110 properties were originally developed with 80 private parcels still remaining today. Cave Rock Estates has approximately 150 residents, 50 of which live there year-round.

Figure 3: Project Boundary

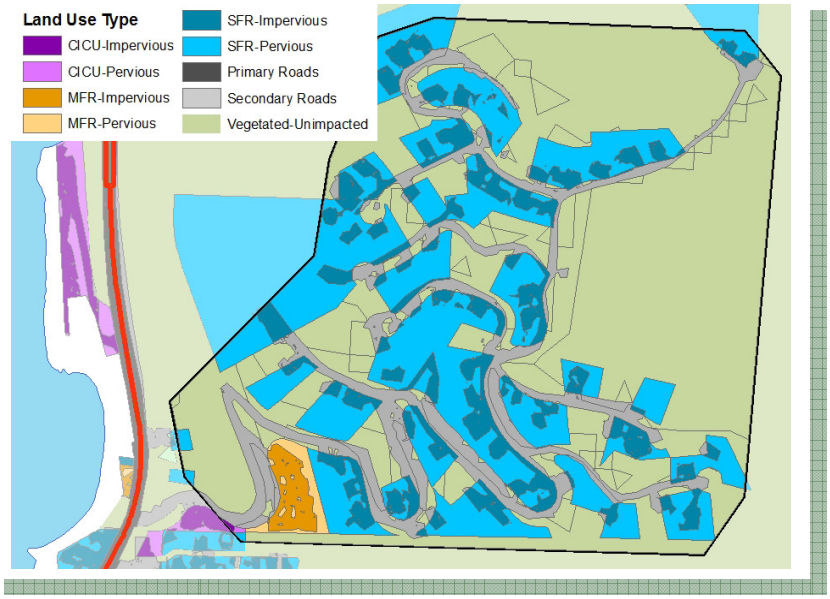
Cave Rock Estates has a General Improvement District (GID) that was established by Douglas County. The GID is responsible for improvements and maintenance of roads, curbs, gutters, sidewalks, storm drains, water system and street lighting. It is governed by 5 elected members that meet twice a year.

Land Use and Ownership

The land use in Cave Rock Estates consists of mostly privately owned single family residences (SFR), vegetated-unimpacted areas, and roads with SFRs and roads comprising the majority of the impervious surfaces.

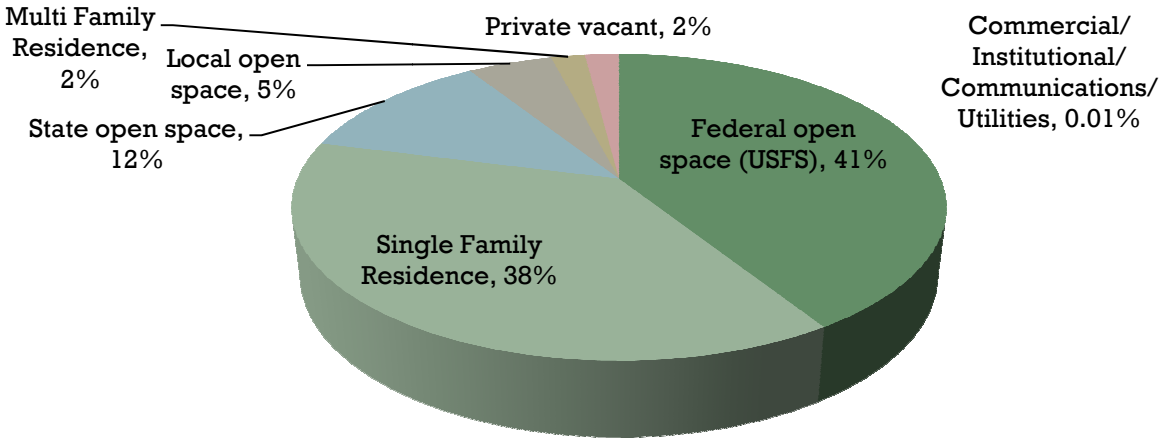
More than half of the area is comprised of open space owned by federal, state, and local entities. Single family residences comprise 38% of the area with only an additional 2% contributed by multi-family residences (MFR).

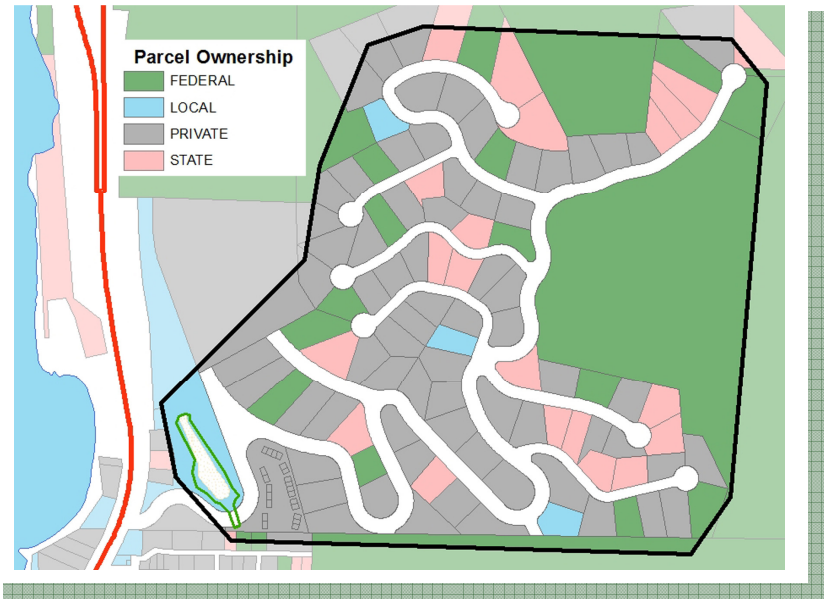
Figure 4: Land Use - 88.74 Total Acres



22.5%	Impervious
77.5%	Pervious

Figure 5 & 6: Parcel Ownership - 74.5 Total Acres without roads

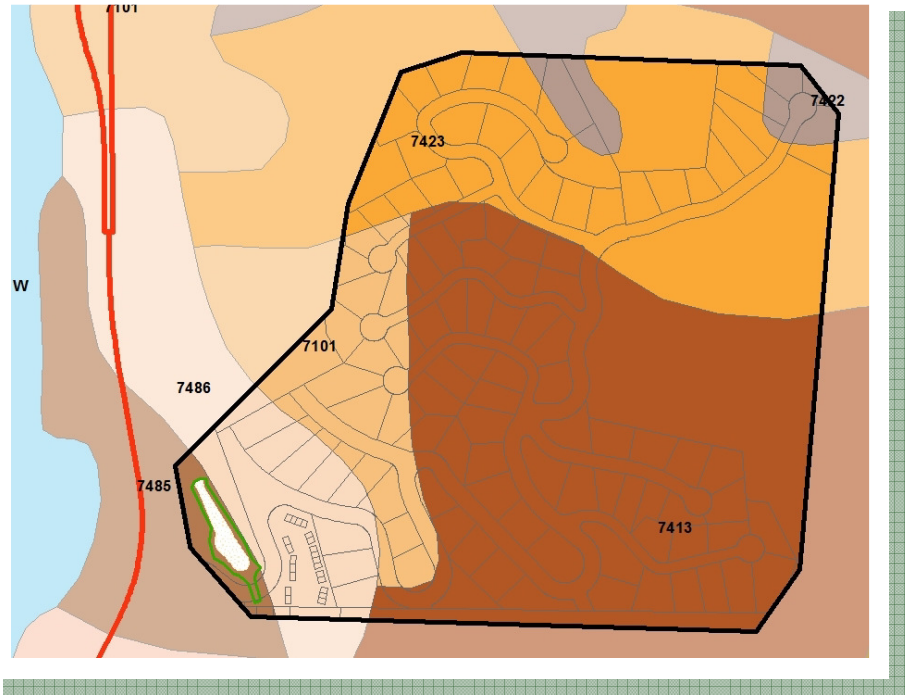




Soils

Soil information helps explain hydrology, potential sources of pollutants, and past watershed conditions. The soils data that was completed in 2006 by the Natural Resources Conservation Service (NRCS) shows the soils in the area to be of 6 different types and are characterized by steep slopes and rocky soils. Cagwin Rock Outcrop Complex and Cassenai Gravelly Loamy Course Sand comprises the majority of the area. A summary of select characteristics of the soil types in the watershed are presented in below. Further descriptions of soil characteristics within the watershed can be found on appendix pages A1 to A7.

Figure 7: Soil Types



Soil Type	Description	% of Total Acreage	Permeability at 12"	Runoff Class
7101	Caverock sandy loam, 9-50% slope	10%	0.7	High
7413	Cagwin Rock outcrop complex, 30-50% slopes, extremely stony	48%	5.7	Medium
7422	Cassenai gravelly loamy coarse sand, 15-30% slopes, very stony	3%	3.92	Medium
7423	Cassenai gravelly loamy course sand, 30-50% slopes, very stony	28%	3.92	Medium
7485	Meeks gravely loamy coarse sand, 15-30%, extremely bouldery	2%	14	Low
7486	Meeks gravelly loamy coarse sand, 30-70% slopes, extremely bouldery	9%	14.2	Low

Vegetation

Existing vegetation at the site is typical of a high, Eastern Sierra plant community. The south to west aspect, well drained soils, steep slopes and annual precipitation makes 'harsh site' species well adapted to this area.

Common Existing Native Vegetation:	
Ceanothus cordulatus	mountain whitethorn
Ceanothus prostratus	mahala mat
Ceanothus velutinus	Tobacco brush
Cercocarpos ledifolius	mountain mahogany
Artemesia tridentata	sagebrush
Arctostaphylos patula	greenleaf manzanita
Punus jeffreyi	Jeffrey pine
Purshia tridentata	antelope bitterbrush
Ericameria nauseosa	rabbitbrush

There are also additional "revegetation" type grasses found in this area. These species are scattered around the area.

Figure 8: Rabbitbrush

Figure 9: Sagebrush

Invasive Weeds

The Lake Tahoe Basin is in the relatively early stages of infestation by invasive weeds, so early detection and rapid response (EDRR) is at the heart of efforts. By detecting and eradicating small populations early and quickly, land owners and managers can save money and time while protecting the area from damage by invasive plants. The Class 1 Weeds listed below are the priority weeds of the Tahoe Basin; to be reported if encountered.

Class 1 Weeds: Present near or in the Tahoe Basin	
Cirsium arvense	Canada thistle
Centaurea diffusa	diffuse knapweed
Cardaria draba	hoary cress
Chondrilla juncea	rush skeletonweed
Acroptilon repens	Russian knapweed
Potentilla recta	sulfur cinquefoil
Dipsacus fullonum	teasel
Centaurea solstitialis	yellow starthistle
Carduus nutans	musk thistle
Onopordum acanthium	Scotch thistle

Class 2 Weeds: Managed infestations	
Cirsium vulgare	bull thistle
Linaria dalmatica	dalmatian toadflax
Hypericum perforatum	klamathweed
Leucanthemum vulgare	oxeye daisy
Lepidium latifolium	perennial pepperweed
Cytisus scoparius	Scotch broom
Centaurea maculosa	Spotted knapweed
Linaria vulgaris	yellow toadflax

The 2013 Weed Data Collection Map for Douglas County can be found on appendix page A8. For more information regarding invasive weeds of the Basin or to report a weed, visit TahoeInvasiveWeeds.org.

Wildlife

Wildlife is abundant in the Lake Tahoe Basin. While Cave Rock Estates is considered an urban area, it hosts many of the common species in the region.

Common Wildlife:	
Ursus americanus	black bear
Odocoileus hemionus	mule deer
Canis latrans	coyote
Tamiasciurus douglasii	Douglas squirrel
Callospermophilus lateralis	golden-mantled ground squirrel
Procyon lotor	raccoon
Cyanocitta stelleri	Stellar's jay
Poecile gambeli	mountain chickadee

Figure 10: Coyote

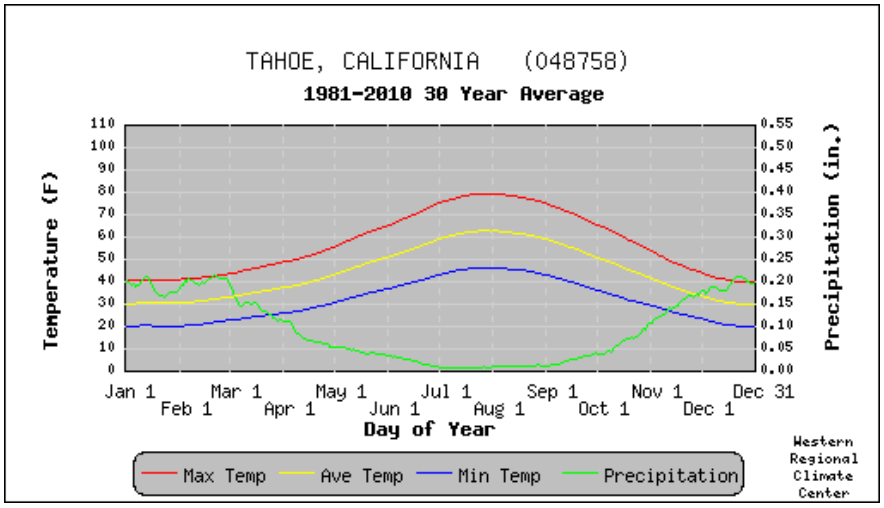
Figure 11: Black Bear

Refer to the *Lake Tahoe Watershed Assessment Volume II* for a full list of species in the Tahoe Basin: http://www.fs.fed.us/psw/publications/documents/gtr-175/

Precipitation and Climate

The average temperature highs are between 43° and 80° and low temperatures between 16° and 41°. The highest temperatures occur in July and August and the lowest in December and January. Precipitation is concentrated during the winter months, the highest precipitation in November with an average of 3.24". NOAA estimates the 25-year storm for the Cave Rock area as 0.99 inches in one hour, which is less than the 20-year storm of 1inch per hour used by the TRPA.

Figure 12: Yearly Temperature and Precipitation Averages



(Desert Research Institute)

Recreation

Recreation in the Cave Rock area includes hiking, biking, boating along with skiing, horseback riding and much more a short distance away. The crest of Cave Rock gives a beautiful view of the entire lake and makes for a perfect sunset hike. There is a short grouping of trails around Cave Rock and at the base of it is a Nevada State Park boat launch that is used by fisherman and recreationalists alike.

Environmental Improvement Projects

Three large water quality improvement projects have occurred in CREGID in the past 25 years. This along with private parcel BMP implementation has reduced the amount of sediment that reaches Lake Tahoe.

1990

The Cave Rock Estates Erosion Control Project (EIP # 10078) was completed. This project created a conveyance system to move the bulk of Cave Rock Estates stormwater runoff to 2 basins in Cave Rock Estates; a detention basin at the bottom of the subdivision and an infiltration basin on Chukkar in the upper area of the GID. The detention basin's runoff joins with Nevada Department of Transportation (NDOT) stormwater runoff, and sent through two deep sediment traps before entering Lake Tahoe.

2003

The Slope Protection Project (EIP# 10078) created retaining walls and other erosion control structures to manage the steep slopes in CREGID and reduce sediment load from these areas.

2014

The Stormwater System Retrofit Project (EIP #01.01.01.16) updated the existing detention basin to enable it to remove FSPs and become one of the first TRPA recognized community BMP systems.

In 2012 it was found that the detention basin installed in 1990 was not meeting the needs of the Lake Tahoe TMDL. It was designed prior to the identification of fine sediment particles (FSP, sub-16 µm diameter sediment) as the target pollutant in the Lake Tahoe Total Maximum Daily Load (TMDL) Program. This system needed to be upgraded to reach the pollutant load reduction targets put forth by EPA and The Nevada Division of Environmental Protection (NDEP).

The detention basin retrofit collaboration started in September 2008 when Cave Rock Estates General Improvement District (CREGID) board member, Bob Heffernan, contacted NTCD regarding the stormwater system at the base of CREGID. Knowing the detention basin was designed to capture stormwater runoff from the entire Cave Rock Estates watershed and not just the road infrastructure, CREGID contracted NTCD to do an analysis to determine if the stormwater system was sized large enough to capture and treat the driveway runoff from untreated driveways. Stormwater monitoring confirmed the detention basin was large enough to take on this additional runoff but does not remove FSPs, the pollutant of concern in the TMDL.

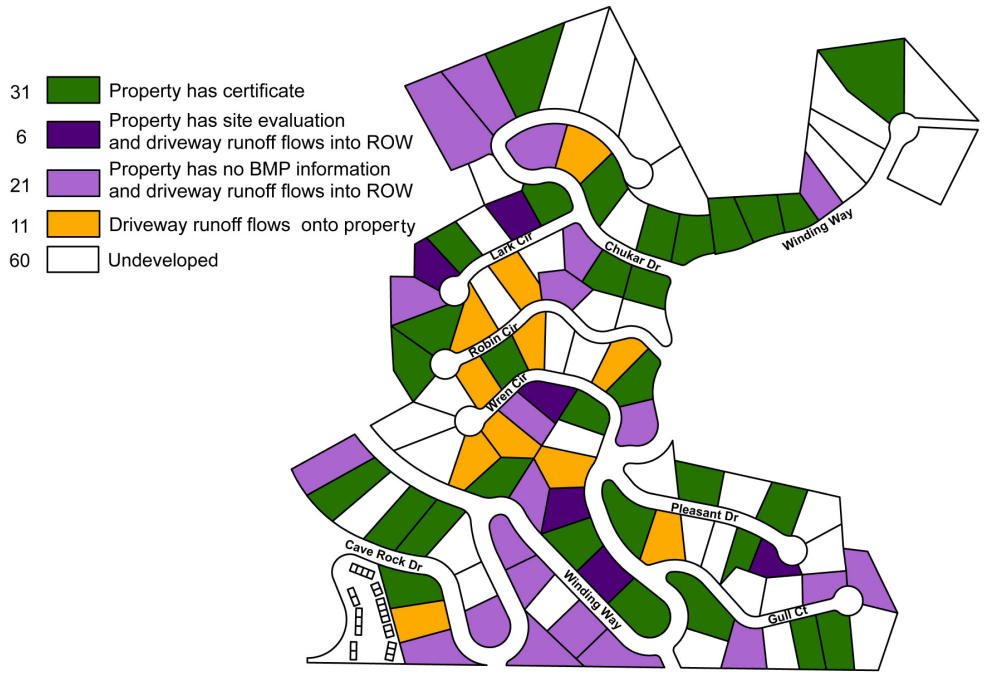


Figure 13: BMP Parcel Status and Pervious Surface Discharge (2/1/2014)

CREGID then approached TRPA with the suggestion of creating a community-based BMP in the form of the existing CREGID detention basin. The Tahoe Regional Planning Agency (TRPA) was open to the concept of a community BMP as long as CREGID could prove the system met the Lake Tahoe TMDL requirements for removing FSPs. CREGID hired the NTCD to conduct additional stormwater monitoring to determine the appropriate retrofit of the system and design the system. The construction of this system took place during the summer of 2014. Plans for this system can be found on page A9.

An inventory of all stormwater assets in Cave Rock Estates was compiled by NTCD. This includes all stormwater treatments that have been completed to date, but does not include slope stabilization measures that have been installed. A map of these assets can be found on page A10. Below is a summary of assets for the area.

Asset	Total Number	Approximate Feet
Conveyance Pipes		2234 ft
Conveyance Ditches		2040 ft
Drainage Outlets	5	
Sediment Traps	8	
Outfalls	1	
Manholes	8	
Curb & Gutter		8381 ft
Settling Basins	2	1126 sq ft
Dry Basins	1	2860 sq ft
Bed Filters	1	17860 sq ft

Ongoing

In conjunction with the community-wide stormwater treatment systems, single family residences (SFRs) and multi-family residences (MFRs) are working to complete and maintain their private parcel BMPs. The community system accepts and treats homeowner's driveway runoff that flows off of property, but homeowners are still required to armor drip lines and elevated structures and implement slope stabilization measures. In November 2013, all homeowners in the Cave Rock Estates community received an email through the CREGID board and a letter from TRPA consisting of a packet of information detailing the BMPs recommended for their area (pages A11-21). Maintenance of existing system includes refreshing drip lines, decks and impervious surfaces on the property, and tending to bare soil and steep slopes. Driveways that flow to the street can allow their water to discharge into the street. If the driveway flows onto the property, armor needs to be maintained in the area that water exits the driveway.

TYPICAL BMPS

Figure 14: Armor under elevated

Figure 15: Armor under drip line

Approximately 70% of SFRs in CREGID have not completed their BMPs and are therefore are out of compliance with the TRPA BMP ordinance. This increases the amount of fine sediment that is entering the watershed and puts a larger strain on any area wide system put in place to improve water quality.

Water Quality

The Cave Rock project area is hydrologically directly connected to Lake Tahoe. Through multiple large erosion control projects, basins, conveyance system and slope stabilization structures were constructed to reduce sediment load and control erosion in CREGID.

Load Reductions

The Pollutant Load Reduction Model (PLRM) was developed to help stakeholders in Lake Tahoe quantify FSP load reductions. Baseline modeling (2004 conditions) using the PLRM estimated an approximately load of 1,600 pounds of FSP per year come from catchment CR02 (this is what the area that encompasses CREGID is named in the Model). This assumed the bed filter installed in 1996 was working to some degree. Under the Existing Conditions modeling done in 2012, the bed filter functionality was assumed to be working better than originally modeled due to the expected retrofit being accounted for; this resulted in an estimated load reduction of approximately 500 lbs/year, reducing the load from CR02 to 1,125 lbs/yr FSP. Currently, the PLRM model is being revised through the Stormwater Tools Improvement Project. NTCD is working with Northwest Hydraulic

Consultants (nhc) to determine the appropriate way to model this retrofitted bed filter. The new bed filter modeled load reduction may be greater than the estimated 500 lbs/year.

Additional credits will not be gained from private party BMP installation. Increased road operations could provide load reduction through decreased delivery of sediment to the bed filter.

Monitoring

In 2012, a feasibility study on the 1990 detention basin was completed. This study tested the ability of the system to treat stormwater runoff from private parcels in the Cave Rock Estates GID detention basin. Results showed that the existing treatment system can accommodate both public and private runoff resulting from the 20 year storm for the region if the system is properly maintained. The basin does not capture the fine sediment needed to be in compliance with the TMDL requiring a retrofit of the existing system to bring it up to current standards.

NTCD has funding to provide 1 year of post monitoring on the retrofit. The results of this monitoring will be available through NTCD.

This catchment is planned to be registered by Douglas County by 2016. In accordance to the TMDL, annual monitoring will be performed using the current BMP RAM protocols once the catchment is registered.

Monitoring of private parcel BMP maintenance is handled through the TRPA. For Multi-family Residences, this includes submitting maintenance logs and potentially photographs of systems.

Inspection and Maintenance

Jurisdictions gain or lose TMDL credits based on the performance condition of each BMP. Actively inspecting and maintaining BMPs is an effective way to earn or maintain TMDL credits.

Cave Rock Estates GID is committed to maintaining the stormwater system. Sediment traps would have to be cleaned once or twice annually and this project would add one additional sediment trap. For the bed filter, once ½ inch of sediment accumulates in the first treatment cell, it should be removed. No benchmark currently exists for the GID to determine the amount of accumulation. The sand filter media would need to be tilled every 5 to 7 years (Center for Watershed Protection, 1996) and possibly replaced if performance declines dramatically.

The stormwater system in Cave Rock Estates needs regular inspection to insure functionality. This should be scheduled based on observations, experiences, inspection findings, and the changing conditions of the site.

What to look for during an inspection:

- Flow obstruction at inlet or outlet
- Infiltration capacity of filter media
- Sediment accumulation
- Vegetation encroachment
- Aesthetics
- Safety hazards & spills
- Maintenance of the system involves

The primary maintenance tasks associated with bed filters are:

- Removing accumulated sediment and debris from sediment traps and conveyance features
- Maintaining infiltration capacity of the filter media
- Controlling vegetation encroachment

In addition to maintaining the stormwater system, CREGID performs road operations to reduce the amount of sediment reaching the system. Application of road abrasives is minimized to the extent possible while maintaining traffic safety. The GID sweeps their streets once in the spring and once in the fall with a regenerative air sweeper to capture additional sediment load.

Refer to the Cave Rock Estates Stormwater System Maintenance Plan, May 2012 and the Cave Rock Estates GID Stormwater System Retrofit Project Final Design Report, 2014 for more detailed information regarding inspection and maintenance for the Cave Rock Estates bed filter and associated treatments.

Multi-family Residences maintenance includes servicing of sub-surface systems to insure surface systems are clean and functioning along with cleaning of any pipes, drain inlets, sediment traps, and other treatments that exist. Maintenance logs can be generated to guide property maintenance and monitor treatment functionality. These logs include site specific information on existing treatments and recommended cleaning needs. Technical guidance can be found in the TRPA BMP Handbook (tahoebmp.org/bmphandbook.aspx).

Single Family Residences should be inspect systems after major storms, in the spring, and just before winter to make sure they are functioning properly and to remove accumulated sediment.

Funding

Installation

The original installation of the community system in 1990 cost $1,458,981. This included the installation of 2 basins, conveyance infrastructure, and other measures to reduce sediment load from the area. The 2003 slope stabilization project was funded by US Forest Service, Nevada Division of State Lands, and Douglas County for $1,342,210 to construct rock walls and other erosion control structures.

The 2014 basin retrofit was paid for by CREGID, TRPA/Douglas County, and the United States Forest Service (USFS). A grant of $125,000 was awarded through the USFS and additional funds of $75,000 (TRPA-Douglas County) and $50,000 (CREGID) were given to NTCD to complete the system retrofit. CREGID afforded this project by building up their general fund in anticipation of this retrofit but did not raise fees. Construction of the bed filter cost $102,931 (see below for breakdown) while design, permitting, and construction management cost approximately $80,000.

Figure 16: Cave Rock Bed Filter Retrofit Construction Cost

Bid Item	Unit	Quantity	Cost/Unit	Total
Mobilization/Demobilization	LS	1	$4,000.00	$4,000.00
Temporary BMPS	LS	1	$2,100.00	$2,100.00

Rock Work	LS	1	$2,300.00	$2,300.00
Sand Filter Construction	LS	1	$22,600.00	$22,600.00
Settling Pond Construction	LS	1	$6,725.00	$6,725.00
Remove and Replace 12" Inlet Pipe and AC Pavement	LS	1	$3,800.00	$3,800.00
Inlet Sediment Trap and Headwall	EA	1	$5,000.00	$5,000.00
Repair Forebay	EA	3	$325.00	$975.00
Concrete Wall	LS	1	$9,675.00	$9,675.00
Perforated Riser	EA	1	$1,650.00	$1,650.00
Overflow Standpipe	EA	1	$1,950.00	$1,950.00
Emergency Overflow	LS	1	$2,200.00	$2,200.00
Retrofit Existing Outlets	LS	1	$575.00	$575.00
Vegetation Removal	LS	1	$1,500.00	$1,500.00
Clean Existing Inlets, Outlets, and Sediment Cans	LS	1	$1,850.00	$1,850.00
Revegetation	LS	1	$2,000.00	$2,000.00
Irrigation	LS	1	$9,100.00	$9,100.00
Pave Parking Bed Filter Maintenance Area	SF	2580	$6.95	$17,931.00
Note - irrigation was not completed			**Impact**	**$95,931.00**
Additional Rock Work	$11,500.00			
Purchase and Import Compost	$400.00			
Weep Holes	$500.00			
			Impact	**$99,231.00**
Construction work outside of scope above				
Build material storage bin	**$3,700.00**			

Source control is still required for CREGID private properties within the community treatment area. These treatments are typically less costly than full BMP implementation. Runoff areas need only be armored and driveways that flow to the street do not require treatment. Driveway systems usually carry the largest expense and therefore not having to install this treatment will drastically reduce the cost of implementation. An average BMP implementation price per property of $3,900 has been derived from information provided by SFR property owners and installation contractors between 2006 and 2013. This price is an average of all properties that received BMP certificates for both source control and full implementation. An average cost taken from source control installations in Tyrolian Village in 2012 is $900. Tyrolian Village has similar site characteristics as Cave Rock Estate and may be a more comparable estimate to determine potential cost.

Total Estimated Cost of Private Parcel BMP Installation for Cave Rock

80 private parcels x $900 installation cost per property =

$72,000

CREGID does not have any program to encourage homeowners to complete their BMPs, nor are there any plans for this in the future. Currently, NTCD has funds to assist homeowners with design of BMP systems including technical assistance on design and maintenance. It is unknown how many homeowners will be installing their BMPs in the future.

Inspection and Maintenance

CREGID will be responsible for future inspection and maintenance costs of the system and other stormwater projects including sweeping. Once the catchment is registered, BMP RAM will need to be performed annually to proved system functionality. The yearly inspection cost is estimated at $4,686 (breakdown in Figure 17). Maintenance is expected to cost approximately $5,000 per year. A breakdown of these costs can be found in Figure 18. These numbers include labor, equipment, and disposal fees and were derived from the project cost estimate. At the end of the 20 years, major maintenance will be needed including a complete replacement of the septic sand. These costs are being worked into the budget without any increases of GID fees.

Figure 17: Estimated Annual Inspection Budget

Inspection	Notes	Estimated Cost
BMP RAM of Bed Filter and inspection of Trench Drain, Sediment Traps & Treatment Vault	12 hours x 1 person at $40/hr	$480
Personnel Costs	%	
Travel	10 miles x $.55/mile x 3 trips	$330
Supplies and Recurring Costs	notebooks & misc BMP RAM supplies	$13
Indirect	%	
	Total Estimated Cost	

Figure 18: Total Estimated Budget for Maintenance

Assets	Number	Linear Feet	Notes	Unit Cost	Maintenance per/year	Cost Estimate
Sediment Traps & Manholes	16			$86.27	1	$1,400.00
Conveyance Pipe		2234		$0.28	1	$600.00
Conveyance Ditch		2040		$1.95	1	$4,000.00
Bed Filter & Dry Basins	2			$713.38	1	$1,400.00
Settling Basin	2			$812.18	1	$1,600.00
General erosion control	1		lump sum	$1,000.00	1	$1,000.00
General road shoulder and storm drain maintenance	1		lump sum	$1,000.00	1	$1,000.00
					Total Estimated Cost:	**$5,000.00**

One of the uncalculated costs is private parcel BMP maintenance. No information has been gathered on actual cost, but it can be deduced that maintenance of deep systems associated with Certificate of Completion is more expensive than source control type installations.

Effectiveness of private parcel BMPs over time has also not been quantified. There is no private party BMP data on functionality of installed systems. It has been conservatively estimated that private parcel BMP effectiveness is reduced by 50% after 5 years. Maintenance of BMPs for SFR is currently required, but not enforced. Many homeowners considered BMPs to be completed after receiving a certificate and do not maintain them once installed. In comparison, community systems that are

registered in the TMDL are required to perform BMP RAM and measure the effectiveness of the system. This ensures large public systems are functioning as intended and are maintained if they are not. This is a notable qualitative advantage of community systems over private SFR systems in regards to water quality.

Economy of Scale: Separation of Public Runoff versus Combination of Public-Private Runoff

Stormwater projects in the Lake Tahoe basin often received funding from public agencies and these agencies prefer that the bulk of this work both occurs on public land and treats public runoff. Public and private properties share watersheds and stormwater runoff from the two is usually not separated unless 100 percent of private-parcel best management practices are in compliance and fully functional. Therefore, the question has arisen as to how much additional cost is incurred by treating private runoff in a public facility.

Civil engineers are responsible for designing most public stormwater treatment systems in the United States. As a responsible engineer, the engineer of record must ensure that designs do not endanger the public or their property. Because civil engineers working in water resources work within less than predictable natural systems, facilities are typically designed with a factor of safety. This factor of safety is integrated throughout the design process. For stormwater, an engineer may calculate the possible runoff from the entire watershed using a few different methods and choose the midpoint for the treatment criteria but the maximum point for the overflow criteria. Three different but common methods to calculate runoff (the Rational Method, the SCS Curve Number method, and the unit hydrograph method) have potential to yield considerably different results. This was the case for the Cave Rock Stormwater System (KB Foster 1991). The engineer may also simply round up at all steps to create a factor of safety. For example, the watershed size may be rounded up as well as the impervious surface and finally, the basin size. There are numerous ways a factor of safety can be applied throughout design, but it is rare that an engineer would disregard private runoff in the design process. The private runoff would have to be completely disconnected and therefore not a part of the design watershed to be ignored. Because of engineering ethics and responsibility code, there are not public stormwater projects in the ground that did not account for private runoff during the design process.

The next way to examine the differences between public and private costs would be to examine projects on a per-project basis. For the most recent Cave Rock Stormwater System Retrofit Project, one could look at the construction costs by item and determine if a decrease in stormwater quantity would have led to a decrease in cost. The Cave Rock Stormwater System was originally designed to treat the 25 year storm from the entire watershed with the assumption that the entire subdivision would be developed. If private runoff were contained on the individual parcels, the system could have potentially been 25 to 30 percent smaller. This estimate is based on the maximum allowable coverage by TRPA for residential lots of 25 to 30 percent so it may be a high estimate, but for discussion, this section will use a size reduction of 30 percent.

If the Retrofit were for a system 30 percent smaller, there would likely be a similar 30 percent cost reduction in the following bid items:

- Settling pond construction

- Vegetation removal
- Revegetation (Including import of compost)

In addition, there would likely be smaller reductions of perhaps 5 to 20 percent in the following bid items:

- Mobilization/Demobilization
- Sand Filter Construction

Little to no change in cost would occur for the remainder of the items. Therefore, by adding up the cost savings of the bid items discussed above, the cost reduction would be approximately $6,000 or 6 percent of the total project cost.

Examining the Retrofit would likely yield different results from examining costs of the original project. The original project costs are not available on a per item basis, but assumptions can be made based on knowledge of the project cost and the design plans. The total project cost was approximately $1.5 million and installed 2 basins, conveyance infrastructure, slope stabilization, and revegetation. Figure X has an engineering opinion on how these costs may have been separated and affected.

Figure 19: Engineering opinion of original project costs

Item	Percent of Project Cost	Cost	Potential Reduction	Savings
Conveyance	35%	$525,000	0%	$0
Slope Stabilization and Revegetation	25%	$375,000	0%	$0
Chukkar Infiltration Basin	5%	$75,000	10%	$7,500
Detention Pond	25%	$375,000	25%	$93,750
			Total Savings	$101,250
			Percent Savings	7%

Both the overall conveyance and slope stabilization/revegetation would not have any cost savings. As a steep watershed, the conveyance structures were relatively small because of the steep slopes (See Darcy-Weisbach or Hazen Williams equations). The watershed steepness also likely led to the slope stabilization being expensive in that numerous retaining walls and rip rap areas were installed as well as vegetation on steep slopes. Costs that would be reduced would be the cost of the infiltration basin on Chukkar. This basin was already small and so the cost savings of the actual basin compared to the costs of the inlet and outlet would've been much less than 30 percent. The large detention pond that was retrofit this past year would have seen the most savings from a reduction in size. Savings would include less grading and a smaller quantity of pond liner. A savings of 25 percent may be an overestimate, but overall, the cost of the original project would have saved 5 to 10 percent if it were designed to treat less water, i.e. the contribution of the public areas only.

In summary, we see a similar total savings for both the original project and the retrofit of 5 to 10 percent if engineers designed the system to be 30 percent smaller. Again, 30 percent less volume

with public-private separation is an estimate for Cave Rock, but it serves to show that increasing a system size does not result in a proportional increase in cost.

Old Info… derived from numbers compiled by Meghan… will be deleted, but didn't want to quite yet.

Category	Cost	Notes
Wages	$3,194	
Personnel Costs (15.59%)	$498	
Travel (vehicle mileage)	$17	8 trips
Equipment	$-	
Supplies and Recurring Costs	$13	Notebooks and misc BMP RAM Supplies
Lab Analyses	$ -	
Subtotal	$3,722	
Indirect (25.9% of all costs)	$964	
TOTAL	$4,686	

Type of Maintenance	Notes	Estimated Cost	Frequency	Cost over life span
Sediment Trap Maintenance	16 hours at $30/hr, vactor truck & disposal	$1,480	annual	$9,120
3" Bed Filter Raking				
Upper Basin Sediment Removal	16 hours at $30/hr	$480	Every10 years	$480
Tilling of Bed Filter	8 hours at $30/hr, equipment rental	$340	Every 5-7 years	$1,020
Total Cost Over Life of Bed Filter				$10,620
TOTAL ESTMATED ANNUAL COST*				$559
* this cost will be dependent on actual maintenance needs dictated by BMP RAM and assumes at 20 years, an assessment on the functionality of the system will be evaluated and larger maintenance or redesign will be necessary.				

Appendix
Brief Soils Descriptions

Brief Soil Descriptions (Tahoe)

Tahoe Basin Area, California and Nevada

[Absence of an entry indicates that the feature is not a concern or that data were not estimated. Data applies to the entire extent of the map unit within the survey area. Map unit and soil properties for a specific parcel of land may vary somewhat and should be determined by onsite investigation]

7101--Caverock sandy loam, 9 to 50 percent slopes

Composition

- Caverock and similar soils: 80 percent of the unit
- Cagwin and similar soils: 5 percent of the unit
- Cassenai, gravelly loamy coarse sand and similar soils: 5 percent of the unit
- Deerhill and similar soils: 3 percent of the unit
- Genoapeak and similar soils: 2 percent of the unit
- Southcamp and similar soils: 2 percent of the unit
- Zephyrcove and similar soils: 2 percent of the unit
- Aquic Xerorthents and similar soils: 1 percent of the unit

Setting

Landform(s): hillslopes, mountain slopes, mountains
Elevation: 6234 to 7808 feet
Precipitation: 23 to 31 inches
Slope gradient: 9 to 50 percent
Air temperature: 41 to 44 °F
Frost-free period: 40 to 90 days

Characteristics of Caverock and similar soils

Average total avail. water in top five feet (in.): 4.0
Available water capacity class: Low
Parent material: colluvium over residuum weathered from latite
Restrictive feature(s): paralithic bedrock at 20 to 39 inches
Depth to Water table: none within the soil profile
Drainage class: somewhat excessively drained
Flooding hazard: none
Ponding hazard: none
Soil loss tolerance (T factor): 3
Wind erodibility group (WEG): 3
Wind erodibility index (WEI): 86
Land capability class, irrigated:
Land capability class, nonirrigated: 7e
Hydric soil: no
Hydrologic group: C
Runoff class: high
Potential frost action: moderate

Saturated hydraulic conductivity class: Moderately Low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Ksat (in/hr) low	Ksat (in/hr) Rv	Ksat (in/hr) high	Excavation Difficulty
Oi -- 0 to 2	Slightly decomposed plant material	1.1 to 1.3		14.2	56.7	99.9	Low
A -- 2 to 4	Sandy loam	0.2 to 0.3	5.6 to 7.3	0.1	1.1	1.4	Moderate
BA -- 4 to 11	Sandy loam	0.7 to 0.9	5.6 to 7.3	0.1	0.7	1.4	Moderate
Bw1 -- 11 to 19	Cobbly sandy loam	0.6 to 1.0	5.6 to 7.3	0.1	0.7	1.4	Moderate
Bw2 -- 19 to 26	Sandy loam	0.8 to 1.0	5.6 to 7.3	0.1	0.7	1.4	Moderate
Cr -- 26 to 36	Bedrock		6.1 to 7.3	0.0	0.1	0.1	High

Ecological class(es): NRCS Forestland Site - Pinus jeffreyi/Purshia tridentata-Arctostaphylos patula

Brief Soil Descriptions (Tahoe)

Tahoe Basin Area, California and Nevada

[7413 - Cagwin Rock outcrop complex, 30 to 50 percent slopes, extremely stony]

7413 - Cagwin Rock outcrop complex, 30 to 50 percent slopes, extremely stony

Composition

°Cagwin and similar soils: 50 percent of the unit
°Rock outcrop, Granitic: 20 percent of the unit
°Cassenai, gravelly loamy coarse sand and similar soils: 10 percent of the unit
°Toem and similar soils: 10 percent of the unit
°Dagget, very gravelly loamy coarse sand and similar soils: 5 percent of the unit
°Temo and similar soils: 2 percent of the unit
°Witefels and similar soils: 2 percent of the unit
°Marla and similar soils: 1 percent of the unit

Setting

Landform(s) hillslopes, mountain slopes, mountains
Elevatio 6234 to 8317 feet
Precipitatio 19 to 55 inches
Slope 30 to 50 percent
Air temperature: 41 to 46 °F
Frost-free 25 to 75 days

Characteristics of Cagwin and similar soils

Average total avail. water in top five feet 2.1
Available water capacity Very low
Parent colluvium over grus derived from
Restrictive paralithic bedrock at 20 to 39 inches
Depth to Water none within the soil profile
Drainage somewhat excessively drained
Flooding none
Ponding none
Soil loss tolerance (T 3
Wind erodibility group 7
Wind erodibility index 38
Land capability class, irrigated:
Land capability class, non- 7e
Hydric soil: no
Hydrologic B
Runoff class: medium
Potential frost low

Saturated hydraulic conductivity Moderately High

Representative soil profile:

Horizon --	Depth (inches)	Texture	Ksat	pH	Salinity (mmhos/cm)	SAR
Oi --	0 to 1	Slightly decomposed plant	56.7		0 - 0	0 - 0
A --	1 to 9	Gravelly loamy coarse sand	7.1	5.1 to 6.5	0 - 0	0 - 0
AC --	9 to 13	Gravelly loamy coarse sand	5.7	5.1 to 6.5	0 - 0	0 - 0
C --	13 to 27	Gravelly coarse sand	5.7	5.1 to 6.5	0 - 0	0 - 0
Cr --	27 to 37	Bedrock	0.1		-	-

Ecological class(es): NRCS Forestland Site - Pinus jeffreyi/Purshia tridentata-Arctostaphylos

Brief Soil Descriptions (Tahoe)

Tahoe Basin Area, California and Nevada

[7413 - Cagwin Rock outcrop complex, 30 to 50 percent slopes, extremely stony]

Characteristics of Rock outcrop, Granitic

Average total avail. water in top five feet
Available water capacity NA
Parent
Restrictive
Depth to Water
Drainage
Flooding
Ponding

Saturated hydraulic conductivity NA

Ecological class(es):

Soil loss tolerance (T
Wind erodibility group
Wind erodibility index
Land capability class, irrigated:
Land capability class, non-
Hydric soil: no
Hydrologic
Runoff class: very high
Potential frost

7422 - Cassenai gravelly loamy coarse sand, 15 to 30 percent slopes, very stony

Composition

- Cassenai, gravelly loamy coarse sand and similar soils: 73 percent of the unit
- Cagwin and similar soils: 12 percent of the unit
- Dagget, very gravelly loamy coarse sand and similar soils: 5 percent of the unit
- Toem and similar soils: 4 percent of the unit
- Aquic Xerorthents and similar soils: 2 percent of the unit
- Christopher, Gravelly Loamy Coarse Sand and similar soils: 2 percent of the unit
- Rock outcrop, Granitic: 2 percent of the unit

Setting

Landform(s): hillslopes, mountain slopes, mountains
Elevation: 6234 to 7989 feet
Precipitation: 21 to 49 inches
Slope gradient: 15 to 30 percent
Air temperature: 42 to 46 °F
Frost-free period: 40 to 90 days

Characteristics of Cassenai, gravelly loamy coarse sand and similar soils

Average total avail. water in top five feet (in.): 5.6
Available water capacity class: Low
Parent material: colluvium derived from granodiorite
Restrictive feature(s): none
Depth to Water table: none within the soil profile
Drainage class: somewhat excessively drained
Flooding hazard: none
Ponding hazard: none
Soil loss tolerance (T factor): 5
Wind erodibility group (WEG): 7
Wind erodibility index (WEI): 38
Land capability class, non-irrigated: 6e
Hydric soil: no
Runoff class: medium
Potential frost action: low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Ksat (inches per hour)	% cobbles	% stones and boulders	Excavation Difficulty
Oi -- 0 to 1	Slightly decomposed plant material	56	-	-	Low
A -- 1 to 6	Gravelly loamy coarse sand	3.92	0 - 0	0 - 0	Low
Bw -- 6 to 43	Gravelly loamy coarse sand	3.92	0 - 0	0 - 0	Low
C -- 43 to 79	Gravelly loamy coarse sand	3.92	0 - 0	0 - 0	Low

Ecological class(es): NRCS Forestland Site - Pinus jeffreyi/Arctostaphylos patula-Ceanothus cordulatus/Elymus elymoides

7423 - Cassenai gravelly loamy coarse sand, 30 to 50 percent slopes, very stony

Composition

- Cassenai, gravelly loamy coarse sand and similar soils: 78 percent of the unit
- Cagwin and similar soils: 12 percent of the unit
- Toem and similar soils: 4 percent of the unit
- Rock outcrop, Granitic: 3 percent of the unit
- Christopher, Gravelly Loamy Coarse Sand and similar soils: 2 percent of the unit
- Aquic Xerorthents and similar soils: 1 percent of the unit

Setting

Landform(s): hillslopes, mountain slopes, mountains
Elevation: 6234 to 8120 feet
Precipitation: 19 to 47 inches
Slope gradient: 30 to 50 percent
Air temperature: 42 to 46 °F
Frost-free period: 40 to 90 days

Characteristics of Cassenai, gravelly loamy coarse sand and similar soils

Average total avail. water in top five feet (in.): 5.6
Available water capacity class: Low
Parent material: colluvium derived from granodiorite
Restrictive feature(s): none
Depth to Water table: none within the soil profile
Drainage class: somewhat excessively drained
Flooding hazard: none
Ponding hazard: none
Soil loss tolerance (T factor): 5
Wind erodibility group (WEG): 7
Wind erodibility index (WEI): 38
Land capability class, non-irrigated: 7e
Hydric soil: no
Runoff class: medium
Potential frost action: low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Ksat (inches per hour)	% cobbles	% stones and boulders	Excavation Difficulty
Oi -- 0 to 1	Slightly decomposed plant material	56	-	-	Low
A -- 1 to 6	Gravelly loamy coarse sand	3.92	0 - 0	0 - 0	Low
Bw -- 6 to 43	Gravelly loamy coarse sand	3.92	0 - 0	0 - 0	Low
C -- 43 to 79	Gravelly loamy coarse sand	3.92	0 - 0	0 - 0	Low

Ecological class(es): NRCS Forestland Site - Pinus jeffreyi/Arctostaphylos patula-Ceanothus cordulatus/Elymus elymoides

7485 - Meeks gravelly loamy coarse sand, 15 to 30 percent slopes, extremely bouldery

Composition

- Meeks, extremely bouldery and similar soils: 80 percent of the unit
- Burnlake and similar soils: 5 percent of the unit
- Meeks, rubbly and similar soils: 5 percent of the unit
- Dagget, moist and similar soils: 3 percent of the unit
- Tallac, very stony and similar soils: 3 percent of the unit
- Roadcat and similar soils: 2 percent of the unit
- Aquic Xerorthents and similar soils: 1 percent of the unit
- Jabu and similar soils: 1 percent of the unit

Setting

Landform(s): moraines, mountains
Elevation: 6217 to 8120 feet
Precipitation: 23 to 63 inches
Slope gradient: 15 to 30 percent
Air temperature: 41 to 46 °F
Frost-free period: 40 to 90 days

Characteristics of Meeks, extremely bouldery and similar soils

Average total avail. water in top five feet (in.): 3.0
Available water capacity class: Low
Parent material: till derived from granodiorite
Restrictive feature(s): duripan at 41 to 73 inches
Depth to Water table: none within the soil profile
Drainage class: somewhat excessively drained
Flooding hazard: none
Ponding hazard: none
Soil loss tolerance (T factor): 5
Wind erodibility group (WEG): 7
Wind erodibility index (WEI): 38
Land capability class, non-irrigated: 6e
Hydric soil: no
Runoff class: low
Potential frost action: low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Ksat (inches per hour)	% cobbles	% stones and boulders	Excavation Difficulty
Oi -- 0 to 2	Slightly decomposed plant material	56	-	-	Low
A -- 2 to 13	Gravelly loamy coarse sand	14	0 - 28	0 - 0	
Bw -- 13 to 63	Extremely stony loamy coarse sand	14	20 - 35	22 - 36	
Bqm -- 63 to 73	Gravelly loamy coarse sand	0.1274	0 - 20	0 - 0	Very high

Ecological class(es): NRCS Forestland Site - Abies concolor-Pinus lambertiana/Quercus vacciniifolia-Amelanchier utahensis/Pyrola picta

Brief Soil Descriptions (Tahoe)

Tahoe Basin Area, California and Nevada

[Absence of an entry indicates that the feature is not a concern or that data were not estimated. Data applies to the entire extent of the map unit within the survey area. Map unit and soil properties for a specific parcel of land may vary somewhat and should be determined by onsite investigation]

7486--Meeks gravelly loamy coarse sand, 30 to 70 percent slopes, extremely bouldery

Composition

- Meeks, extremely bouldery and similar soils: 80 percent of the unit
- Burnlake and similar soils: 5 percent of the unit
- Meeks, rubbly and similar soils: 5 percent of the unit
- Dagget, moist and similar soils: 3 percent of the unit
- Tallac, very stony and similar soils: 3 percent of the unit
- Roadcat and similar soils: 2 percent of the unit
- Aquic Xerorthents and similar soils: 1 percent of the unit
- Jabu and similar soils: 1 percent of the unit

Setting

Landform(s): moraines, mountains
Elevation: 6234 to 8202 feet
Precipitation: 27 to 59 inches
Slope gradient: 30 to 70 percent
Air temperature: 41 to 46 ºF
Frost-free period: 40 to 90 days

Characteristics of Meeks, extremely bouldery and similar soils

Average total avail. water in top five feet (in.): 3.0
Available water capacity class: Low
Parent material: till derived from granodiorite
Restrictive feature(s): duripan at 41 to 73 inches
Depth to Water table: none within the soil profile
Drainage class: somewhat excessively drained
Flooding hazard: none
Ponding hazard: none
Soil loss tolerance (T factor): 5
Wind erodibility group (WEG): 2
Wind erodibility index (WEI): 134
Land capability class, irrigated:
Land capability class, nonirrigated: 7e
Hydric soil: no
Hydrologic group: A
Runoff class: low
Potential frost action: low

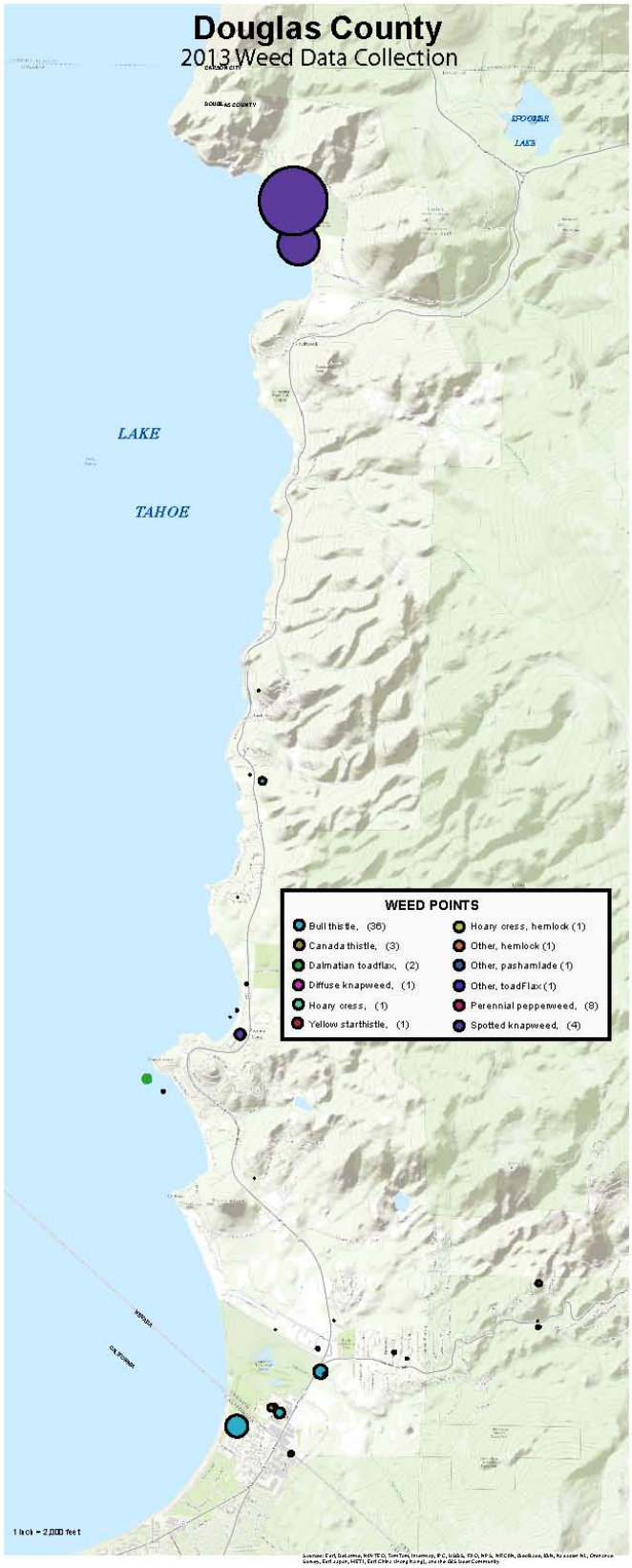
Saturated hydraulic conductivity class: Moderately Low

Representative soil profile:

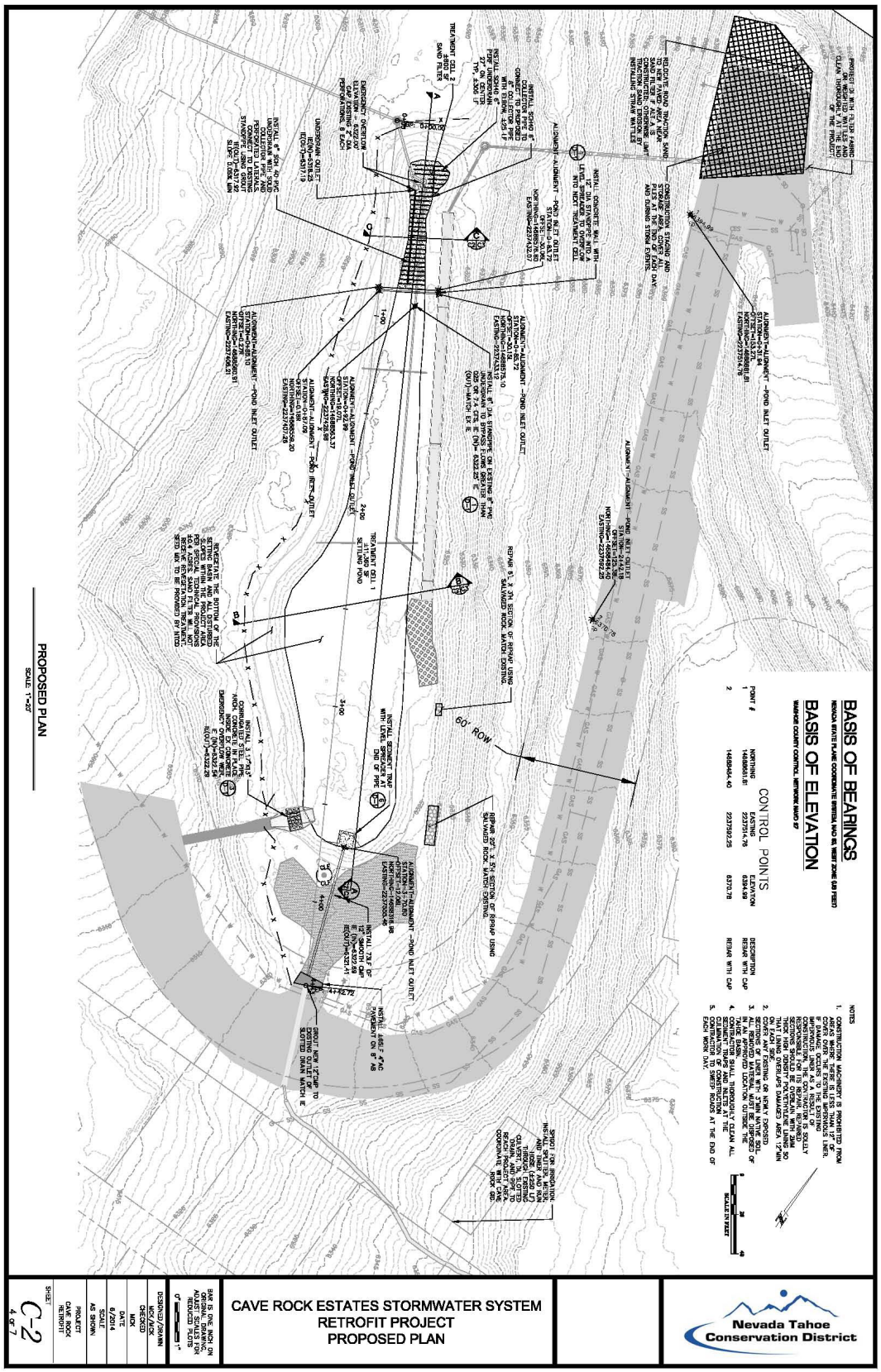
Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Ksat (in/hr) low	Ksat (in/hr) Rv	Ksat (in/hr) high	Excavation Difficulty
Oi -- 0 to 2	Slightly decomposed plant material	1.1 to 1.3		14.2	56.7	99.9	Low
A -- 2 to 13	Gravelly loamy coarse sand	0.2 to 0.4	5.6 to 6.5	10.6	14.2	28.3	Moderate
Bw -- 13 to 63	Extremely stony loamy coarse sand	1.0 to 2.0	5.6 to 6.5	10.6	14.2	28.3	Moderate
Bqm -- 63 to 73	Gravelly loamy coarse sand	0.0 to 0.0	5.1 to 6.0	0.1	0.1	0.2	Very high

Ecological class(es): NRCS Forestland Site - Abies concolor-Pinus lambertiana/Quercus vacciniifolia-Amelanchier utahensis/Pyrola picta

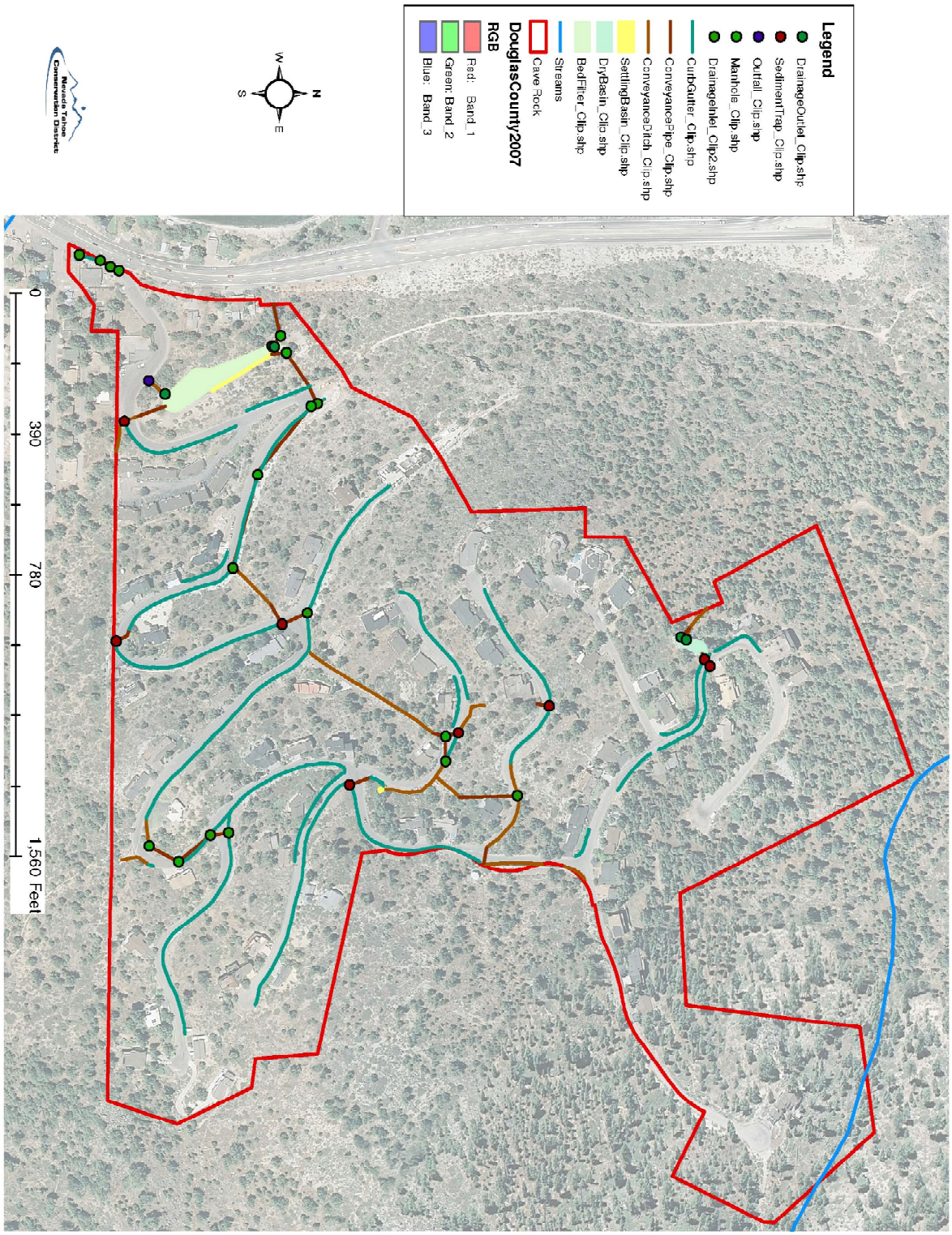
2013 Weed Data Collection Map



CRE Bed Filter Retrofit Plan



Cave Rock Estates Assets



Nevada Tahoe Conservation District

PO Box 915
400 Dorla Court
Zephyr Cove, NV 89448
Phone (775) 586-1610
Fax (775) 586-1612
www.ntcd.org

September 20, 2013

Dear Homeowner,

The Nevada Tahoe Conservation District developed this informational packet to assist you with determining what Best Management Practices (BMPs) are required on your property in Cave Rock Estates. This information will help you to comply with Chapter 60 (Best Management Practices Requirements) of the Tahoe Regional Planning Agency's (TRPA) Code of Ordinances. One of the programs that the Nevada Tahoe Conservation District (NTCD) is involved with is designing BMPs for single family homes. Our assistance currently comes at no cost to you. The NTCD is a grant funded, non regulatory agency that focuses on assisting homeowners with controlling erosion, native and adapted plant landscaping, and identifying and removing invasive species along with many other conservation initiatives.

The intent of Best Management Practices is to help designed landscapes better mimic their natural surroundings and reduce the amount of sediment that flows into Lake Tahoe. In undisturbed areas such as forests and meadows, soil and plants act as natural purification systems by filtering water before it reaches lakes and streams. In urban areas, runoff filled with excess nutrients, sediment and other harmful pollutants reaches waterways without the benefits of this natural filtration process. This degrades streams and reduces the famous clarity of Lake Tahoe. The *Home Landscaping Guide for Lake Tahoe and Vicinity* is an invaluable resource which helps homeowners develop healthy, low-maintenance landscapes and improve water quality. Please contact the NTCD to receive your free copy.

The Best Management Practices Retrofit Ordinance requires landowners to infiltrate stormwater runoff, stabilize eroding soil, rehabilitate disturbed soil areas and pave approved roads, driveways and parking areas. This BMP informational packet covers the different treatments necessary to accomplish these goals.

Due to difficult site characteristics, it is not required that you implement infiltration BMPs on your property. Enclosed are *BMP Treatment Descriptions* detailing what treatment options are available for your property. This BMP packet will guide you or your contractor through the process of BMP design and implementation. This packet is specific to Cave Rock Estates and only relates to properties in this community.

If you are using a contractor to install your BMPs, please be sure to supply them with all of the enclosed information. Before you install your BMPs, refer to the *Living with Fire* guidelines to be sure that the recommended BMP treatments are not in conflict with the most current fire defensible space requirements. You may also request a free fire defensible space inspection by calling the Tahoe Douglas Fire Protection District at (775) 588-3591 ext.227.

NTCD staff is available to provide technical assistance to homeowners and contractors. If you have any questions regarding the content of this packet or the implementation of BMPs on your property, please call our BMP Hotline at (775) 586-1610 ext. 28.

Mission Statement: To promote the conservation and improvement of the Lake Tahoe Basin's natural resources by providing leadership, education and technical assistance to all basin users.

Following the installation of your BMPs, please call the BMP Hotline for a final inspection. If the completed work meets the requirements for Tahoe Regional Planning Agency's BMP Retrofit Ordinance, a Source Control Certificate will be requested from the TRPA for your property. Implementing your BMPs is very important, however, it is not the end of the process. In order to remain in compliance, all BMPs must be maintained.

Applying Best Management Practices on properties helps minimize stormwater runoff and protects the quality and beauty of Lake Tahoe. Your participation is greatly appreciated.

Respectfully,

Jason Brand
Phone: (775) 586-1610 ext.28
jbrand@NTCD.org
NTCD.org

BMP Informational Packet Includes
BMP Treatment Descriptions
Generic BMP Site Plan
Typical BMP Treatment Photos
Homeowner BMP Checklist
TRPA Site Constraint Letter

Online information
Tahoe BMP Resources: TahoeBMP.org/BMPResources.aspx
Lake Tahoe Standard Drawings
Materials and Service Providers
Home Landscaping Guide for Lake Tahoe and Vicinity
Living with Fire for the Lake Tahoe Basin

NTCD Homeowner BMPs: NTCD.org/html/BMPs.php
Dirt Driveway Tip Sheet
Turf Watering Management Handout
Yard Fertility Management Handout
Materials Calculator

Best Management Practices Treatment Descriptions

For Properties with Rocky Soils

Revised 9/13

Considerations while addressing Best Management Practices

Soils: The Nevada Tahoe Conservation District (NTCD) uses the Natural Resources Conservation Service (NRCS) Soil Survey and on-site soil tests to determine the soil type for properties. This information is then used to recommend Best Management Practices (BMPs).

Groundwater: Tahoe Regional Planning Agency water quality regulations prohibit BMPs from being installed within one foot of the seasonal high water table. If ground water is encountered during BMP installations, contact the NTCD for technical assistance and further instructions.

Property Lines: BMP treatment systems must be installed within the property boundary limits. The NTCD *does not* establish property boundary lines. Before installing BMPs confirm property boundary lines and any setback requirements established by your local building or planning departments.

Fire Defensible Space: NTCD staff and the Natural Resources Conservation Service do not have the authority to perform fire defensible space inspections. Fire defensible space information is included with these BMP prescriptions as a courtesy to the Fire Protection Districts. All references and prescriptions for defensible space were provided by the Lake Tahoe Fire Prevention Officers. Through cooperation with the Tahoe Regional Planning Agency, Tahoe Resource Conservation District, Nevada Tahoe Conservation District, Natural Resources Conservation Service, and University of Nevada Cooperative Extension, efforts have been taken to provide a conservation plan and BMP designs that are compatible with Living with Fire guidelines. The final determination that landscaping and BMPs installed for water quality purposes meet defensible space requirements lies solely with the fire protection districts that have the proper authority.

Note that BMP minimum treatment dimensions do not always encompass the 0 to 5 foot non-combustible area. Therefore, the *Materials Calculator* can be used to determine quantities for drain rock armoring that will also meet the defensible space criteria.

Refer to *Living with Fire – Lake Tahoe Basin Second Edition* for more information regarding maintaining a fire defensible landscape while planning BMP implementation.

Please contact the local fire district or department for defensible space requirements and recommendations: Tahoe Douglas Fire Protection District at (775) 588-3591 or *TahoeFire.com*.

Underground Utilities: Before excavating soil for the installation of BMPs, it is imperative that underground utilities be located and marked on the property to avoid damage or service interruption during construction. According to Government Code 4216, the individual conducting excavation is responsible for notifying utilities before digging. Underground Service Alert (USA), the one call system, enables this notification. **Call 811** at least two full working days and not more than 14 days before any excavation occurs. Additional information is available at *usanorth.org*.

Drainage: If stormwater from neighboring public or private properties flows onto the property, contact the local jurisdiction for technical assistance or more information. A licensed engineer may need to be consulted to develop an appropriate solution that protects structures from potential water damage.

TRPA Coverage: It is advisable to document existing conditions before making any changes to the property to avoid losing existing coverage rights. For information on land capability and land coverage, please visit *TRPA.org*.

Grading and Temporary BMPs: Tahoe Regional Planning Agency (TRPA) regulations state that between October 15th and May 1st it is prohibited to grade or excavate more than 3 cubic yards of soil. Installation of temporary BMPs is also required on all sites where the vegetation and soil will be disturbed. Temporary BMP practices will help prevent sediment or contaminated water from leaving the site during construction activities. Temporary BMPs are site-specific, must be constantly maintained, and are usually good for only one year or one winter season. Temporary BMPs should be installed before starting construction and must be maintained until all construction activity is completed and/or until permanent BMPs are installed. In order to maintain properly functioning temporary BMPs, systems should be checked immediately before an impending storm as well as after the storm has passed.

Materials: NTCD recommends the use of 3/4 inch to 1-1/2 inch washed drain rock; however, any kind of rock can be utilized to achieve desired aesthetic and use characteristics for the property. You may even use rock found on the property to create a more natural look and to reduce the cost of BMP installations. Refer to the enclosed *Materials Calculator* to determine the amount of drain rock needed for rock armoring under drip lines and/or the five-foot non combustible zone.

Maintenance Considerations: Construct a border around drain rock treatments to contain materials and reduce maintenance. Economical border materials include used lumber, small logs, or cobble-sized rock found on site. Materials such as pressure-treated wood, landscape edging, and/or one of the many recycled composite products available can also be utilized. If using any type of flammable material, ensure that these materials do not connect to the structure to help protect the structure from fire.

Over time, infiltration systems fill in with sediment and fail; therefore, maintenance is required to keep these systems functioning properly. Visually check BMPs after major storms, in the spring, and just before winter to ensure they are working properly. For more information on BMP maintenance, visit the NTCD website at *NTCD.org*.

Expiration after 3 years: Beginning May 1, 2009 all evaluations will expire three years from the date the evaluation was conducted. If homeowners do not complete the recommended BMP installation treatments within this three year time frame, they will be required to call the appropriate agency and have the evaluation reviewed and, if necessary, revised. This will ensure that all homeowners are incorporating the most current technology and Best Management Practices treatments on their property that meet TRPA's requirements.

Online Document Resources

TRPA Stormwater Management Program Website TahoeBMP.org

- BMP Resources including Tip Sheets, Standard Drawings, Installation Providers: TahoeBMP.org/BMPResources.aspx
- Home Landscaping Guide: www.unce.unr.edu/publications/files/nr/2006/eb0601.pdf

TRPA Website TRPA.org

- Land Coverage/Land Capability Information: TRPA.org/permitting/land-coverage
- Site Assessment Application: TRPA.org/permitting/permit-applications/site_assessment_application
- Permitting Information/Application: TRPA.org/permitting/homeowner-info/permit-process

Fire Defensible Space Information

- Defensible Space: LivingWithFire.info/Tahoe
- Public Resource Code 4291: fire.ca.gov

Nevada Tahoe Conservation District NTCD.org

- Invasive Weed Information
- Community Watershed Partnership Information

BMP Treatments

The following descriptions explain the BMPs recommended for properties in Cave Rock Estates GID. These treatments are recommended based on Chapter 60 of the TRPA Code of Ordinances. To learn more about the ordinance, visit *TRPA.org/regional-plan/code-of-ordinances*. Visit *TahoeBMP.org* to download the most current Tip Sheets and BMP Standard Drawings and Installation Guidelines.

A: General Landscape/Soil Areas

Although bare ground may be effective in reducing wildfire threat around the property, there are other options to help promote fire defensible space and water quality together. Please be aware that excessive bare ground may increase the soil erosion potential of the property and contribute to a decline in the clarity of Lake Tahoe.

Options to treat bare soil on the property include but are not limited to establishing a mosaic of vegetation and mulch. Combustible mulch should not be used in a widespread manner within 30' of the structure. Some sites may require mechanical stabilization methods such as retaining walls, rock riprap, and terraces. Contact the local fire district, for information on acceptable treatment options for the property.

B: Drip Lines

Stormwater falling from the roof onto bare soil causes noticeable erosion. Bare soil under drip lines must be stabilized with an appropriate BMP. The options outlined below are commonly used methods to stabilize drip lines in order to mitigate erosion from roof runoff.

Option 1: Armor bare soil under drip lines

Install drain rock or cobble directly under the drip line to armor the soil in this area. For all installations, this treatment must extend a minimum of 6" inside of the drip line and extend a minimum of 12" beyond the drip line of a single story roof, 18" beyond the drip line of a 2-story roof, and 24" beyond the drip line of a 3-story roof. Border the treatment to retain the material and exclude adjacent soil. Before applying drain rock under drip lines, it is important to break up the existing soil with a hard rake or shovel to increase permeability. Refer to the online *Lake Tahoe Standard Drawing **BMP-009*** for installation instructions. If the drip line slope is between 5% and 15%, baffles will need to be installed. For drip lines with slopes of 15% or greater, armor the drip line with rip rap and stabilize any flow paths from runoff exiting the lower end of the drip line. If there are roof valleys next to the armored area, refer to the online *Lake Tahoe Standard Drawing **BMP-002*** for additional installation instructions.

Option 2: Maintain or enhance existing vegetation under drip lines

Vegetation under the drip line protects the soil from the impact of the concentrated roof runoff and promotes stormwater infiltration. Well established vegetation in this area will satisfy the TRPA requirement for drip line treatments. Maintain or enhance the existing vegetation under the drip line to meet the requirements of the BMP Ordinance. This treatment must extend a minimum of 6 inches inside of the drip line and a minimum of 12 inches beyond the drip line of a single story roof, 18 inches beyond the drip line of a 2-story roof, and 24 inches beyond the drip line of a 3-story roof.

Refer to online resources and the *Home Landscaping Guide for Lake Tahoe and Vicinity*, for plant selection, planting, and care instructions. Examples of adequate vegetation include:

- Maintained grasses or turf that have been established directly up to the foundation
- Low growing (18" or less), non-woody (herbaceous) perennials and annuals with minimal bare soil exposed

Option 3: Gutter conveyance system
Gutter conveyance systems need to remain in good repair and clear of debris in order to remain functional. If there is currently a gutter conveyance system installed on the house, install an energy dissipater under the gutter downspout. To do this, armor the runoff receiving area with rock or adequate vegetation to promote infiltration and minimize erosion. There are many options to dissipate energy under the gutter downspout. Possible options include splash pads/blocks, gravel, rock or adequate vegetation. Current design practices recommend that all concentrated runoff be conveyed at least 10 feet from existing structures.

C: Driveways

Scenario 1
Paved: Flows into right-of-way (roadside drainage or street)
No additional treatment necessary at this time. Homeowners will be notified when the TRPA approves the community BMP for managing driveway runoff in this community.

Scenario 2
Paved: Flows back onto property
If driveway runoff flows onto the property, armor the area where water is exiting the paved surface with a 3-inch layer of drain rock, cobble, or riprap. This armoring should be a minimum of 2 feet wide to adequately capture and infiltrate the runoff from the driveway. Before applying drain rock, it is important to break up compacted soil with a hard rake or shovel to increase its permeability. If the runoff is dispersed onto an area with established vegetation and there are no signs of erosion, this may be an acceptable BMP treatment.

Scenario 3
Unpaved
Driving on unpaved surfaces compacts the soil making it nearly impermeable. Because stormwater cannot infiltrate into this compacted area, it can leave the property carrying contaminants and sediment into the local waterways. For these reasons, all property owners are required to pave approved roads, driveways, and parking areas. Because driveways connect to the public right-of-way contact the local jurisdiction for information on required permits and local regulations. Currently, it is not necessary to install driveway conveyance and infiltration systems when paving the driveway because of the community BMP in this area. Grading considerations can make a difference in implementing appropriate source control measures. One option may be to slope the driveway to one side so that all runoff flows into a rock armored or well vegetated area.

Any area of the property that has been compacted due to vehicular traffic needs to be either paved or restored to a point that it can sustain vegetation. Refer to the *Paving Residential Dirt Driveways* tip sheet and *Lake Tahoe Standard Drawing* ***BMP-026*** and the *General Landscaping/Soil Areas* section earlier in this document for more information.

It is advisable to document existing conditions before making any changes to the property to avoid losing existing coverage rights. For information on land capability and coverage, please visit *TRPA.org/permitting/land-coverage*.

Auxiliary Parking

Auxiliary parking areas are those used for long term storage of vehicles or trailers that are seldom moved off of the property. Treatment options for these areas include vegetation, organic mulch, and drain rock armor. If the area will not sustain vegetation, armor the area with a 3-inch layer of drain rock or woodchips.

D: Decks / Stairs / Walkways

Homeowners are responsible for stabilizing bare soil under elevated structures and/or around the perimeter of low elevated structures. To protect the soil under these structures from water and wind erosion, refer to the relevant treatment descriptions listed below. Border treatments to contain the rock and reduce maintenance.

Install drain rock under elevated structures (decks, stairs and walkways)
Install a 3-inch layer of drain rock, cobble, or riprap under the entire footprint with a one foot extension past the edges of the structure. This will protect the soil under elevated structures from water and wind erosion. Refer to the online *Lake Tahoe Standard Drawing **BMP-010*** for more information.

Install drain rock around perimeter of low elevated structures
If the area below the deck, stairs, and/or walkways is inaccessible, install a 12-inch wide, 3-inch deep surface layer of drain rock or cobble around the perimeter of the structure. When accessible, extend the treatment under the structure. Refer to the online *Lake Tahoe Standard Drawing **BMP-011*** for more information.

Install rock slope protection (riprap) under elevated structures
If the area under the deck/stairs/walkway/driveway is sloped, install rock slope protection (riprap) under the entire footprint extending it a minimum of one foot past the edges of the structure. Refer to pages 16 - 19 of the *Home Landscaping Guide for Lake Tahoe and Vicinity* for more information on slope stabilization practices.

Vegetation
Maintained turf and low growing herbaceous vegetation controls erosion under or around low or elevated structures.

E: Slope Stabilization

If steep slopes exist on the property, it is important to stabilize them to prevent potential movement of sediment into the local waterways and eventually into Lake Tahoe. A variety of options are available to homeowners who have eroding slopes on their properties. While gentler slopes may be stabilized with vegetation, mulch, and/or erosion control blankets, steep slopes may require the use of riprap, terracing, or retaining walls. Refer to pages 16 - 19 of the *Home Landscaping Guide for Lake Tahoe and Vicinity* for more information on slope stabilization practices. Please contact the NTCD with questions regarding which technique is most appropriate and for installation information.

Install rock slope protection (riprap)
Riprap (larger angular rock material) may be used to stabilize steep slopes. It is a good practice to spread native or adapted seed on the slope prior to rock placement. Rock slope

protection works best when integrated with vegetation. Refer to online *Lake Tahoe Standard Drawings **BMP-40*** and *Lake Tahoe Standard Drawing **BMP-41*** for more information.

Install retaining walls or terracing
Retaining walls and terraces are a good way to stabilize steep eroding slopes. Common building materials include boulders, rocks, concrete blocks, or wood products.

A building permit is required for the construction of retaining walls that are over 4 feet in height measured from the bottom of the footing to the top of the wall. Large projects and walls higher than 4 feet require professional engineering expertise. If manufactured products are used, follow the manufacturer's specifications for proper installation. When installing retaining walls or terraces, contact the local jurisdiction to verify building codes. Refer to online *Lake Tahoe Standard Drawings **BMP-42*** and *Lake Tahoe Standard Drawing **BMP-43*** for more information.

General BMP Maintenance
Infiltration systems should be tested after major storms, in the spring, and just before winter to make sure they are functioning properly. To test a system, run a garden hose on the associated impervious surface (the driveway or roof, for example) for at least 10 minutes and monitor the flow of water. Confirm that it is being captured by the associated BMP.

To clean infiltration systems, follow these steps:
1. Remove pine needles and any other matter that has collected on top of the system.
2. Remove drain rock from the system and sift with wire mesh to remove sediment.
3. Rinse drain rock.
4. Line excavated area with new or cleaned filter fabric.
5. Refill with sifted, clean drain rock leaving 3 inches of open space on top.
6. Cover rock with filter fabric, when appropriate, and the last 3 inches of drain rock.
7. Place recovered fine sediments and dirty water in bordered planter bed or other contained area and cover with mulch.

For more information on BMP maintenance, visit the NTCD website at *NTCD.org*.

Typical BMP Treatments

use appropriate material in the 5 foot non-combustible area

Erosion Control at Perimeter of Low Deck

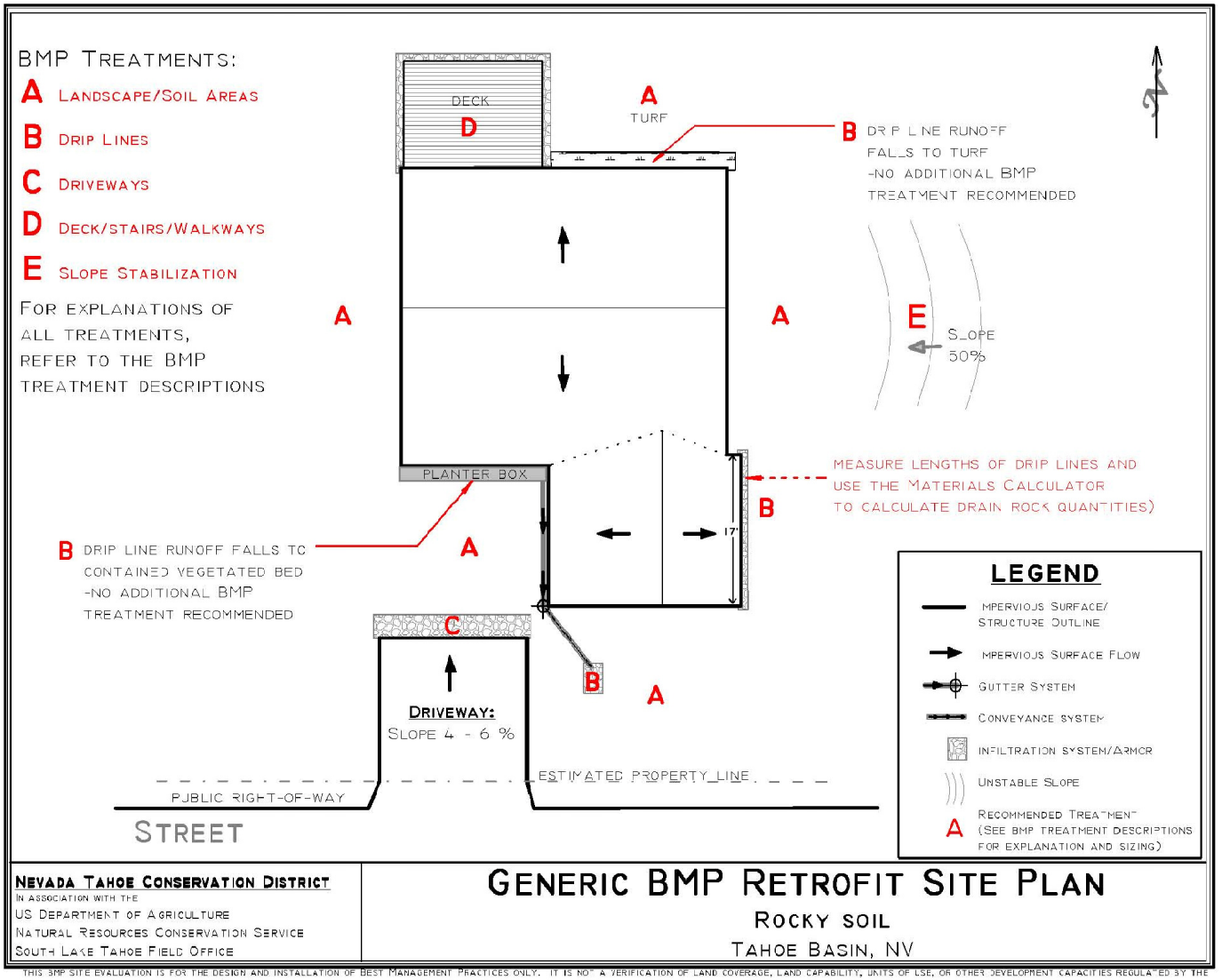
Erosion Control under Elevated Deck

Roof Runoff Infiltrates in Turf

Roof Runoff Infiltrates in Vegetated Bed

Roof Runoff Infiltrates in Rock Armor

Roof Runoff Infiltrates in Energy Dissipater under Gutter Downspout


BMP TREATMENTS:
A LANDSCAPE/SOIL AREAS
B DRIP LINES
C DRIVEWAYS
D DECK/STAIRS/WALKWAYS
E SLOPE STABILIZATION
FOR EXPLANATIONS OF ALL TREATMENTS, REFER TO THE BMP TREATMENT DESCRIPTIONS
DECK
D
A
TURF
B DRIP LINE RUNOFF FALLS TO TURF -NO ADDITIONAL BMP TREATMENT RECOMMENDED
A
A
E
SLOPE 50%
PLANTER BOX
MEASURE LENGTHS OF DRIP LINES AND USE THE MATERIALS CALCULATOR TO CALCULATE DRAIN ROCK QUANTITIES)
B
17'
B DRIP LINE RUNOFF FALLS TO CONTAINED VEGETATED BED -NO ADDITIONAL BMP TREATMENT RECOMMENDED
A
C
B
A
DRIVEWAY:
SLOPE 4 - 6 %
ESTIMATED PROPERTY LINE
PUBLIC RIGHT-OF-WAY
STREET
LEGEND
IMPERVIOUS SURFACE/ STRUCTURE OUTLINE
IMPERVIOUS SURFACE FLOW
GUTTER SYSTEM
CONVEYANCE SYSTEM
INFILTRATION SYSTEM/ARMOR
UNSTABLE SLOPE
A RECOMMENDED TREATMENT (SEE BMP TREATMENT DESCRIPTIONS FOR EXPLANATION AND SIZING)
NEVADA TAHOE CONSERVATION DISTRICT
IN ASSOCIATION WITH THE
US DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
SOUTH LAKE TAHOE FIELD OFFICE
GENERIC BMP RETROFIT SITE PLAN
ROCKY SOIL
TAHOE BASIN, NV
THIS BMP SITE EVALUATION IS FOR THE DESIGN AND INSTALLATION OF BEST MANAGEMENT PRACTICES ONLY. IT IS NOT A VERIFICATION OF LAND COVERAGE, LAND CAPABILITY, UNITS OF USE, OR OTHER DEVELOPMENT CAPACITIES REGULATED BY THE TAHOE REGIONAL PLANNING AGENCY (TRPA) NOR IS IT A CONCEPTUAL APPROVAL OF ANY UNRELATED FUTURE PROJECT. THESE VERIFICATIONS REQUIRE THE SUBMITTAL OF A SEPARATE APPLICATION TO THE TRPA FOR REVIEW AND APPROVAL.
BMP TREATMENTS MUST BE INSTALLED WITHIN THE PROPERTY BOUNDARY LINES. ANY REFERENCE TO A PROPERTY BOUNDARY LINE IS AN APPROXIMATION. BEFORE ANY INSTALLATION CONFIRM PROPERTY BOUNDARY LINES.

Homeowner BMP Checklist

For properties with rocky soils

	Yes	No	N/A
A: Bare Soil Areas:			
Is all bare soil stabilized with vegetation, mulch, or appropriate armor?	☐	☐	☐
Are compacted dirt areas restored, revegetated, and blocked from vehicle access?	☐	☐	☐
B: Drip Lines:			
Are areas under the drip lines armored with 3" of drain rock, cobble, rip rap or vegetated with healthy, irrigated, non- woody vegetation (i.e. vegetation or turf)?	☐	☐	☐
Are drain rock areas installed with containment borders?	☐	☐	☐
Do all gutter downspouts have energy dissipaters underneath outfall locations?	☐	☐	☐
In areas with a slope of more than 5%, are drip line treatments installed with baffles, terraces or rip rap? Refer to standard drawing BMP-009.	☐	☐	☐
C: Driveway:			
Is the driveway paved?	☐	☐	☐
If the driveway runoff flows back onto the property, is the runoff outflow area armored with drain rock or adequate vegetation?	☐	☐	☐
Are all auxiliary parking areas stabilized with vegetation, mulch or drain rock armor?	☐	☐	☐
D: Decks/Stairs/Walkways:			
For elevated structures: Is the entire footprint (plus a 1' extension) armored with a 3" layer of drain rock, cobble or rip rap? If drain rock, is the treatment bordered? Refer to standard drawings BMP-010.	☐	☐	☐
In areas with a slope of more than 5%, is the rock under elevated structures installed with baffles, terraces or rip-rap?	☐	☐	☐
For low elevated structures (inaccessible areas): Is the perimeter of the structure surrounded by a 12" wide drain rock, cobble, rip rap treatment or adequate vegetation? If drain rock, is the treatment bordered? Refer to standard drawing BMP- 011.	☐	☐	☐
E: Slope Stabilization:			
Are all slopes stabilized with an appropriate strategy?	☐	☐	☐

Final Inspection:

If you answered "Yes" or N/A** to all of the above questions, contact NTCD to schedule a final inspection. Reference the enclosed BMP Treatment Descriptions for further information on the above treatments.

** N/A answers should only apply if you do not have an issue on your property (e.g. no decks present)