I Title page

Southern Nevada Public Land Management Act

Research Proposal in Support of the Lake Tahoe Restoration Act and the Lake Tahoe Environmental Improvement Program

I.a. Project title: Urban stormwater fine sediment filtration using granular perlite.

I.b. Theme and subtheme: Water Quality and Effectiveness of urban and roadway BMPs in removing fine sediment from stormwater runoff.

I.c. Principal investigators:

Steve Kooyman, P.E.
El Dorado County DOT
924 B Emerald Bay Rd.
South Lake Tahoe, CA 96150
Phone: (530) 573-7910
Fax: (530) 541-7049
skooyman@edcgov.us

Russ Wigart
El Dorado County DOT
924 B Emerald Bay Rd.
South Lake Tahoe, CA 96150
Phone: (530) 573-7924
Fax: (530) 541-7049
Russell.wigart@edcgov.us

I.d. Grant contact person:

Justin Rall
El Dorado County DOT
924 B Emerald Bay Rd.
South Lake Tahoe, CA 96150
Phone: (530) 573-7906
Fax: (530) 541-7049
Justin.rall@edcgov.us

I.e. Total funding requested: $73,300

I.f. Total cost share: $14,700

II Proposal narrative

II.a Project abstract:

The infiltration of stormwater is not always practical as a treatment BMP in the Lake Tahoe basin, so an effective and economical treatment alternative is needed. The operation of manned sedimentation or filtration systems for stormwater is not technically or economically feasible. Granular Perlite has been tested and utilized as an unmanned stormwater filter media. However, the benefits and costs relative to improving Lake Tahoe clarity are not well understood. In order to further the understanding of the benefits and costs of a perlite filter media as a treatment BMP in the Lake Tahoe Basin, El Dorado County proposes to conduct full scale testing of this BMP in an existing urban stormwater system that currently discharges directly to Trout Creek.

II.b Justification statement:

Disturbance within the Lake Tahoe Basin increased rapidly in the late 1950s' including an extensive road network located mainly in the lower reaches of the watershed (Reuter, 2003). The most dominant pollutant of concern for Lake Tahoe clarity is sediment particles less than 16-microns (Swift, 2005). Roberts (2007) estimated that 72% of the less than 20-micron sediment load to Lake Tahoe originated from the urban upland source category establishing the importance of treating urban stormwater. In order to improve the clarity of Lake Tahoe, the cost effective removal of fine sediment from urban runoff is a fundamental problem since the benefits of erosion control measures that target total suspended sediment may be less than anticipated as earlier hypothesized by Jassby (1999).

A highly effective and economical means of reducing the transport of fine sediment from the urban environment to Lake Tahoe involves infiltration of runoff into subsurface soils. However, the infiltration of stormwater is not always practical due to surface water proximity, high groundwater, or the absence of available land for the construction of infiltration systems at stormwater outlets. In order to meet the Total Maximum Daily Load (TMDL) goals as identified by Roberts (2007), an effective and economical treatment alternative to infiltration must be identified.

II.c Concise background and problem statement:

Sedimentation of fine sediment by gravity or filtration of stormwater are alternatives to infiltration for the removal of sediment from urban runoff. However, in order to achieve high removal efficiencies of fine sediment from highway runoff using sedimentation, some type of particle coagulation and flocculation methods are required (Kang, 2007). Furthermore, the California Department of Transportation investigated the feasibility of treating stormwater in the Lake Tahoe Basin by sedimentation and fine sand filtration. They found that without chemical dosing, none of the sedimentation and fine sand filtration systems tested consistently met surface water discharge standards that included a maximum turbidity of 20 NTUs (Cal Trans, 2003). Treatment of stormwater using manned stoichiometric particle destabilization systems is difficult and undesirable (Kang, 2007) and for these reasons a more effective filtration alternative for treatment is required for locations where infiltration is not feasible.

Granular perlite media is proposed as a filtration media because of its use in proprietary treatment systems for the removal of fine sediment from stormwater. Aqua Filter stormwater filter has demonstrated between 65% and 80% reduction in total suspended sediment (tss) including sediment less than 20-micron (Mailloux, 2006). In 2008, El Dorado County DOT

conducted a series of small-scale filtration tests to evaluate the effectiveness of perlite for reducing turbidity in simulated stormwater. The effectiveness was measured to range between a 40% and 90% reduction in turbidity. These small-scale tests, existing Aqua Filter literature, the inert composition of perlite, and the low cost of the media have demonstrated the potential for perlite to reduce fine sediment, turbidity and tss in stormwater.

The granular perlite filter media will be installed in existing drainage inlets within a functioning stormwater collection system that discharges directly to Trout Creek. The filter will be maintained, operated, and evaluated for 12 months allowing for development of accurate sediment reduction credits for use in the Pollutant Load Reduction Model (PLRM).

II.d. Goals, objectives, and hypotheses to be tested:

The goal of this research is to advance understanding in the Lake Tahoe Basin relative to media filtration options available for the treatment of fine sediment in urban runoff by evaluating perlite filtration media. This research will quantify the water quality benefits, fine sediment treatment, and actual load reduction. This understanding will be used to evaluate the cost effectiveness of granular perlite relative to other treatment systems, and will also be used to accurately apply credits for the PLRM and TMDL. The objective of these experiments will be to demonstrate the water quality benefits, life cycle of the filter media, and the costs associated with the installation and operation of perlite media filters in an existing stormwater system. The water quality benefits will be determined by comparing the turbidity, fine sediment concentration, and total suspended sediment between the unfiltered and filtered stormwater. The hypothesis of this research is that filtering urban stormwater with granular perlite is:

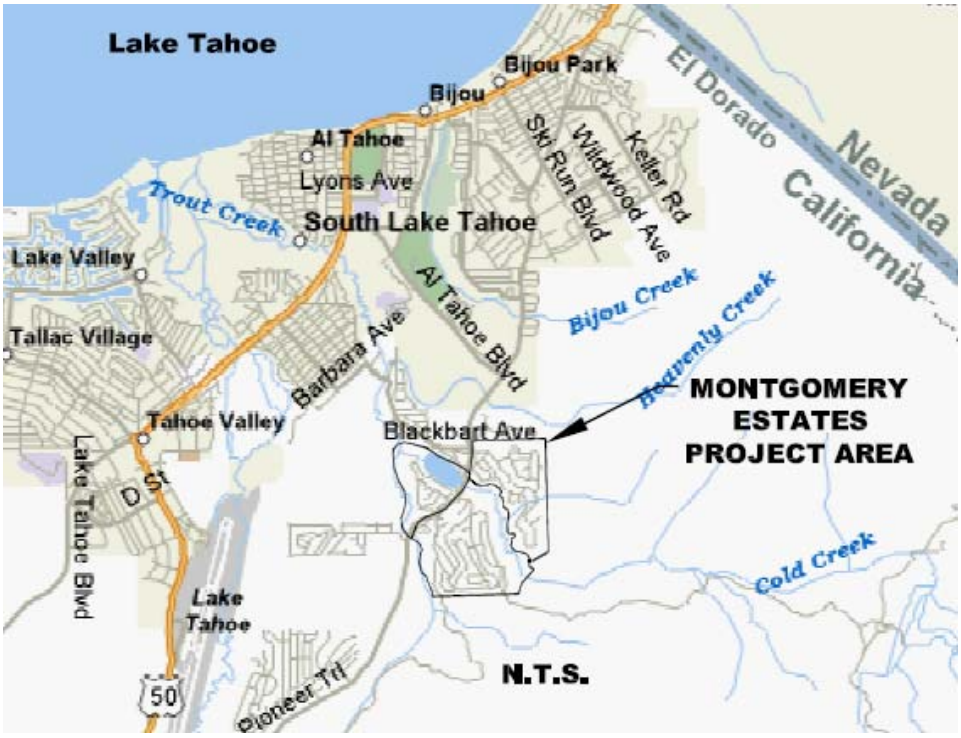
- effective in significantly reducing fine sediment from urban runoff
- practical for installation and operation in a drainage inlet within an extensive storm drain system
- economic relative to other filtration alternatives for the treatment of fine sediment.

II.e. Approach, methodology and location of research:

The approach to this research will include direct installation, operation, and maintenance of three perlite granular filters in three different existing drainage inlets within an existing stormwater system. The filters will be operated and maintained for 12 months using urban stormwater. This approach will allow for the measurement and evaluation of the filter during a complete hydrological season based on average stormwater conditions. The research will be conducted in the Montgomery Estates subdivision bounded by the Cold Creek and Trout Creek watersheds, see Figure 1. Montgomery Estates was selected due to the presence of an existing stormwater conveyance system, lack of treatment of stormwater in the subdivision, stormwater outfall connectivity directly to Trout Creek, location within half of a mile to the Sierra House meteorological station, and the proximity to the residences of the principal investigators.

The typical spacing between drainage inlets in the Montgomery Estates subdivision is approximately 300 feet. With drainage inlets on each side of the 24-foot road, the impervious surface contributing flow for each drainage inlet is approximately 3,600 ft^2. The design rain intensities range from the most typical intensity equal to 0.1 inches per hour to a maximum of 1 inches per hour, which will result in runoff ranging from 0.01 to 0.1 cfs. Three existing concrete drainage inlets will be modified using steel framing, concrete anchor bolts, and grating to direct

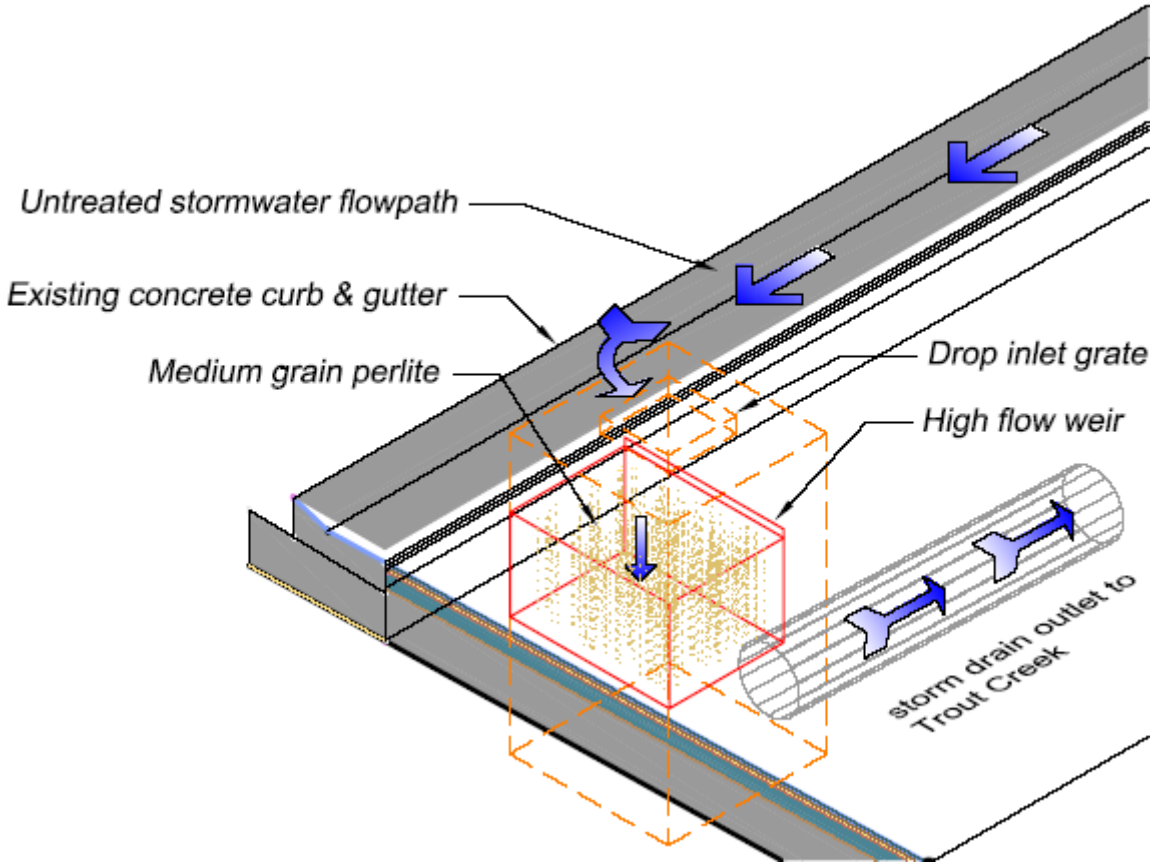
Figure 1 Montgomery Estates Project Location



stormwater into the granular perlite filter media each with a surface area of approximately 2 ft^2. The proposed configuration of the filter is presented in Figure 2. The stormwater loading rate will range from a typical flow rate of 2 gpm/ft^2 to a maximum of 20 gpm/ft^2, which is within the application rate tested by Aqua Filter (Mailloux, 2006). These flow rates are based on existing 15-minute rain intensity measurements maintained by El Dorado County from the Sierra House station. A high flow diversion weir will allow flow to bypass the filter into the existing storm drain system if the flow exceeds the filter capacity of the perlite media. Granular perlite will be purchased from a landscaping supply company at a cost of approximately 3 dollars per cubic foot. Depending on the hydrologic conditions and measured treatment effectiveness of the filter during the experiment, the perlite filter media will be replaced at 6-month or 12-month intervals.

Unfiltered stormwater samples will be collected manually as flow enters the drainage inlet and filtered stormwater will be collected at the filter outlet. As each sample is collected, the flow rate will be measured volumetrically. Precipitation will be documented using measurements from the existing Sierra House meteorological station maintained by El Dorado County and used to develop a continuously simulated hydrologic model. Measured flow rates will be used to calibrate and validate the hydrologic model. The turbidity of the unfiltered and filtered stormwater will be measured in the field using a Hach 2100 portable turbidimeter. Water quality samples will be collected and analyzed in accordance with the BMP performance monitoring and reporting protocol guidance document which is currently in development.

Figure 2 Modified Drainage Inlet Perlite Media Filter

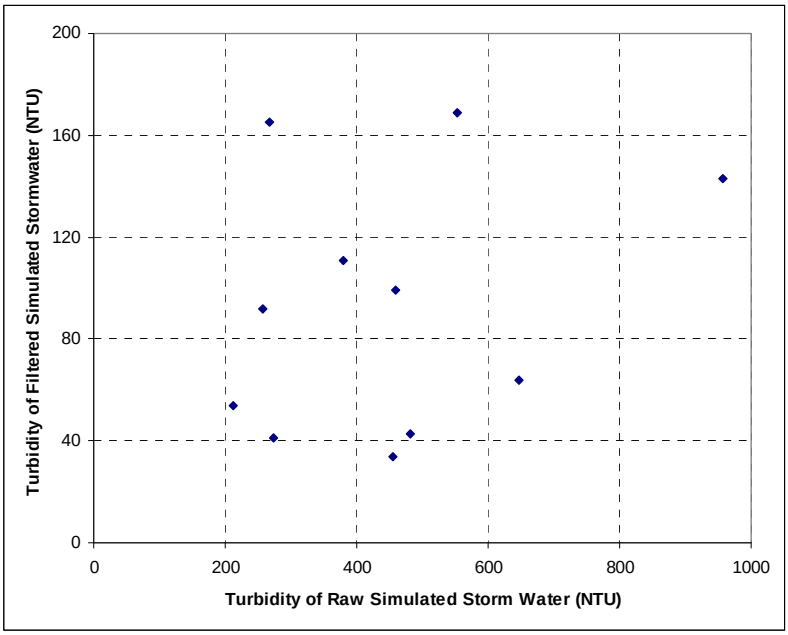


II.f. Relationship of the research to previous relevant research, monitoring, and/or environmental improvement efforts:

Aqua Filter has measured the effectiveness of reducing tss in simulated stormwater using Sil-Co-Sil 106 sediment which has a d_{50} particle size of approximately 21-microns. At application rates of 10 and 20 gpm/ft^2 the filter reduced tss between 80% and 65% respectively (Mailloux, 2006). This study did not measure turbidity or particles size distribution of the influent or effluent and was conducted using simulated stormwater only.

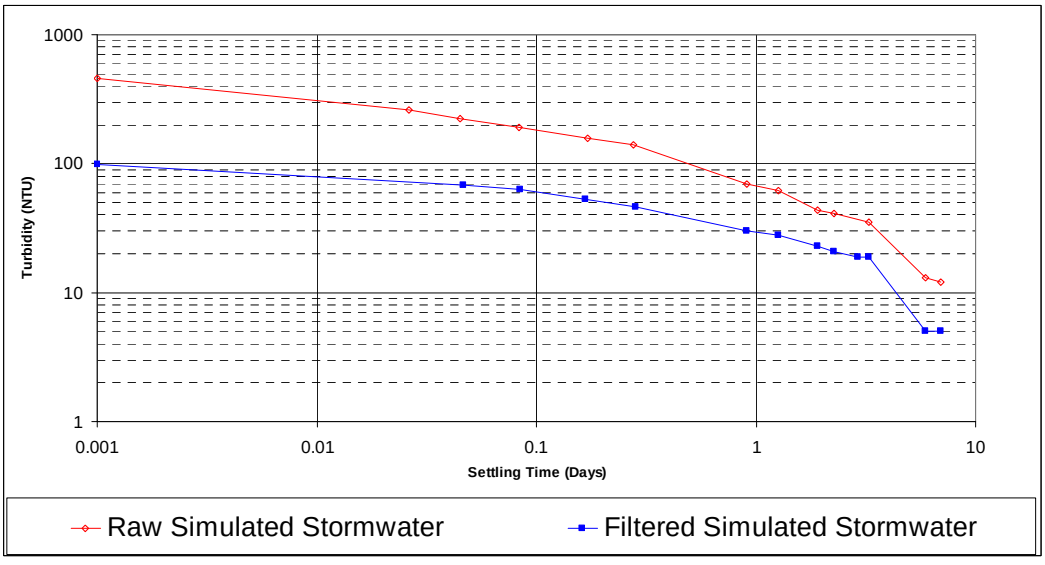
Between July and September 2008, El Dorado County DOT prepared thirteen different batches of simulated stormwater by suspending abrasive cinders in water, washing sediment from asphalt with water, and suspending sediment collected from various eroding slopes and channels in water. Each sample was screened through a 63-micron sieve so all sediment that contributed to a reduction in turbidity was less than 63-micron. Each sample was filtered through an 8" medium grained perlite filter fabricated by El Dorado County specifically for small-scale tests at a flow rate of approximately 1 gpm/ft^2. The turbidity of the simulated stormwater before and after filtration is presented in Figure 3. From the thirteen samples the average raw turbidity was 440 NTUs and the average treated turbidity was 91 NTUs representing an average reduction in turbidity of approximately 80%.

Figure 3 Simulated Stormwater Turbidity



This study did not measure particle size distribution and for this reason the results presented in Figure 3 do not assure that filtration of stormwater with perlite is effective in removing 20-micon and less particles. Furthermore, the long term water clarity benefits of perlite filtration were not demonstrated by these experiments. In order to partially address these unknowns, one of the simulated stormwater samples was allowed to settle in an imhoff cone for 7 days. The turbidity of the raw and filtered sample is presented in Figure 4 for the 7 day experiment. The unfiltered turbidity was 460 NTUs and the filtered turbidity was equal to 99 NTUs which represented a 78% reduction in turbidity. After 7 days, the turbidity of the unfiltered and filtered samples were 12 NTU and 5 NTU respectively representing a water clarity benefit based on 7 days of settling of approximately 60%.

Figure 4 Raw and Filter Turbidity Verse Time



II.g. Strategy for engaging with managers:

Mr. Kooyman and Mr. Wigart regularly meet with and discuss critical aspects of the Environmental Improvement Program (EIP) as representatives of various committees and subcommittees including:

- Storm Water Quality Improvement Committee (SQWIC)
- Pollutant Load Reduction Model (PLRM)
- Credit Accounting and Tracking committee
- Lake Tahoe Interagency Monitoring Program (LTIMP)
- Regional Stormwater Monitoring Program (RSWMP)
- Tahoe Science Agency Coordination Committee (TSACC)

In addition, El Dorado County is currently engaged in planning and implementing numerous water quality and erosion control projects. From these meetings and discussions and as an implementer of the EIP Dorado County is developing a keen understanding of the scientific needs relative to meaningful research to improve the benefits of the EIP.

II.h. Description of deliverables/products:

The Deliverables for this project will include the hydrologic and water quality results as necessary to comply with the BMP performance monitoring and reporting protocol guidance document that is currently in development. In addition, the results will be presented in a database once the protocols are developed. The results will include the following:

- Meteorological measurements at Sierra House station
- Flow measurements at the perlite media filter
- Water quality characteristics of the unfiltered and filtered stormwater including turbidity, particle size distribution and total suspended sediment (the methods will be developed and adjusted as appropriate once the reporting protocols are finalized)
- Hydrological and water quality modeling results presenting the annual flow volume. In addition, the benefit of the filter will be quantified by determining the mass of sediment captured by the filters.
- Cost of the construction and maintenance of the perlite granular filter systems and a calculation of the benefit/cost ratio of the filter for use as a BMP in areas where infiltration of stormwater is not feasible.

III Schedule

Milestones/Deliverables:	Starting Date	Ending Date
Establish agreement between PSW and El Dorado County	6/1/2009	9/15/2009
Kickoff meeting	9/30/2009	10/31/2009
Quarterly Progress Reports	12/31/2009	12/31/2010
Develop Sampling Plan and Protocols	9/30/2009	10/30/2009
Design Filter System	9/30/2009	11/30/2009
Order, Fabricate and Install Filters	10/30/2009	12/15/2009
Monitoring Filter	12/1/2009	12/1/2010
Replace Filter Media	TBD	TBD
Compile Results	12/1/2010	2/15/2011
Prepare Draft Findings Report	1/1/2011	2/29/2011
Prepare and submit final Findings Report	2/28/2010	4/15/2011

IV. References

Caltrans (2007). Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Porject Phas II Report. December, 2003.

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Kang, Joo H. et al. (2007). Particle destabilization in highway runoff to optimize pollutant removal. Journal of Environmental Engineering. 133 (4): 426-434.

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Reuter, J. E. et al., (2003). An integrated watershed approach to studying ecosystem health at Lake Tahoe, CA-NV. Managing for Healthy Ecosystems, 1283-1298.

Roberts, David M. and Reuter, John E. Draft Lake Tahoe Total Maximum Daily Load Technical Report, California and Nevada, September 2007.

Swift, Theodore J. et al. (2005). Water clarity modeling in Lake Tahoe: Linking suspended matter characteristics to secchi depth. Aquatic Scinece 68: 1-15.

V. Figures (contained within the text)