OHIO DEPARTMENT OF TRANSPORTATION
OFFICE OF HYDRAULIC ENGINEERING
RESEARCH IMPLEMENTATION PLAN

Project Title:	Exfiltration Trenches for Post Construction Storm Water Management for Linear Transportation Projects		
Research Agency:	Ohio University	Researcher(s):	Gayle Mitchell, Shad Sargand
Sponsor(s):	Office of Hydraulic Engineering	Technical Liaison(s):	Jeff Syar, Becky Humphreys
State Job #:	134384	PID:	84102
Project Start Date:	May 1, 2008	Project End Date:	June 30, 2013
Project Cost:	$579,623.43	Funding Type:	SP&R2 (80/20)

1) Background

As specified by law, the Ohio Environmental Protection Agency (OEPA) requires that ODOT implement best management practices (BMPs) that reduce pollution from storm water runoff on linear transportation systems sold after March 10, 2006. Among the various pollutant mitigation options available, exfiltration trenches are reportedly constructable, have manageable construction costs, and are relatively easy to maintain. The exfiltration trench also has the benefit of being a linear treatment system which occupies a very small footprint within the roadway right-of-way and can be easily incorporated into the standard design of a curbed roadway typical section. They can be installed in ultra-urban, urban and transitional urban areas. As a BMP for storm water mitigation and pollutant removal, exfiltration trenches have significant merit and promise. In order to maximize the benefits from exfiltration trenches, it is necessary to optimize the design and verify the performance. Construction techniques and maintenance criteria also need to be established.

2) Research Objectives

The goal of the research was to examine the design, construction, operation (pollutant removal and runoff quantity capabilities), and durability of exfiltration trenches. Special emphasis was placed on optimizing the design and selection of materials to maximize capture and treatment of the water quality flow of highway storm runoff, while being cognizant of the material costs.

3) Research Deliverables

- Proposed revisions to Volume 2 of ODOT's *Location and Design Manual* section on exfiltration trenches
- Proposed revisions to Supplemental Specification SS 835
- Proposed revisions to Standard Construction Drawing WQ-1.2
- Pollutant removal report to Ohio EPA
- Final Report incorporating the following:
    - Documentation of the durability of exfiltration trenches.
    - Maintenance manual for exfiltration trenches with guidelines based on traffic and environmental conditions.
    - Summary report addressing recommendations from OEPA as to the functionality of the device and the removal efficiencies.

4) Researcher's Recommendations

From laboratory study:

- Prewash the aggregate and sand prior to installation in the trench or use as clean a material as possible.
- Utilize an alternative filter media to sand if metals' removals above about 70% are warranted.
- Review the list of Type 3 Backfill currently accepted by ODOT for suitability in the intermediate layer; any material that could be a source of pollutants should not be used in the exfiltration trench.
- Utilize sweeping and vacuuming for maintenance of the porous concrete layer

From Reno field study:

- Utilize a fully enclosed concrete chamber that is of good quality.
- Ensure installation of the filter fabric does not provide pathways for runoff to bypass the filter media.
- If enhanced removal of metals is needed, consider alternate filter media to the filter sand.

- Find an alternative to the pervious concrete as this layer tends to experience early age clogging and maintenance only recovers a portion of the lost permeability.

From Athens field study:

- The main focus of this study was to determine the removal of suspended solids from the runoff. The new designed exfiltration trench system in Athens removed on average about 86% of the material that entered the device.
- The new design has three advantages. First, the enclosed bottom ensures that all the runoff travels through the filter and extraneous flow does not occur. Second, the surface layer of the plate reduces clogging significantly and is easily cleaned. Third, the design is accessible for maintenance and inspection.
- With the appropriate design, maintenance frequency could be reduced to semi-annual, depending on site conditions.
- Future installations of excavation trenches must be designed to have adequate capacity to handle site flow conditions.
- Further refinement of the plastic bubble plate (patent pending) such as modifications to the dome height and the size, number, and location of orifices on the dome need to be studied in order to optimize the performance of the plate and reduce frequency of maintenance without sacrificing the overall performance.

From observations at other field sites:

- Schedule the filling of exfiltration trench cavities with filter media, aggregate, and pervious concrete layers as the last feasible step in the construction process to reduce the potential for premature clogging of exfiltration trenches by construction residue.
- Sweeping and vacuuming are effective maintenance methods. Power washing does not add much more results. Maintenance should be conducted every six months or sooner if an inspection warrants.
- Ensure that existing exfiltration trenches are regularly inspected and maintained.

5) Liaison's Recommendations

This research tested two different designs of exfiltration trenches. Findings demonstrated that the original design (drawing no.: WQ-1.2) does not perform as initially thought. As a result, the Office of Hydraulic Engineering (OHE) intends to modify the L&D Vol. 2 manual by removing this particular design. The second design tested incorporated a filter (referred to as "bubble plate") designed by the research team. The performance of this revised trench design has shown promise; however, further evaluation of the bubble plate is needed to confirm the researcher's recommended maintenance schedule.

Pending the success of further testing, OHE anticipates including the redesigned exfiltration trench, inclusive of the bubble plate, in a future update of the L&D Vol. 2 manual as an optional BMP for storm water management on projects that met the criteria for its use. The further testing will occur as an in-house, pilot research project conducted by OHE.

6) Implementation Actions and Schedule

This pilot project will evaluate the maintenance scheduled of the redesigned exfiltration trench, with emphasis on the bubble plate, at four test sites. Two test sites will utilize a single bubble plate design while two sites will utilize a double bubble plate design.

Item	Actions	Participants	Completion Date / Duration	Comments
1	Acquire bubble plates from researcher for use in field testing.	Becky Humphreys (OHE) Vicky Fout (Research)	March 2014	Research will assist OHE in obtaining a quote from Dr. Sargand for building and delivering 6 bubble plates. Research will provide OHE with funding to purchase the bubble plates. OHE, utilizing their appropriate procurement procedure, will purchase and

				receive the plates from Ohio University.
2	Coordination of field sites for pilot testing and trench installation.	Becky Humphreys (OHE)	October 2015	OHE has identified two potential site locations in D6 (FRA-3-24.47) for pilot testing. OHE will coordinate with D6 to confirm sites and include the construction of trenches (with bubble plates) in the construction contract. OHE will coordinate with D6 to ensure the contractor has installed the trenches and bubble plates as specified.
3	Conduct pilot field testing	Becky Humphreys (OHE)	October 2015 to October 2016	OHE will monitor the field site and collect pertinent data for the period of one year. Data collection will occur at a minimum of six month intervals. Additional collection times may be added as necessary. OHE will analyze the performance of trenches, post-maintenance, and make adjustments to the maintenance schedule as needed.
4	Summarize findings	Jeff Syar (OHE) Becky Humphreys (OHE)	November 2016 to December 2016	OHE will summarize the findings from the pilot field test. Findings will include a determination on the maintenance schedule for the redesigned trench (with bubble plate). Summary will be formatted in accordance with ODOT's Research Section In-House Research Program.
5	Modify ODOT's L&D Vol. 2 Manual	Jeff Syar (OHE) Becky Humphreys (OHE) Vicky Fout (Research)	January 2016	Based on positive findings, OHE will coordinate revisions to the L&D Vol. 2 manual (as appropriate) with OEPA and appropriate ODOT personnel. OHE will update Research on the outcome of any revisions to the L&D Vol. 2 manual pertinent to this pilot project.

7) Expected Benefits

Clarification of the appropriate maintenance schedule for the bubble plate is expected to result in being able to include the revised design of the exfiltration trench in the L&D Vol. 2 manual. Being an extension of the OEPA permit, inclusion in the L&D manual will certify the redesigned exfiltration trench as a BMP for storm water management. This provides designers and engineers with another tool from which to choose when trying to address drainage issues in compact areas.

8) Expected Risks, Obstacles, and Strategies to Overcome Them

Risk/Obstacle	Strategy to Overcome
Unable to obtain bubble plates for pilot testing from researcher.	Construction of bubble plates might be incorporated into the build of the trenches and performed by the contractor installing the exfiltration trench at the test site.
Loss of field site(s) due to scheduling conflicts.	OHE will coordinate with other ODOT districts to identify additional pending construction projects that include the use of an exfiltration trench in the design.
Incorporation of redesign into the L&D Vol. 2 manual is not approved.	Presenting the redesigned exfiltration trench for inclusion in the L&D Vol. 2 manual would only occur if the findings from the

	pilot test are positive and confirmed. Rejection at this point would indicate that additional work is needed. OHE would re-evaluate the findings and purpose for rejection and determine the appropriate course of action (e.g.: further work is needed or exfiltration trenches should be abandoned all together).
Limited application of final product.	Due to the limitations on the effectiveness of exfiltration trenches, it is known that their applicability is restricted to small drainage areas (e.g.: > 0.22 acres). For these small areas, exfiltration trenches are a relatively affordable solution (estimated at $5,000 per unit); however, in cases where multiple trenches would be needed, the construction costs can become excessive. While their applicability may be narrow, having an acceptable BMP as an option for these instances will be beneficial.

9) Groups Impacted by the Implementation

In addition to ODOT, its' districts, and the OEPA, the findings of this pilot test may also impact Ohio's local public agencies (counties, townships, and municipalities), construction contractors, roadway designers, and transportation engineers. Other state DOTs will also be influenced by these findings as it will provide them with clarification on the potential use of the Ohio's redesigned exfiltration trench in their respective state.

10) Progress Reporting and Time Frame

Date	Progress Report
February 2014	Research will follow up with OHE on the progress of action item #1.
July 2014	Research will follow up with OHE on the progress of action item #2. At this this time, the schedule for remaining action items will be reviewed and modifications may be made as necessary.
May 2015	Research will follow up with OHE on the progress of action item #3. Based on the findings to-date, OHE will inform Research if the time period for field monitoring needs to be extended to ensure adequate evaluation of potential revisions to the maintenance schedule.
December 2015	Research will finalize the summary report provided by OHE for action item #4.
January 2016	Research will follow up with OHE concerning progress on action item #5. In the event modifications to the L&D Vol. 2 manual are forthcoming, Research will follow up with OHE on a quarterly basis until the outcome modifications to the manual are known.

11) Technology Transfer Methods to be Used

The technical report summarizing the findings from the pilot project will be published on ODOT's Research Section website and included in the State of Ohio library and TRB's Transport Research International Documentation (TRID) database. Depending on the results, an article on the outcome may also be included in ODOT's Research Section newsletter, "Moving Forward."

In the event the findings result in the inclusion of the redesigned exfiltration trench in the L&D Vol. 2 manual, those who receive updates on changes to the manual will also be informed through existing avenues (e.g.: OHE's website, etc.).

12) Implementation Costs and Sources of Funding

The anticipated costs with developing a plan of action as described in this implementation plan will not be significant. Cost for the construction of the redesigned exfiltration trench will be absorbed by the district in which the trench is being installed as part of the larger construction project. Costs associated with salary for OHE personal to monitor, evaluate, and summarize findings of the field work will be absorbed by OHE. ODOT's Research Section may transfer funding to OHE to cover costs associated with the procurement of bubble plates for field testing. Funding for this activity is currently estimated at $1,000; however, this amount may be modified.

13) Implementation Evaluation / Return on Investment

The intent of this pilot project is to confirm the redesigned exfiltration trench as a viable BMP option to allow for its inclusion in ODOT's L&D Vol. 2 manual. Actual use will not be required. The construction of exfiltration trenches and in particular the bubble plate - which this pilot is evaluating – are typically included in larger scale construction projects and do not include a specific pay item number which would allow for tracking

of their direct use. Therefore, a quantifiable evaluation of whether or not bubble plate exfiltration trenches are being used is not feasible to obtain.

In the event additional information is required in the future, a survey could be sent to the ODOT district offices asking if any known cases of installation of the redesigned trench took place; however, information obtained from the survey would be incidental at best.

The most significant return-on-investment that could result from this would be leverage with the OEPA that ODOT performed its due diligence in ensuring BMP options available to state and local officials are validated reliable, and effective.

Signatures below constitute review of the liaison recommendations and subsequent sections of the implementation plan. Modifications to the plan can be made at any time. All modifications must be in writing. For assistance with making modifications to an implementation plan, contact the Research Section.

Approved By: (attached additional sheets as necessary)

Technical Liaison(s):

Signature: Rebecca J Hoagland Office: OHE Date: 11/26/13

Signature: _____ Office: _____ Date: _____

Office Administrator(s):

Signature: J SDyer Office: OHE Date: 11/27/13

Signature: _____ Office: _____ Date: _____