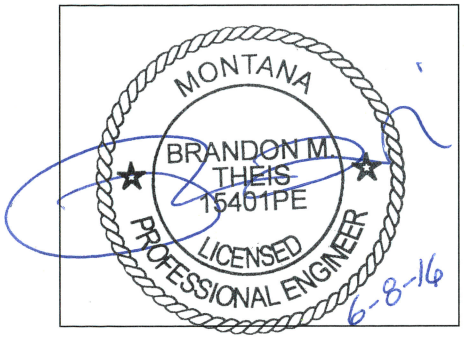
ROBERT PECCIA & ASSOCIATES

# Technical Memorandum

**TO:** Treasure State Acres Homeowners Assoc.
Attn: Steve Shirley, Secretary

**CC:** Lewis and Clark County Department of Public Works
Attn: Jesse Whitford, CET IV, CWI, Construction/RID Coordinator

**FROM:** Thomas Cavanaugh, PE, Robert Peccia & Associates
Brandon Theis, PE, Robert Peccia and Associates




**SUBJECT:** Treasure State Acres – Storm Drainage Improvement Project Technical Memorandum

**DATE:** June 8, 2016

## Project Understanding

This Technical Memorandum addresses the Scope of Services under Task Order 18 with Lewis and Clark County. There are multiple curb and drop inlets throughout the Treasure State Acres (TSA) subdivision. We understand all except one are open-bottomed concrete manhole barrels that function as sumps discharging runoff by infiltration into the subsoil. Each sump functions fair-to-poor with historical, repeat issues of sediment clogging. Anecdotal evidence brought forth at the time of scoping and task field reviews also suggest the single-barrel manhole-type sumps are undersized to adequately discharge most storm events. Their capacity and repeat sediment clogging result in long term standing water at these locations. Our work follows up based on the preliminary actions and recommendations contained in the 2015 TSA Road Maintenance Plan to focus on improving storm runoff storage, maintenance and infiltration at existing inlets. The intended results are the TSA's roads will experience less structural damage by removing standing water by improving the rate of surface water dissipation. From scoping, eight intersection locations were chosen to investigate. These are:

1. Bighorn Road and Red Fox Drive
2. Bighorn Road and Cougar Drive
3. Otter Road and Red Fox Drive
4. Kodiak Road and Red Fox Drive
5. Kodiak Road and Cougar Drive
6. Cayuse Road and Red Fox Drive
7. Mustang Road and Red Fox Drive
8. W. Cayuse Road and Wolverine Drive

## Summary of Field Work

SK Geotechnical was retained by Lewis and Clark County to complete a Geotechnical Report to provide RPA with soils and percolation testing to assist us to complete the analyses for this technical memorandum. Refer to **Appendix G** for a copy of that report. Infiltration rates for the onsite soils were determined by SK Geotechnical by performing percolation testing at 4 of the 8 intersections. Rates for the other 4 intersections were assigned by averaging the nearest two percolation test results. In general, the infiltration rates can be classified as moderate for the purpose of infiltrating stormwater by the methodology examined in this task. The best infiltration rates were found near the intersection of Cayuse & Red Fox.

## Engineering Calculations

DEQ Circular 8 Analyses

Each of the 8 intersections was analyzed per DEQ Circular 8 – Infiltration Facilities. The results are mixed due to the moderate properties of the site soils. See the appendices table of contents at the end of this memorandum for exhibits, sizing calculations, cost estimates and product information sheets. The methodology is based on a subsurface StormTech® chamber infiltration system as initially considered in the 2015 TSA Road Maintenance Plan, sized to the DEQ Circular 8 requirements for infiltrating and storing the 2-year, 1-hour storm event. From a hydrology perspective, a 2-year event statistically has a 50% chance of occurring in any given year.

With an Estimated Total Project Cost of $1.27 Million (**Appendix A**) for all eight intersections, and understanding there are other intersection drainage issues that need to be addressed apart from this pilot study assessment, we recognize that the cost of this system is outside obtainable future project budgets. This is partially due to the moderate properties of the site soils resulting in a large number of chambers required. However, this is mostly due to the understanding that most of the stormwater generated on this site is not currently stored onsite, but instead is allowed to bypass sheet flow through the intersections to the vicinity of Buffalo and Cougar where it ultimately leaves the subdivision and flows to ditches along I-15.

Given the construction cost calculated to store the 2-year, 1-hour event on site, we did not further calculate the construction costs that would be required to store the larger 10-year occurrence storm event, as it would be orders of magnitude more expensive. However, as a comparison as shown in **Appendix C,** the cumulative 2-year, 1-hour storm event storage amounts to approximately 560 chamber installations (at over 7 feet long each), spread across the eight intersections, while the amount to fully store the 10-year, 1-hour event is 885 chambers, or more than 6,000 linear feet!

In essence, to deal with all of the stormwater, if it is an issue to the subdivision, is best to consider other potential methods outside the scope of this task. Such as the classic storm drain system with lateral lines connecting inlets, discharging to larger mainline trunk lines, to then outfall to acceptable low point locations rather than by infiltration. The obvious issue is TSA lacks appropriate outfalls to our knowledge to handle all of the stormwater. Unlike newer subdivisions, no outfalls or retention basins were created or set aside within the subdivision at the time it was developed to store stormwater. Instead, all lots are residences. The only open area is the center common area park. That area could be considered for developing storm retention storage if the need is fully identified.

Having the findings of the DEQ Circular 8 Analysis, RPA instead decided to add a second analysis to this Technical Memorandum (the “Allowed Bypass Analysis”) that allows for bypass flow, lessens storage costs and focuses on infiltrating the stormwater that is left behind after the storm has ended at the intersection low points. In essence, the task became using the same process, but focusing on removing the remaining residual water ponding at the intersections. In this method, we used perforated corrugated plastic pipe instead of the StormTech® chamber infiltration system since the quantity of storm water to address is substantially reduced. This method is very much similar to what was installed approximately 20 years ago at the southwest corner of the Bobcat Drive and Buffalo Road intersection, except that installation utilized a length of perforated reinforced concrete pipe to increase the existing sump’s capacity and rate of stormwater infiltration.

Allowed Bypass Analysis

This methodology is to improve existing conditions. After storm events, pooling water is present at many of the intersections that contain sumps as seen in the photo below.


Photo 1 – Intersection of Red Fox and Kodiak, May 16, 2016.

After time, ponding water either evaporates, is splashed on to adjacent property to infiltrate into adjacent soils, or more slowly infiltrates into the ground through the asphalt or roadside inlet sumps. This current scenario at the worst performing intersections can take several days and is likely due to the sedimentation and clogging of the existing open-bottomed barrel inlets. Below is a photo of the same intersection shown above, a day later, and exhibiting minimal change in the water level. Some intersections contain more or less ponding. This is reflective of the elevation of the road that either allows or not for the water to bypass flow along the curb line to locations further downstream, and the degree of how well the existing sumps operate.


Photo 2 – Intersection of Red Fox and Kodiak, May 17, 2016.

The effects of standing water can range from being a nuisance to detrimental. One nuisance is the obvious splash and spray to adjacent property and potential bystanders. For the purpose of this study, the detrimental aspects are that significant standing water eventually infiltrates through the voids, pores and cracks of the road's asphalt surfacing, which is very hard but not totally impervious, to eventually penetrate the underlying road base. Once saturated, the road base's structural integrity is lessened, weakening its ability to support the loads imposed upon it from traffic. Over repeat occurrences the result can be to accelerate road breakup and increase the frequency and magnitude of road maintenance. That study was completed in the 2015 TSA Road Maintenance Plan. It is the increased road maintenance due to ponding water that we are trying to rectify.

To address this issue, we propose connecting and installing infiltration beds to the existing barrel inlets. Again, similar to what was done at the intersection of Bobcat Drive and Buffalo Road. However, perforated plastic pipe is light weight and easy to hand-work into place as compared to the concrete pipe used at Bobcat Drive and Buffalo Road. To minimize costs, these infiltration basins can be installed in the green space areas between the existing curbs and right-of-way lines in order to eliminate cutting and removing more expensive road material. We mention this, however understanding that installations outside the road curb line will require disturbing grassed boulevards and other potential improvements beyond the edge of the road, but still within the road right-of-way boundaries. We understand excavating green space maintained by the adjacent homeowner may not be very palatable.

Refer to the appendices table of contents below for exhibits, sizing calculations, cost estimate and product information sheets for the proposed infiltration beds. If installed, the stormwater drawdown time at these intersections will be greatly improved. The result should be to eliminate ponding and potential road damage over time. For example, the estimate for the intersection shown above, at Red Fox and Kodiak, the drawdown time to free the intersection of surface water would be 1-3 hours by installing two 32-foot long infiltration beds. For all 8 intersections, we estimate that infiltration beds can be installed for an Estimated Total Project Cost of $110,600.

**Appendix D** contains catalog sheet information on example products that serve as a filter/screens installed just under sump inlet grates. This product is developed to catch sediment and larger debris prior to it making its way into the system, thereby providing an initial guard for inspecting and easily removing sediment to reduce its ability to detrimentally clog the sump's infiltration capability.

**Appendices**

Appendix A: DEQ Circular 8 Analyses – Overall Project Estimate

Appendix B: TSA Drainage Basins Overview

Appendix C: DEQ Circular 8 Analyses – Sizing Calculations

Appendix D: Materials Catalog Sheets – Filter Bags

Appendix E: Materials Catalog Sheets - StormTech® Chambers

Appendix F: Allowed Bypass Analysis – Exhibits, Sizing Calculations, Cost Estimate and Product Information Sheets

Appendix G: SK Geotechnical Report for the Treasure State Acres Subdivision, April 22, 2016

# Appendix A

## DEQ Circular 8 Analyses – Overall Project Estimate

# Engineers Opinion of Probable Cost
# TREASURE STATE ACRES
## *DEQ 8 INFILTRATION CHAMBER OPTION*

*Robert Peccia & Associates, Inc.*
*825 Custer Avenue * Helena * Montana * (406) 447-5000*
*102 Cooperative Way, Suite 300 * Kalispell * Montana * (406) 752-5025*

| Item No. | Quantity | Unit | Unit Description | Engineer's Estimate Unit Price (Figures) | Engineer's Estimate Total Price (Figures) |
|---|---|---|---|---|---|
| **Estimated Construction Costs** | | | | | |
| 1 | **560** | EA | Infiltration Chambers - 91" L x 51" W x 30" H | $1,000.00 | $560,000.00 |
| 2 | **800** | LF | Pipe - 18" HDPE Corrugated Storm Pipe (100 feet per intersection) | $50.00 | $40,000.00 |
| 3 | **32** | EA | 48" Slotted Drain Inlet with Drain Rock (new inlet at each intersection quadrant) | $3,500.00 | $112,000.00 |
| 4 | **32** | EA | Inlet Filter Inserts | $500.00 | $16,000.00 |
| 5 | **29,000** | SF | Roadway Section Removal & Replacement (125% of total chamber footprint) | $4.00 | $116,000.00 |
| 6 | **400** | LF | Curb & Gutter Removal & Replacement (50 feet per intersection) | $35.00 | $14,000.00 |
| 7 | **1** | LS | Construction Staking (2%) | $17,200.00 | $17,200.00 |
| 8 | **1** | LS | Traffic Control (2%) | $17,200.00 | $17,200.00 |
| 9 | **1** | LS | Mobilization (5%) | $44,600.00 | $44,600.00 |
| 10 | **1** | LS | Project Contingency (15%) | $140,600.00 | $140,600.00 |
| | | | | *Subtotal =* | *$1,077,600.00* |
| **Estimated Engineering Costs (18%)** | | | | | |
| 1 | **1** | LS | Preliminary Design Phase (3%) | $32,300.00 | $32,300.00 |
| 2 | **1** | LS | Design Phase (10%) | $107,800.00 | $107,800.00 |
| 3 | **1** | LS | Bid to Award Phase (1%) | $10,800.00 | $10,800.00 |
| 4 | **1** | LS | Construction Engineering Phase (4%) | $43,100.00 | $43,100.00 |
| | | | | *Subtotal =* | *$194,000.00* |
| | | | | **TOTAL ESTIMATED PROJECT COST (ROUNDED) =** | **$1,272,000.00** |

# Appendix B

## TSA Drainage Basins Overview

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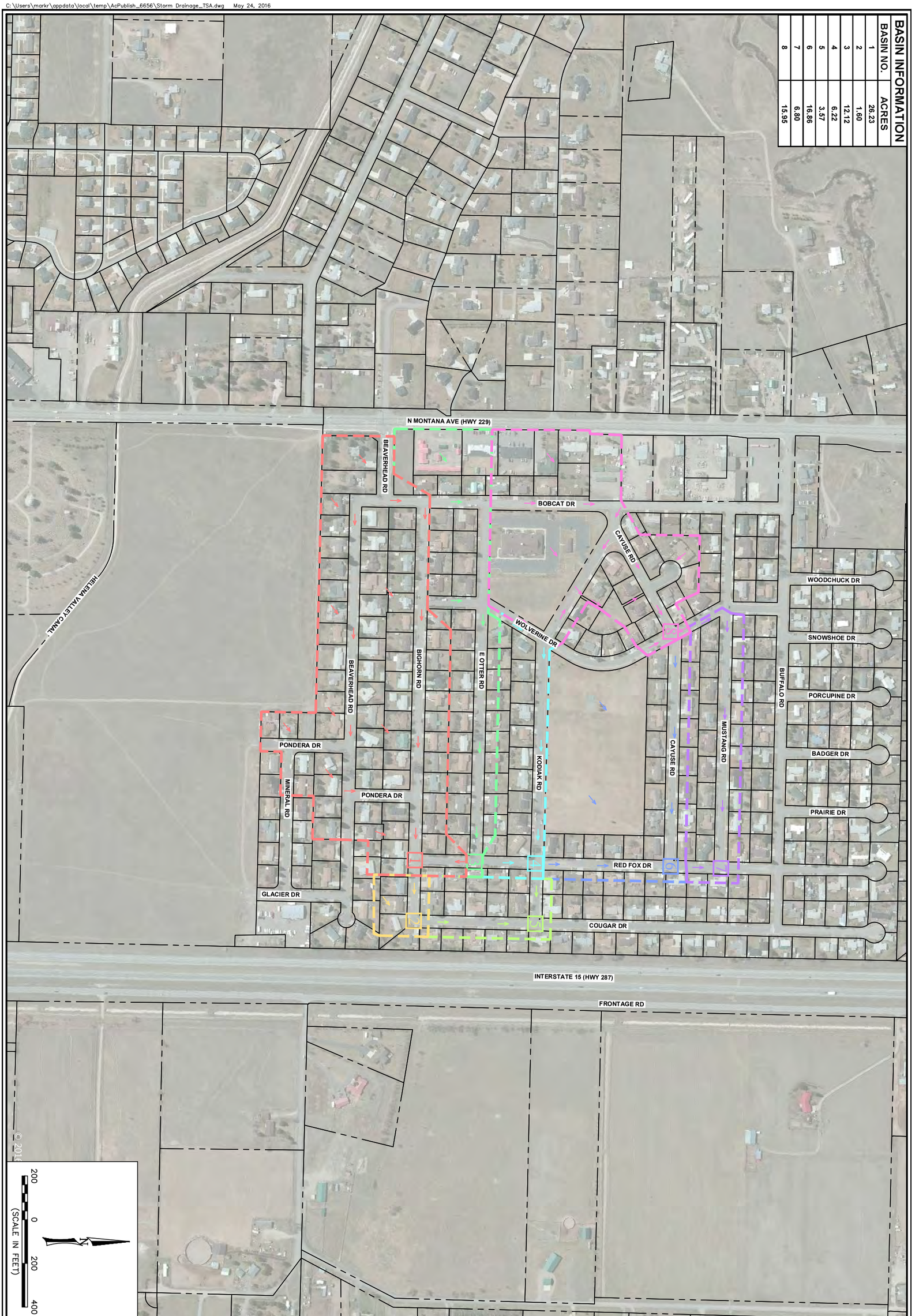


## BASIN INFORMATION

| BASIN NO. | ACRES |
|---|---|
| 1 | 26.23 |
| 2 | 1.60 |
| 3 | 12.12 |
| 4 | 6.22 |
| 5 | 3.57 |
| 6 | 16.86 |
| 7 | 6.80 |
| 8 | 15.95 |

200 0 200 400
(SCALE IN FEET)

SHEET
A

SHEET TITLE
**BASIN OVERVIEW (WITH AERIAL PHOTO)**

PROJECT TITLE
**TREASURE STATE ACRES STORM DRAINAGE PLANNING**
*Helena, Montana*

B.THEIS — DESIGNED BY
M.ROGERS — DRAWN BY
R.MITCHELL — CHECKED BY
MAY 2016 — DATE
10501.018 — PROJECT NO.
Storm Drainage_TSA — FILE

| SYM | REVISION | BY | APPR. | DATE |
|---|---|---|---|---|
| | PRELIMINARY NOT FOR CONSTRUCTION | | | |

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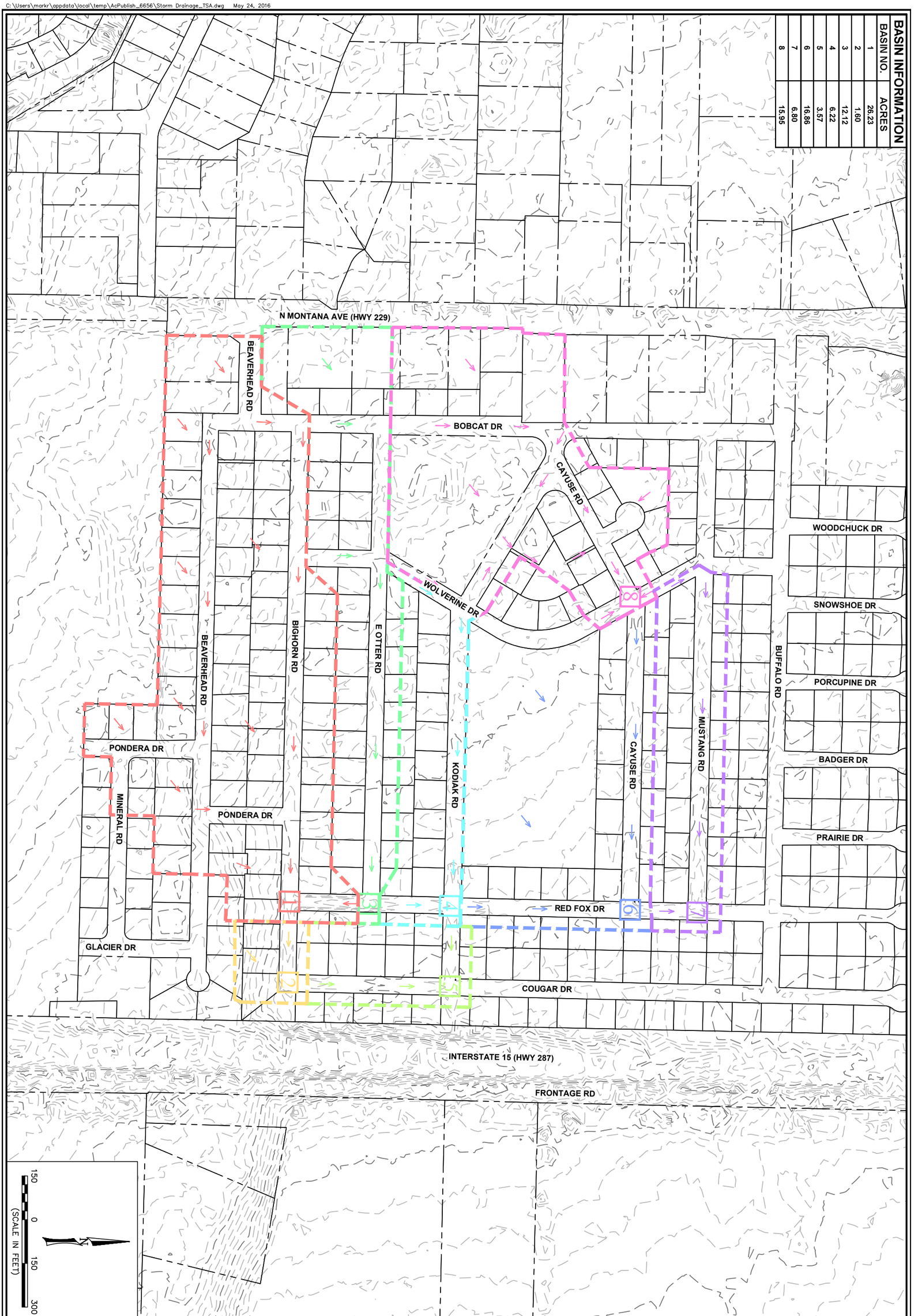


**BASIN INFORMATION**

| BASIN NO. | ACRES |
|---|---|
| 1 | 26.23 |
| 2 | 1.60 |
| 3 | 12.12 |
| 4 | 6.22 |
| 5 | 3.57 |
| 6 | 16.86 |
| 7 | 6.80 |
| 8 | 15.95 |

SHEET B

SHEET TITLE

**BASIN OVERVIEW (WITHOUT AERIAL PHOTO)**

PROJECT TITLE

**TREASURE STATE ACRES STORM DRAINAGE PLANNING**

*Helena, Montana*

| | |
|---|---|
| B.THEIS DESIGNED BY | MAY 2016 DATE |
| M.ROGERS DRAWN BY | 10501.018 PROJECT NO. |
| R.MITCHELL CHECKED BY | Storm Drainage_TSA FILE |

| SYM | REVISION | BY | APPR. | DATE |
|---|---|---|---|---|
| | PRELIMINARY NOT FOR CONSTRUCTION | | | |

RPA

# Appendix C

## DEQ Circular 8 Analyses – Sizing Calculations

| BASIN COLLECTION INTERSECTION | BASIN LABEL | BASIN AREA (ACRE) | Rational Method C-Value | Chamber System Percolation Rate (min/in) | 2-Year Storm Chambers Needed StormTech SC-740 | 10-Year Storm Chambers Needed StormTech SC-740 |
|---|---|---|---|---|---|---|
| Bighorn & Red Fox | 1 | 26.23 | 0.30 | 21.90 | 179 | 284 |
| Bighorn & Cougar | 2 | 1.60 | 0.30 | 12.50 | 10 | 16 |
| E Otter & Red Fox | 3 | 12.12 | 0.30 | 31.30 | 86 | 136 |
| Kodiak & Red Fox | 4 | 6.22 | 0.30 | 17.15 | 41 | 66 |
| Kodiak & Cougar | 5 | 3.57 | 0.30 | 17.15 | 24 | 38 |
| Cayuse & Red Fox | 6 | 16.86 | 0.30 | 3.00 | 76 | 121 |
| Mustang & Red Fox | 7 | 6.80 | 0.30 | 3.00 | 31 | 49 |
| Cayuse & Wolverine | 8 | 15.95 | 0.30 | 25.00 | 112 | 175 |
| | | | | Total Chambers = | 559 | 885 |
| Combined Regional System | | 89.35 | 0.30 | 3.00 | 398 | 641 |
| | | | | Less Chambers = | 96 | 141 |

StormTech
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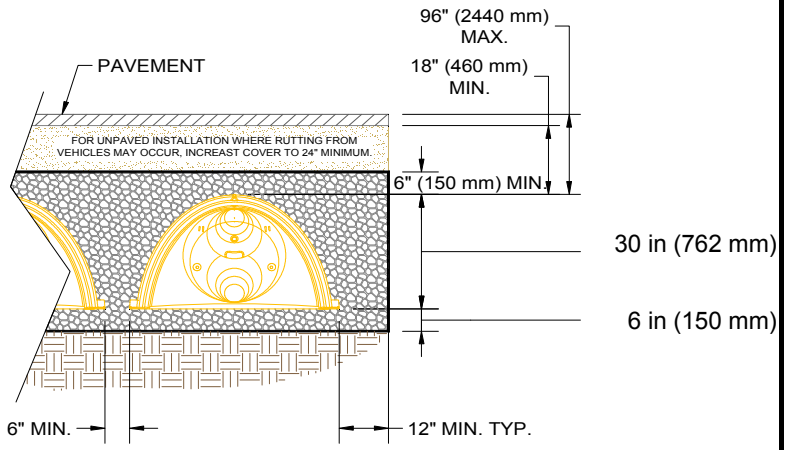
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 2 Year Storm - Basin 1 (Bighorn & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **13,379** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




| | | |
|---|---|---|
| **Number of Chambers Required -** | **179** | |
| Approximate Bed Size Required | 7,988 | SF |
| Tons of Stone Required | 1,024 | Tons |
| Volume of Excavation | 1,479 | CY |
| Area of Filter Fabric | 3,190 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **1274.48** | FT |
| ISOLATOR FABRIC | **708** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **1300** | FT |
| # of Chambers long | 179 | EA |
| # of Rows | 1 | EA |
| Actual Length | 1,278.08 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Bighorn & Red Fox*

2 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 26.23 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 7988 | SF (Enter per StormTech 2-Year Sheet) |
| Percolation Rate = | 21.90 | min/in |
| | 2.74 | in/hr |

$I = 8.0354T^{-0.653}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **2.60** | 0.22 | 0.22 | 2.60 |
| 10 | **1.87** | 0.31 | 0.10 | 1.20 |
| 15 | **1.46** | 0.37 | 0.05 | 0.60 |
| 20 | 1.20 | 0.40 | 0.04 | 0.48 |
| 25 | 1.03 | 0.43 | 0.03 | 0.36 |
| 30 | **0.90** | 0.45 | 0.02 | 0.24 |
| 35 | 0.80 | 0.47 | 0.02 | 0.24 |
| 40 | 0.73 | 0.49 | 0.02 | 0.24 |
| 45 | 0.66 | 0.50 | 0.01 | 0.12 |
| 50 | 0.61 | 0.51 | 0.01 | 0.12 |
| 55 | 0.56 | 0.51 | 0.01 | 0.12 |
| 60 | **0.52** | 0.52 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 2.60 | 20.46 | 6138 | 6138 |
| 10 | 1.20 | 9.44 | 2833 | 8971 |
| 15 | 0.60 | 4.72 | 1416 | 10387 |
| 20 | 0.48 | 3.78 | 1133 | 11520 |
| 25 | 0.36 | 2.83 | 850 | 12370 |
| 30 | 0.24 | 1.89 | 567 | 12937 |
| 35 | 0.24 | 1.89 | 567 | 13503 |
| 40 | 0.24 | 1.89 | 567 | 14070 |
| 45 | 0.12 | 0.94 | 283 | 14353 |
| 50 | 0.12 | 0.94 | 283 | 14636 |
| 55 | 0.12 | 0.94 | 283 | 14920 |
| 60 | 0.12 | 0.94 | 283 | 15203 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 6138 | 152 | 5986 | 5986 |
| 10 | 2833 | 152 | 2681 | 8667 |
| 15 | 1416 | 152 | 1264 | 9931 |
| 20 | 1133 | 152 | 981 | 10912 |
| 25 | 850 | 152 | 698 | 11610 |
| 30 | 567 | 152 | 415 | 12025 |
| 35 | 567 | 152 | 415 | 12439 |
| 40 | 567 | 152 | 415 | 12854 |
| 45 | 283 | 152 | 131 | 12985 |
| 50 | 283 | 152 | 131 | 13117 |
| 55 | 283 | 152 | 131 | 13248 |
| 60 | 283 | 152 | 131 | 13379 |

**13379** Max Storage Required (CF)

Value goes to 2-Year StormTech Sheet

StormTech
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Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 10 Year Storm - Basin 1 (Bighorn & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

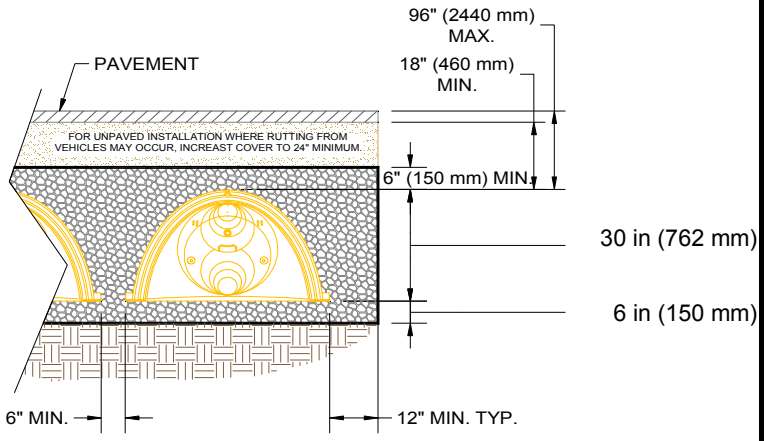
## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **21,212** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |

**Number of Chambers Required - 284**

| | | |
|---|---|---|
| Approximate Bed Size Required | 12,661 | SF |
| Tons of Stone Required | 1,622 | Tons |
| Volume of Excavation | 2,345 | CY |
| Area of Filter Fabric | 5,053 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **2022.08** | FT |
| ISOLATOR FABRIC | **1,123** | SY |

Is the limiting dimension for the bed the width or length? **length**




### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **2050** | FT |
| # of Chambers long | 284 | EA |
| # of Rows | 1 | EA |
| Actual Length | 2,025.68 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres
*Bighorn & Red Fox*
10 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 26.23 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 12661 | SF (Enter per StormTech 10-Year Sheet) |
| Percolation Rate = | 21.90 | min/in |
| | 2.74 | in/hr |

$I = 13.744T^{-0.662}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **4.21** | 0.35 | 0.35 | 4.21 |
| 10 | **3.25** | 0.54 | 0.19 | 2.28 |
| 15 | **2.50** | 0.63 | 0.08 | 0.96 |
| 20 | 2.00 | 0.67 | 0.04 | 0.48 |
| 25 | 1.70 | 0.71 | 0.04 | 0.48 |
| 30 | **1.49** | 0.75 | 0.04 | 0.48 |
| 35 | 1.32 | 0.77 | 0.03 | 0.36 |
| 40 | 1.20 | 0.80 | 0.03 | 0.36 |
| 45 | 1.09 | 0.82 | 0.02 | 0.24 |
| 50 | 0.99 | 0.83 | 0.01 | 0.12 |
| 55 | 0.91 | 0.83 | 0.01 | 0.12 |
| 60 | **0.84** | 0.84 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 4.21 | 33.13 | 9939 | 9939 |
| 10 | 2.28 | 17.94 | 5382 | 15321 |
| 15 | 0.96 | 7.55 | 2266 | 17587 |
| 20 | 0.48 | 3.78 | 1133 | 18720 |
| 25 | 0.48 | 3.78 | 1133 | 19853 |
| 30 | 0.48 | 3.78 | 1133 | 20987 |
| 35 | 0.36 | 2.83 | 850 | 21836 |
| 40 | 0.36 | 2.83 | 850 | 22686 |
| 45 | 0.24 | 1.89 | 567 | 23253 |
| 50 | 0.12 | 0.94 | 283 | 23536 |
| 55 | 0.12 | 0.94 | 283 | 23819 |
| 60 | 0.12 | 0.94 | 283 | 24103 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 9939 | 241 | 9698 | 9698 |
| 10 | 5382 | 241 | 5142 | 14839 |
| 15 | 2266 | 241 | 2025 | 16865 |
| 20 | 1133 | 241 | 892 | 17757 |
| 25 | 1133 | 241 | 892 | 18649 |
| 30 | 1133 | 241 | 892 | 19541 |
| 35 | 850 | 241 | 609 | 20150 |
| 40 | 850 | 241 | 609 | 20759 |
| 45 | 567 | 241 | 326 | 21085 |
| 50 | 283 | 241 | 42 | 21127 |
| 55 | 283 | 241 | 42 | 21170 |
| 60 | 283 | 241 | 42 | 21212 |

**21212** Max Storage Required (CF)
Value goes to 10-Year StormTech Sheet

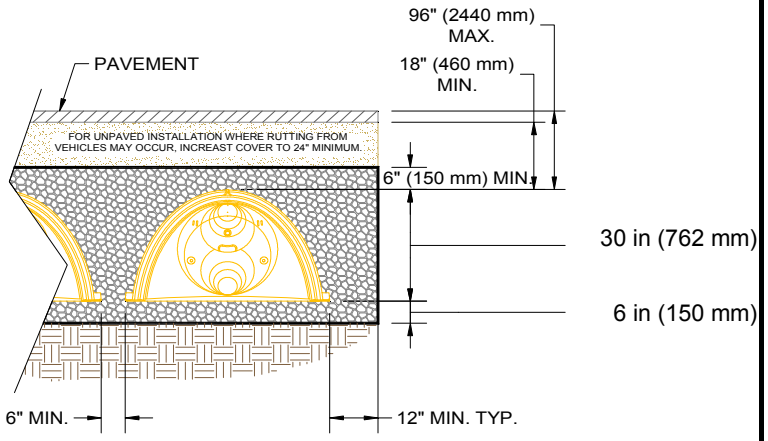
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 2 Year Storm - Basin 2 (Bighorn & Cougar)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **740** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 10**

| | | |
|---|---|---|
| Approximate Bed Size Required | 468 | SF |
| Tons of Stone Required | 61 | Tons |
| Volume of Excavation | 87 | CY |
| Area of Filter Fabric | 192 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **71.2** | FT |
| ISOLATOR FABRIC | **40** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **75** | FT |
| # of Chambers long | 10 | EA |
| # of Rows | 1 | EA |
| Actual Length | 74.80 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Bighorn & Cougar*

2 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 1.60 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 468 | SF (Enter per StormTech 2-Year Sheet) |
| Percolation Rate = | 12.50 | min/in |
| | 4.80 | in/hr |

$I = 8.0354T^{-0.653}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **2.60** | 0.22 | 0.22 | 2.60 |
| 10 | **1.87** | 0.31 | 0.10 | 1.20 |
| 15 | **1.46** | 0.37 | 0.05 | 0.60 |
| 20 | 1.20 | 0.40 | 0.04 | 0.48 |
| 25 | 1.03 | 0.43 | 0.03 | 0.36 |
| 30 | **0.90** | 0.45 | 0.02 | 0.24 |
| 35 | 0.80 | 0.47 | 0.02 | 0.24 |
| 40 | 0.73 | 0.49 | 0.02 | 0.24 |
| 45 | 0.66 | 0.50 | 0.01 | 0.12 |
| 50 | 0.61 | 0.51 | 0.01 | 0.12 |
| 55 | 0.56 | 0.51 | 0.01 | 0.12 |
| 60 | **0.52** | 0.52 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 2.60 | 1.25 | 374 | 374 |
| 10 | 1.20 | 0.58 | 173 | 547 |
| 15 | 0.60 | 0.29 | 86 | 634 |
| 20 | 0.48 | 0.23 | 69 | 703 |
| 25 | 0.36 | 0.17 | 52 | 755 |
| 30 | 0.24 | 0.12 | 35 | 789 |
| 35 | 0.24 | 0.12 | 35 | 824 |
| 40 | 0.24 | 0.12 | 35 | 858 |
| 45 | 0.12 | 0.06 | 17 | 876 |
| 50 | 0.12 | 0.06 | 17 | 893 |
| 55 | 0.12 | 0.06 | 17 | 910 |
| 60 | 0.12 | 0.06 | 17 | 927 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 374 | 16 | 359 | 359 |
| 10 | 173 | 16 | 157 | 516 |
| 15 | 86 | 16 | 71 | 587 |
| 20 | 69 | 16 | 54 | 640 |
| 25 | 52 | 16 | 36 | 677 |
| 30 | 35 | 16 | 19 | 696 |
| 35 | 35 | 16 | 19 | 714 |
| 40 | 35 | 16 | 19 | 733 |
| 45 | 17 | 16 | 2 | 735 |
| 50 | 17 | 16 | 2 | 737 |
| 55 | 17 | 16 | 2 | 738 |
| 60 | 17 | 16 | 2 | 740 |

**740** Max Storage Required (CF)

Value goes to 2-Year StormTech Sheet

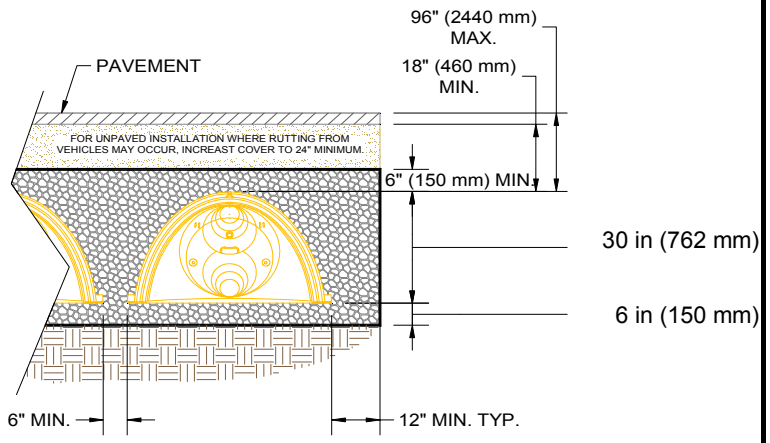
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 10 Year Storm - Basin 2 (Bighorn & Cougar)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **1,198** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




| | | |
|---|---|---|
| **Number of Chambers Required -** | **16** | |
| Approximate Bed Size Required | 735 | SF |
| Tons of Stone Required | 95 | Tons |
| Volume of Excavation | 136 | CY |
| Area of Filter Fabric | 298 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **113.92** | FT |
| ISOLATOR FABRIC | **63** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **125** | FT |
| # of Chambers long | 16 | EA |
| # of Rows | 1 | EA |
| Actual Length | 117.52 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Bighorn & Cougar*

10 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 1.60 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 735 | SF (Enter per StormTech 10-Year Sheet) |
| Percolation Rate = | 12.50 | min/in |
| | 4.80 | in/hr |

$I = 13.744T^{-0.662}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **4.21** | 0.35 | 0.35 | 4.21 |
| 10 | **3.25** | 0.54 | 0.19 | 2.28 |
| 15 | **2.50** | 0.63 | 0.08 | 0.96 |
| 20 | 2.00 | 0.67 | 0.04 | 0.48 |
| 25 | 1.70 | 0.71 | 0.04 | 0.48 |
| 30 | **1.49** | 0.75 | 0.04 | 0.48 |
| 35 | 1.32 | 0.77 | 0.03 | 0.36 |
| 40 | 1.20 | 0.80 | 0.03 | 0.36 |
| 45 | 1.09 | 0.82 | 0.02 | 0.24 |
| 50 | 0.99 | 0.83 | 0.01 | 0.12 |
| 55 | 0.91 | 0.83 | 0.01 | 0.12 |
| 60 | **0.84** | 0.84 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 4.21 | 2.02 | 606 | 606 |
| 10 | 2.28 | 1.09 | 328 | 935 |
| 15 | 0.96 | 0.46 | 138 | 1073 |
| 20 | 0.48 | 0.23 | 69 | 1142 |
| 25 | 0.48 | 0.23 | 69 | 1211 |
| 30 | 0.48 | 0.23 | 69 | 1280 |
| 35 | 0.36 | 0.17 | 52 | 1332 |
| 40 | 0.36 | 0.17 | 52 | 1384 |
| 45 | 0.24 | 0.12 | 35 | 1418 |
| 50 | 0.12 | 0.06 | 17 | 1436 |
| 55 | 0.12 | 0.06 | 17 | 1453 |
| 60 | 0.12 | 0.06 | 17 | 1470 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 606 | 25 | 582 | 582 |
| 10 | 328 | 25 | 304 | 886 |
| 15 | 138 | 25 | 114 | 999 |
| 20 | 69 | 25 | 45 | 1044 |
| 25 | 69 | 25 | 45 | 1089 |
| 30 | 69 | 25 | 45 | 1133 |
| 35 | 52 | 25 | 27 | 1161 |
| 40 | 52 | 25 | 27 | 1188 |
| 45 | 35 | 25 | 10 | 1198 |
| 50 | 17 | 25 | -7 | 1191 |
| 55 | 17 | 25 | -7 | 1183 |
| 60 | 17 | 25 | -7 | 1176 |

**1198** Max Storage Required (CF)

Value goes to 10-Year StormTech Sheet

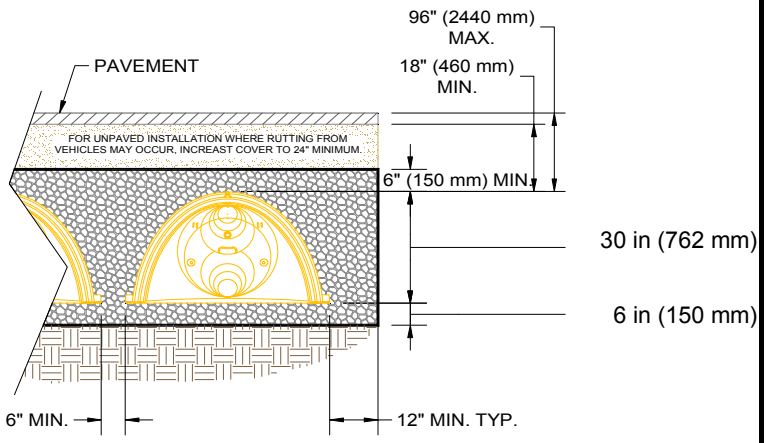
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 2 Year Storm - Basin 3 (E Otter & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **6,410** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 86**

| | | |
|---|---|---|
| Approximate Bed Size Required | 3,850 | SF |
| Tons of Stone Required | 494 | Tons |
| Volume of Excavation | 713 | CY |
| Area of Filter Fabric | 1,540 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **612.32** | FT |
| ISOLATOR FABRIC | **340** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **625** | FT |
| # of Chambers long | 86 | EA |
| # of Rows | 1 | EA |
| Actual Length | 615.92 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*E Otter & Red Fox*

2 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 12.12 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 3850 | SF (Enter per StormTech 2-Year Sheet) |
| Percolation Rate = | 31.30 | min/in |
| | 1.92 | in/hr |

$I = 8.0354T^{-0.653}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **2.60** | 0.22 | 0.22 | 2.60 |
| 10 | **1.87** | 0.31 | 0.10 | 1.20 |
| 15 | **1.46** | 0.37 | 0.05 | 0.60 |
| 20 | 1.20 | 0.40 | 0.04 | 0.48 |
| 25 | 1.03 | 0.43 | 0.03 | 0.36 |
| 30 | **0.90** | 0.45 | 0.02 | 0.24 |
| 35 | 0.80 | 0.47 | 0.02 | 0.24 |
| 40 | 0.73 | 0.49 | 0.02 | 0.24 |
| 45 | 0.66 | 0.50 | 0.01 | 0.12 |
| 50 | 0.61 | 0.51 | 0.01 | 0.12 |
| 55 | 0.56 | 0.51 | 0.01 | 0.12 |
| 60 | **0.52** | 0.52 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 2.60 | 9.45 | 2836 | 2836 |
| 10 | 1.20 | 4.36 | 1309 | 4145 |
| 15 | 0.60 | 2.18 | 654 | 4800 |
| 20 | 0.48 | 1.75 | 524 | 5323 |
| 25 | 0.36 | 1.31 | 393 | 5716 |
| 30 | 0.24 | 0.87 | 262 | 5978 |
| 35 | 0.24 | 0.87 | 262 | 6239 |
| 40 | 0.24 | 0.87 | 262 | 6501 |
| 45 | 0.12 | 0.44 | 131 | 6632 |
| 50 | 0.12 | 0.44 | 131 | 6763 |
| 55 | 0.12 | 0.44 | 131 | 6894 |
| 60 | 0.12 | 0.44 | 131 | 7025 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 2836 | 51 | 2785 | 2785 |
| 10 | 1309 | 51 | 1258 | 4043 |
| 15 | 654 | 51 | 603 | 4646 |
| 20 | 524 | 51 | 472 | 5118 |
| 25 | 393 | 51 | 341 | 5460 |
| 30 | 262 | 51 | 211 | 5670 |
| 35 | 262 | 51 | 211 | 5881 |
| 40 | 262 | 51 | 211 | 6091 |
| 45 | 131 | 51 | 80 | 6171 |
| 50 | 131 | 51 | 80 | 6250 |
| 55 | 131 | 51 | 80 | 6330 |
| 60 | 131 | 51 | 80 | 6410 |

**6410** Max Storage Required (CF)

Value goes to 2-Year StormTech Sheet

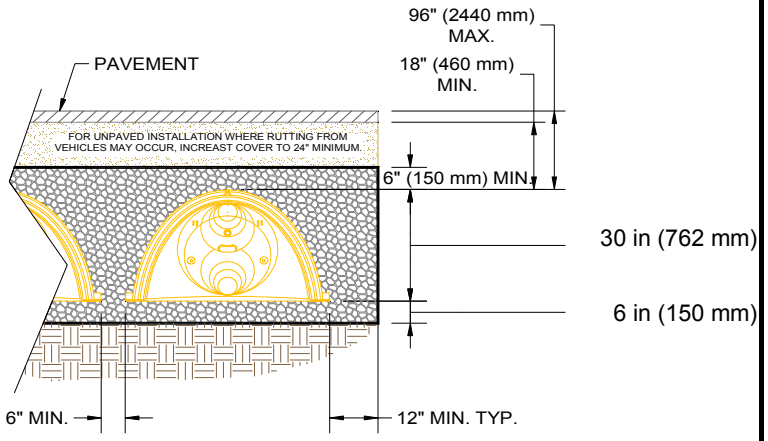
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 10 Year Storm - Basin 3 (E Otter & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **10,167** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




| | | |
|---|---|---|
| **Number of Chambers Required -** | **136** | |
| Approximate Bed Size Required | 6,075 | SF |
| Tons of Stone Required | 779 | Tons |
| Volume of Excavation | 1,125 | CY |
| Area of Filter Fabric | 2,427 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **968.32** | FT |
| ISOLATOR FABRIC | **538** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **975** | FT |
| # of Chambers long | 136 | EA |
| # of Rows | 1 | EA |
| Actual Length | 971.92 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres
*E Otter & Red Fox*
10 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 12.12 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 6075 | SF (Enter per StormTech 10-Year Sheet) |
| Percolation Rate = | 31.30 | min/in |
| | 1.92 | in/hr |

$I = 13.744T^{-0.662}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **4.21** | 0.35 | 0.35 | 4.21 |
| 10 | **3.25** | 0.54 | 0.19 | 2.28 |
| 15 | **2.50** | 0.63 | 0.08 | 0.96 |
| 20 | 2.00 | 0.67 | 0.04 | 0.48 |
| 25 | 1.70 | 0.71 | 0.04 | 0.48 |
| 30 | **1.49** | 0.75 | 0.04 | 0.48 |
| 35 | 1.32 | 0.77 | 0.03 | 0.36 |
| 40 | 1.20 | 0.80 | 0.03 | 0.36 |
| 45 | 1.09 | 0.82 | 0.02 | 0.24 |
| 50 | 0.99 | 0.83 | 0.01 | 0.12 |
| 55 | 0.91 | 0.83 | 0.01 | 0.12 |
| 60 | **0.84** | 0.84 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 4.21 | 15.31 | 4592 | 4592 |
| 10 | 2.28 | 8.29 | 2487 | 7079 |
| 15 | 0.96 | 3.49 | 1047 | 8126 |
| 20 | 0.48 | 1.75 | 524 | 8650 |
| 25 | 0.48 | 1.75 | 524 | 9174 |
| 30 | 0.48 | 1.75 | 524 | 9697 |
| 35 | 0.36 | 1.31 | 393 | 10090 |
| 40 | 0.36 | 1.31 | 393 | 10483 |
| 45 | 0.24 | 0.87 | 262 | 10744 |
| 50 | 0.12 | 0.44 | 131 | 10875 |
| 55 | 0.12 | 0.44 | 131 | 11006 |
| 60 | 0.12 | 0.44 | 131 | 11137 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 4592 | 81 | 4511 | 4511 |
| 10 | 2487 | 81 | 2406 | 6918 |
| 15 | 1047 | 81 | 966 | 7884 |
| 20 | 524 | 81 | 443 | 8327 |
| 25 | 524 | 81 | 443 | 8769 |
| 30 | 524 | 81 | 443 | 9212 |
| 35 | 393 | 81 | 312 | 9524 |
| 40 | 393 | 81 | 312 | 9836 |
| 45 | 262 | 81 | 181 | 10017 |
| 50 | 131 | 81 | 50 | 10067 |
| 55 | 131 | 81 | 50 | 10117 |
| 60 | 131 | 81 | 50 | 10167 |

**10167** Max Storage Required (CF)
Value goes to 10-Year StormTech Sheet

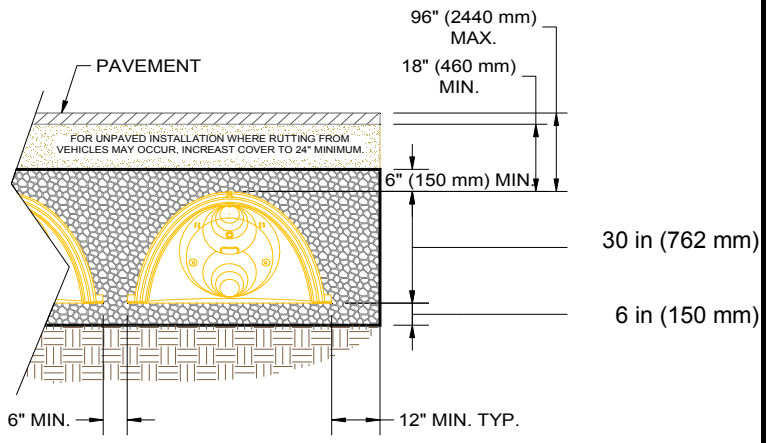
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 2 Year Storm - Basin 4 (Kodiak & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **3,067** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 41**

| | | |
|---|---|---|
| Approximate Bed Size Required | 1,847 | SF |
| Tons of Stone Required | 238 | Tons |
| Volume of Excavation | 342 | CY |
| Area of Filter Fabric | 742 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **291.92** | FT |
| ISOLATOR FABRIC | **162** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **300** | FT |
| # of Chambers long | 41 | EA |
| # of Rows | 1 | EA |
| Actual Length | 295.52 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Kodiak & Red Fox*

2 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 6.22 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 1847 | SF (Enter per StormTech 2-Year Sheet) |
| Percolation Rate = | 17.15 | min/in |
| | 3.50 | in/hr |

$I = 8.0354T^{-0.653}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **2.60** | 0.22 | 0.22 | 2.60 |
| 10 | **1.87** | 0.31 | 0.10 | 1.20 |
| 15 | **1.46** | 0.37 | 0.05 | 0.60 |
| 20 | 1.20 | 0.40 | 0.04 | 0.48 |
| 25 | 1.03 | 0.43 | 0.03 | 0.36 |
| 30 | **0.90** | 0.45 | 0.02 | 0.24 |
| 35 | 0.80 | 0.47 | 0.02 | 0.24 |
| 40 | 0.73 | 0.49 | 0.02 | 0.24 |
| 45 | 0.66 | 0.50 | 0.01 | 0.12 |
| 50 | 0.61 | 0.51 | 0.01 | 0.12 |
| 55 | 0.56 | 0.51 | 0.01 | 0.12 |
| 60 | **0.52** | 0.52 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 2.60 | 4.85 | 1455 | 1455 |
| 10 | 1.20 | 2.24 | 672 | 2127 |
| 15 | 0.60 | 1.12 | 336 | 2463 |
| 20 | 0.48 | 0.90 | 269 | 2732 |
| 25 | 0.36 | 0.67 | 202 | 2933 |
| 30 | 0.24 | 0.45 | 134 | 3068 |
| 35 | 0.24 | 0.45 | 134 | 3202 |
| 40 | 0.24 | 0.45 | 134 | 3336 |
| 45 | 0.12 | 0.22 | 67 | 3404 |
| 50 | 0.12 | 0.22 | 67 | 3471 |
| 55 | 0.12 | 0.22 | 67 | 3538 |
| 60 | 0.12 | 0.22 | 67 | 3605 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 1455 | 45 | 1411 | 1411 |
| 10 | 672 | 45 | 627 | 2037 |
| 15 | 336 | 45 | 291 | 2328 |
| 20 | 269 | 45 | 224 | 2552 |
| 25 | 202 | 45 | 157 | 2709 |
| 30 | 134 | 45 | 89 | 2798 |
| 35 | 134 | 45 | 89 | 2888 |
| 40 | 134 | 45 | 89 | 2977 |
| 45 | 67 | 45 | 22 | 3000 |
| 50 | 67 | 45 | 22 | 3022 |
| 55 | 67 | 45 | 22 | 3044 |
| 60 | 67 | 45 | 22 | 3067 |

**3067** Max Storage Required (CF)

Value goes to 2-Year StormTech Sheet

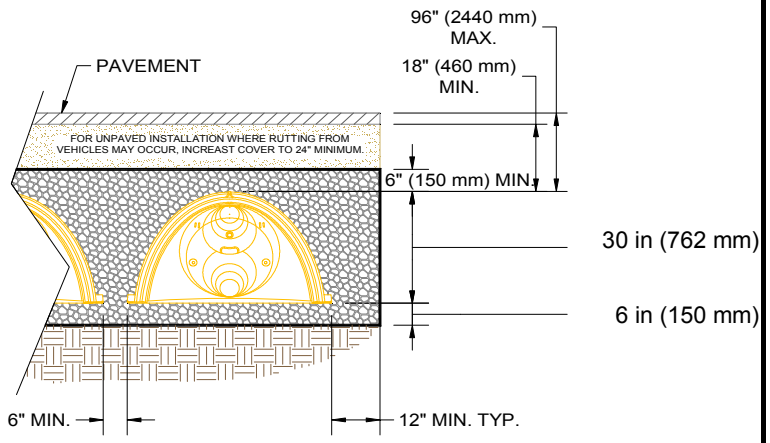
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 10 Year Storm - Basin 4 (Kodiak & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **4,877** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 66**

| | | |
|---|---|---|
| Approximate Bed Size Required | 2,960 | SF |
| Tons of Stone Required | 380 | Tons |
| Volume of Excavation | 548 | CY |
| Area of Filter Fabric | 1,185 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **469.92** | FT |
| ISOLATOR FABRIC | **261** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **475** | FT |
| # of Chambers long | 66 | EA |
| # of Rows | 1 | EA |
| Actual Length | 473.52 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres
*Kodiak & Red Fox*
10 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 6.22 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 2915 | SF (Enter per StormTech 10-Year Sheet) |
| Percolation Rate = | 17.15 | min/in |
| | 3.50 | in/hr |

$I = 13.744T^{-0.662}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **4.21** | 0.35 | 0.35 | 4.21 |
| 10 | **3.25** | 0.54 | 0.19 | 2.28 |
| 15 | **2.50** | 0.63 | 0.08 | 0.96 |
| 20 | 2.00 | 0.67 | 0.04 | 0.48 |
| 25 | 1.70 | 0.71 | 0.04 | 0.48 |
| 30 | **1.49** | 0.75 | 0.04 | 0.48 |
| 35 | 1.32 | 0.77 | 0.03 | 0.36 |
| 40 | 1.20 | 0.80 | 0.03 | 0.36 |
| 45 | 1.09 | 0.82 | 0.02 | 0.24 |
| 50 | 0.99 | 0.83 | 0.01 | 0.12 |
| 55 | 0.91 | 0.83 | 0.01 | 0.12 |
| 60 | **0.84** | 0.84 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 4.21 | 7.86 | 2357 | 2357 |
| 10 | 2.28 | 4.25 | 1276 | 3633 |
| 15 | 0.96 | 1.79 | 537 | 4171 |
| 20 | 0.48 | 0.90 | 269 | 4439 |
| 25 | 0.48 | 0.90 | 269 | 4708 |
| 30 | 0.48 | 0.90 | 269 | 4977 |
| 35 | 0.36 | 0.67 | 202 | 5178 |
| 40 | 0.36 | 0.67 | 202 | 5380 |
| 45 | 0.24 | 0.45 | 134 | 5514 |
| 50 | 0.12 | 0.22 | 67 | 5581 |
| 55 | 0.12 | 0.22 | 67 | 5648 |
| 60 | 0.12 | 0.22 | 67 | 5716 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 2357 | 71 | 2286 | 2286 |
| 10 | 1276 | 71 | 1206 | 3491 |
| 15 | 537 | 71 | 467 | 3958 |
| 20 | 269 | 71 | 198 | 4156 |
| 25 | 269 | 71 | 198 | 4354 |
| 30 | 269 | 71 | 198 | 4552 |
| 35 | 202 | 71 | 131 | 4682 |
| 40 | 202 | 71 | 131 | 4813 |
| 45 | 134 | 71 | 64 | 4877 |
| 50 | 67 | 71 | -4 | 4873 |
| 55 | 67 | 71 | -4 | 4869 |
| 60 | 67 | 71 | -4 | 4866 |

**4877** Max Storage Required (CF)
Value goes to 10-Year StormTech Sheet

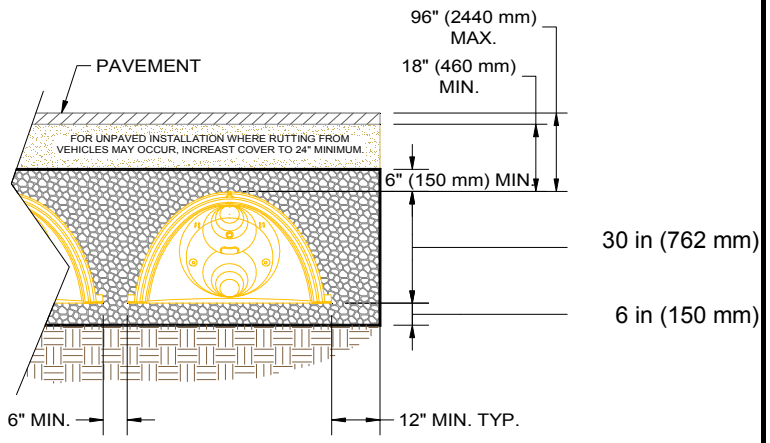
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 2 Year Storm - Basin 5 (Kodiak & Cougar)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **1,751** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 24**

| | | |
|---|---|---|
| Approximate Bed Size Required | 1,091 | SF |
| Tons of Stone Required | 141 | Tons |
| Volume of Excavation | 202 | CY |
| Area of Filter Fabric | 440 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **170.88** | FT |
| ISOLATOR FABRIC | **95** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **200** | FT |
| # of Chambers long | 24 | EA |
| # of Rows | 1 | EA |
| Actual Length | 174.48 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Kodiak & Cougar*

2 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 3.57 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 1091 | SF (Enter per StormTech 2-Year Sheet) |
| Percolation Rate = | 17.15 | min/in |
| | 3.50 | in/hr |

$I = 8.0354T^{-0.653}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **2.60** | 0.22 | 0.22 | 2.60 |
| 10 | **1.87** | 0.31 | 0.10 | 1.20 |
| 15 | **1.46** | 0.37 | 0.05 | 0.60 |
| 20 | 1.20 | 0.40 | 0.04 | 0.48 |
| 25 | 1.03 | 0.43 | 0.03 | 0.36 |
| 30 | **0.90** | 0.45 | 0.02 | 0.24 |
| 35 | 0.80 | 0.47 | 0.02 | 0.24 |
| 40 | 0.73 | 0.49 | 0.02 | 0.24 |
| 45 | 0.66 | 0.50 | 0.01 | 0.12 |
| 50 | 0.61 | 0.51 | 0.01 | 0.12 |
| 55 | 0.56 | 0.51 | 0.01 | 0.12 |
| 60 | **0.52** | 0.52 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 2.60 | 2.78 | 835 | 835 |
| 10 | 1.20 | 1.29 | 386 | 1221 |
| 15 | 0.60 | 0.64 | 193 | 1414 |
| 20 | 0.48 | 0.51 | 154 | 1568 |
| 25 | 0.36 | 0.39 | 116 | 1684 |
| 30 | 0.24 | 0.26 | 77 | 1761 |
| 35 | 0.24 | 0.26 | 77 | 1838 |
| 40 | 0.24 | 0.26 | 77 | 1915 |
| 45 | 0.12 | 0.13 | 39 | 1954 |
| 50 | 0.12 | 0.13 | 39 | 1992 |
| 55 | 0.12 | 0.13 | 39 | 2031 |
| 60 | 0.12 | 0.13 | 39 | 2069 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 835 | 27 | 809 | 809 |
| 10 | 386 | 27 | 359 | 1168 |
| 15 | 193 | 27 | 166 | 1334 |
| 20 | 154 | 27 | 128 | 1462 |
| 25 | 116 | 27 | 89 | 1551 |
| 30 | 77 | 27 | 51 | 1602 |
| 35 | 77 | 27 | 51 | 1652 |
| 40 | 77 | 27 | 51 | 1703 |
| 45 | 39 | 27 | 12 | 1715 |
| 50 | 39 | 27 | 12 | 1727 |
| 55 | 39 | 27 | 12 | 1739 |
| 60 | 39 | 27 | 12 | 1751 |

**1751** Max Storage Required (CF)

Value goes to 2-Year StormTech Sheet

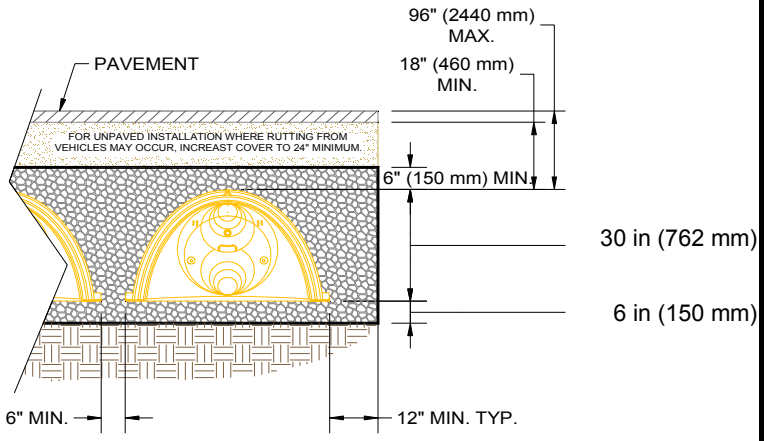
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 10 Year Storm - Basin 5 (Kodiak & Cougar)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **2,790** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




| | | |
|---|---|---|
| **Number of Chambers Required -** | **38** | |
| Approximate Bed Size Required | 1,714 | SF |
| Tons of Stone Required | 221 | Tons |
| Volume of Excavation | 317 | CY |
| Area of Filter Fabric | 689 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **270.56** | FT |
| ISOLATOR FABRIC | **150** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **275** | FT |
| # of Chambers long | 38 | EA |
| # of Rows | 1 | EA |
| Actual Length | 274.16 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Kodiak & Cougar*

10 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 3.57 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 1714 | SF (Enter per StormTech 10-Year Sheet) |
| Percolation Rate = | 17.15 | min/in |
| | 3.50 | in/hr |

$I = 13.744T^{-0.662}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **4.21** | 0.35 | 0.35 | 4.21 |
| 10 | **3.25** | 0.54 | 0.19 | 2.28 |
| 15 | **2.50** | 0.63 | 0.08 | 0.96 |
| 20 | 2.00 | 0.67 | 0.04 | 0.48 |
| 25 | 1.70 | 0.71 | 0.04 | 0.48 |
| 30 | **1.49** | 0.75 | 0.04 | 0.48 |
| 35 | 1.32 | 0.77 | 0.03 | 0.36 |
| 40 | 1.20 | 0.80 | 0.03 | 0.36 |
| 45 | 1.09 | 0.82 | 0.02 | 0.24 |
| 50 | 0.99 | 0.83 | 0.01 | 0.12 |
| 55 | 0.91 | 0.83 | 0.01 | 0.12 |
| 60 | **0.84** | 0.84 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 4.21 | 4.51 | 1353 | 1353 |
| 10 | 2.28 | 2.44 | 733 | 2085 |
| 15 | 0.96 | 1.03 | 308 | 2394 |
| 20 | 0.48 | 0.51 | 154 | 2548 |
| 25 | 0.48 | 0.51 | 154 | 2702 |
| 30 | 0.48 | 0.51 | 154 | 2856 |
| 35 | 0.36 | 0.39 | 116 | 2972 |
| 40 | 0.36 | 0.39 | 116 | 3088 |
| 45 | 0.24 | 0.26 | 77 | 3165 |
| 50 | 0.12 | 0.13 | 39 | 3203 |
| 55 | 0.12 | 0.13 | 39 | 3242 |
| 60 | 0.12 | 0.13 | 39 | 3280 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 1353 | 42 | 1311 | 1311 |
| 10 | 733 | 42 | 691 | 2002 |
| 15 | 308 | 42 | 267 | 2269 |
| 20 | 154 | 42 | 113 | 2381 |
| 25 | 154 | 42 | 113 | 2494 |
| 30 | 154 | 42 | 113 | 2607 |
| 35 | 116 | 42 | 74 | 2681 |
| 40 | 116 | 42 | 74 | 2755 |
| 45 | 77 | 42 | 35 | 2790 |
| 50 | 39 | 42 | -3 | 2787 |
| 55 | 39 | 42 | -3 | 2784 |
| 60 | 39 | 42 | -3 | 2781 |

**2790** Max Storage Required (CF)

Value goes to 10-Year StormTech Sheet

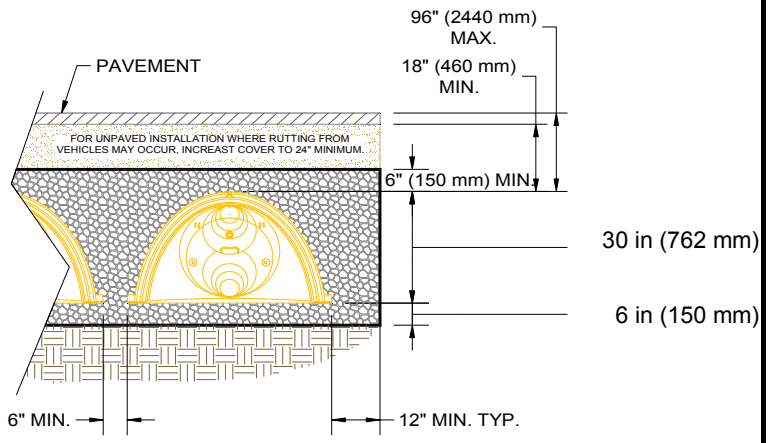
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 2 Year Storm - Basin 6 (Cayuse & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **5,618** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 76**

| | | |
|---|---|---|
| Approximate Bed Size Required | 3,405 | SF |
| Tons of Stone Required | 437 | Tons |
| Volume of Excavation | 630 | CY |
| Area of Filter Fabric | 1,363 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **541.12** | FT |
| ISOLATOR FABRIC | **301** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **550** | FT |
| # of Chambers long | 76 | EA |
| # of Rows | 1 | EA |
| Actual Length | 544.72 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Cayuse & Red Fox*

2 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 16.86 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 3360 | SF (Enter per StormTech 2-Year Sheet) |
| Percolation Rate = | 3.00 | min/in |
| | 20.00 | in/hr |

$I = 8.0354T^{-0.653}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **2.60** | 0.22 | 0.22 | 2.60 |
| 10 | **1.87** | 0.31 | 0.10 | 1.20 |
| 15 | **1.46** | 0.37 | 0.05 | 0.60 |
| 20 | 1.20 | 0.40 | 0.04 | 0.48 |
| 25 | 1.03 | 0.43 | 0.03 | 0.36 |
| 30 | **0.90** | 0.45 | 0.02 | 0.24 |
| 35 | 0.80 | 0.47 | 0.02 | 0.24 |
| 40 | 0.73 | 0.49 | 0.02 | 0.24 |
| 45 | 0.66 | 0.50 | 0.01 | 0.12 |
| 50 | 0.61 | 0.51 | 0.01 | 0.12 |
| 55 | 0.56 | 0.51 | 0.01 | 0.12 |
| 60 | **0.52** | 0.52 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 2.60 | 13.15 | 3945 | 3945 |
| 10 | 1.20 | 6.07 | 1821 | 5766 |
| 15 | 0.60 | 3.03 | 910 | 6677 |
| 20 | 0.48 | 2.43 | 728 | 7405 |
| 25 | 0.36 | 1.82 | 546 | 7951 |
| 30 | 0.24 | 1.21 | 364 | 8315 |
| 35 | 0.24 | 1.21 | 364 | 8680 |
| 40 | 0.24 | 1.21 | 364 | 9044 |
| 45 | 0.12 | 0.61 | 182 | 9226 |
| 50 | 0.12 | 0.61 | 182 | 9408 |
| 55 | 0.12 | 0.61 | 182 | 9590 |
| 60 | 0.12 | 0.61 | 182 | 9772 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 3945 | 467 | 3479 | 3479 |
| 10 | 1821 | 467 | 1354 | 4833 |
| 15 | 910 | 467 | 444 | 5277 |
| 20 | 728 | 467 | 262 | 5538 |
| 25 | 546 | 467 | 80 | 5618 |
| 30 | 364 | 467 | -102 | 5515 |
| 35 | 364 | 467 | -102 | 5413 |
| 40 | 364 | 467 | -102 | 5310 |
| 45 | 182 | 467 | -285 | 5026 |
| 50 | 182 | 467 | -285 | 4741 |
| 55 | 182 | 467 | -285 | 4457 |
| 60 | 182 | 467 | -285 | 4172 |

**5618** Max Storage Required (CF)

Value goes to 2-Year StormTech Sheet

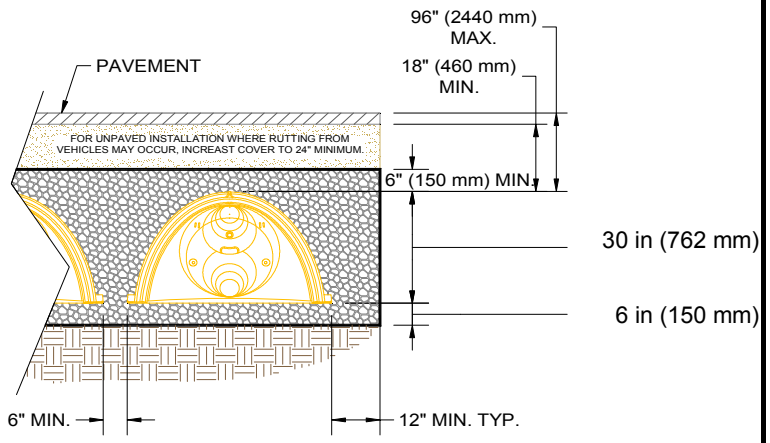
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 10 Year Storm - Basin 6 (Cayuse & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **9,052** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




| | | |
|---|---|---|
| **Number of Chambers Required -** | **121** | |
| Approximate Bed Size Required | 5,407 | SF |
| Tons of Stone Required | 693 | Tons |
| Volume of Excavation | 1,001 | CY |
| Area of Filter Fabric | 2,161 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **861.52** | FT |
| ISOLATOR FABRIC | **479** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **875** | FT |
| # of Chambers long | 121 | EA |
| # of Rows | 1 | EA |
| Actual Length | 865.12 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Cayuse & Red Fox*

10 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 16.86 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 5407 | SF (Enter per StormTech 10-Year Sheet) |
| Percolation Rate = | 3.00 | min/in |
| | 20.00 | in/hr |

$I = 13.744T^{-0.662}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **4.21** | 0.35 | 0.35 | 4.21 |
| 10 | **3.25** | 0.54 | 0.19 | 2.28 |
| 15 | **2.50** | 0.63 | 0.08 | 0.96 |
| 20 | 2.00 | 0.67 | 0.04 | 0.48 |
| 25 | 1.70 | 0.71 | 0.04 | 0.48 |
| 30 | **1.49** | 0.75 | 0.04 | 0.48 |
| 35 | 1.32 | 0.77 | 0.03 | 0.36 |
| 40 | 1.20 | 0.80 | 0.03 | 0.36 |
| 45 | 1.09 | 0.82 | 0.02 | 0.24 |
| 50 | 0.99 | 0.83 | 0.01 | 0.12 |
| 55 | 0.91 | 0.83 | 0.01 | 0.12 |
| 60 | **0.84** | 0.84 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 4.21 | 21.29 | 6388 | 6388 |
| 10 | 2.28 | 11.53 | 3460 | 9848 |
| 15 | 0.96 | 4.86 | 1457 | 11305 |
| 20 | 0.48 | 2.43 | 728 | 12033 |
| 25 | 0.48 | 2.43 | 728 | 12761 |
| 30 | 0.48 | 2.43 | 728 | 13490 |
| 35 | 0.36 | 1.82 | 546 | 14036 |
| 40 | 0.36 | 1.82 | 546 | 14582 |
| 45 | 0.24 | 1.21 | 364 | 14946 |
| 50 | 0.12 | 0.61 | 182 | 15128 |
| 55 | 0.12 | 0.61 | 182 | 15311 |
| 60 | 0.12 | 0.61 | 182 | 15493 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 6388 | 751 | 5637 | 5637 |
| 10 | 3460 | 751 | 2709 | 8346 |
| 15 | 1457 | 751 | 706 | 9052 |
| 20 | 728 | 751 | -23 | 9029 |
| 25 | 728 | 751 | -23 | 9006 |
| 30 | 728 | 751 | -23 | 8984 |
| 35 | 546 | 751 | -205 | 8779 |
| 40 | 546 | 751 | -205 | 8574 |
| 45 | 364 | 751 | -387 | 8188 |
| 50 | 182 | 751 | -569 | 7619 |
| 55 | 182 | 751 | -569 | 7050 |
| 60 | 182 | 751 | -569 | 6481 |

**9052** Max Storage Required (CF)

Value goes to 10-Year StormTech Sheet

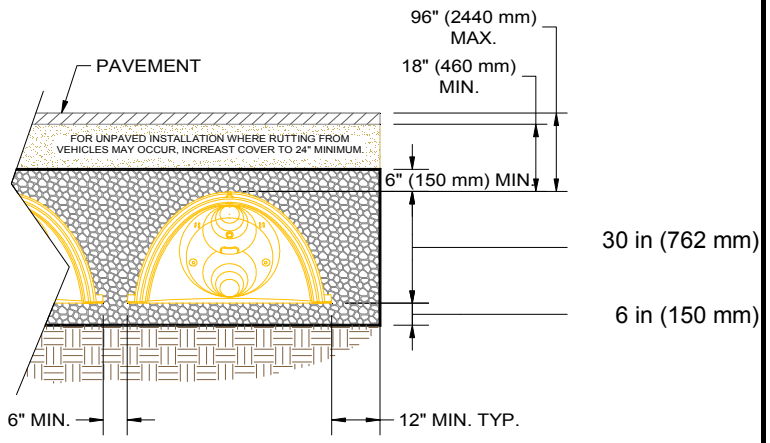
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 2 Year Storm - Basin 7 (Mustang & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **2,264** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 31**

| | | |
|---|---|---|
| Approximate Bed Size Required | 1,402 | SF |
| Tons of Stone Required | 181 | Tons |
| Volume of Excavation | 260 | CY |
| Area of Filter Fabric | 565 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **220.72** | FT |
| ISOLATOR FABRIC | **123** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **225** | FT |
| # of Chambers long | 31 | EA |
| # of Rows | 1 | EA |
| Actual Length | 224.32 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Mustang & Red Fox*

2 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 6.80 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 1358 | SF (Enter per StormTech 2-Year Sheet) |
| Percolation Rate = | 3.00 | min/in |
| | 20.00 | in/hr |

$I = 8.0354T^{-0.653}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **2.60** | 0.22 | 0.22 | 2.60 |
| 10 | **1.87** | 0.31 | 0.10 | 1.20 |
| 15 | **1.46** | 0.37 | 0.05 | 0.60 |
| 20 | 1.20 | 0.40 | 0.04 | 0.48 |
| 25 | 1.03 | 0.43 | 0.03 | 0.36 |
| 30 | **0.90** | 0.45 | 0.02 | 0.24 |
| 35 | 0.80 | 0.47 | 0.02 | 0.24 |
| 40 | 0.73 | 0.49 | 0.02 | 0.24 |
| 45 | 0.66 | 0.50 | 0.01 | 0.12 |
| 50 | 0.61 | 0.51 | 0.01 | 0.12 |
| 55 | 0.56 | 0.51 | 0.01 | 0.12 |
| 60 | **0.52** | 0.52 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 2.60 | 5.30 | 1591 | 1591 |
| 10 | 1.20 | 2.45 | 734 | 2326 |
| 15 | 0.60 | 1.22 | 367 | 2693 |
| 20 | 0.48 | 0.98 | 294 | 2987 |
| 25 | 0.36 | 0.73 | 220 | 3207 |
| 30 | 0.24 | 0.49 | 147 | 3354 |
| 35 | 0.24 | 0.49 | 147 | 3501 |
| 40 | 0.24 | 0.49 | 147 | 3648 |
| 45 | 0.12 | 0.24 | 73 | 3721 |
| 50 | 0.12 | 0.24 | 73 | 3794 |
| 55 | 0.12 | 0.24 | 73 | 3868 |
| 60 | 0.12 | 0.24 | 73 | 3941 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 1591 | 189 | 1403 | 1403 |
| 10 | 734 | 189 | 546 | 1948 |
| 15 | 367 | 189 | 179 | 2127 |
| 20 | 294 | 189 | 105 | 2232 |
| 25 | 220 | 189 | 32 | 2264 |
| 30 | 147 | 189 | -42 | 2222 |
| 35 | 147 | 189 | -42 | 2180 |
| 40 | 147 | 189 | -42 | 2139 |
| 45 | 73 | 189 | -115 | 2023 |
| 50 | 73 | 189 | -115 | 1908 |
| 55 | 73 | 189 | -115 | 1793 |
| 60 | 73 | 189 | -115 | 1678 |

**2264** Max Storage Required (CF)

Value goes to 2-Year StormTech Sheet

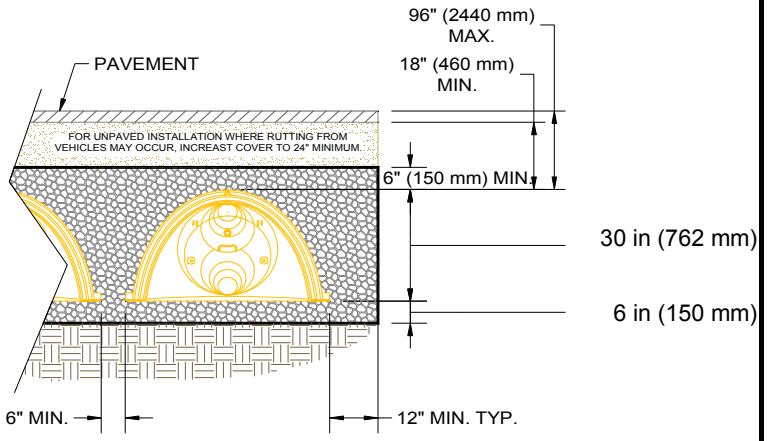
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 10 Year Storm - Basin 7 (Mustang & Red Fox)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **3,641** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 49**

| | | |
|---|---|---|
| Approximate Bed Size Required | 2,203 | SF |
| Tons of Stone Required | 283 | Tons |
| Volume of Excavation | 408 | CY |
| Area of Filter Fabric | 884 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **348.88** | FT |
| ISOLATOR FABRIC | **194** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **375** | FT |
| # of Chambers long | 49 | EA |
| # of Rows | 1 | EA |
| Actual Length | 352.48 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres
*Mustang & Red Fox*
10 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 6.80 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 2203 | SF (Enter per StormTech 10-Year Sheet) |
| Percolation Rate = | 3.00 | min/in |
| | 20.00 | in/hr |

$I = 13.744T^{-0.662}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **4.21** | 0.35 | 0.35 | 4.21 |
| 10 | **3.25** | 0.54 | 0.19 | 2.28 |
| 15 | **2.50** | 0.63 | 0.08 | 0.96 |
| 20 | 2.00 | 0.67 | 0.04 | 0.48 |
| 25 | 1.70 | 0.71 | 0.04 | 0.48 |
| 30 | **1.49** | 0.75 | 0.04 | 0.48 |
| 35 | 1.32 | 0.77 | 0.03 | 0.36 |
| 40 | 1.20 | 0.80 | 0.03 | 0.36 |
| 45 | 1.09 | 0.82 | 0.02 | 0.24 |
| 50 | 0.99 | 0.83 | 0.01 | 0.12 |
| 55 | 0.91 | 0.83 | 0.01 | 0.12 |
| 60 | **0.84** | 0.84 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 4.21 | 8.59 | 2577 | 2577 |
| 10 | 2.28 | 4.65 | 1395 | 3972 |
| 15 | 0.96 | 1.96 | 588 | 4559 |
| 20 | 0.48 | 0.98 | 294 | 4853 |
| 25 | 0.48 | 0.98 | 294 | 5147 |
| 30 | 0.48 | 0.98 | 294 | 5441 |
| 35 | 0.36 | 0.73 | 220 | 5661 |
| 40 | 0.36 | 0.73 | 220 | 5881 |
| 45 | 0.24 | 0.49 | 147 | 6028 |
| 50 | 0.12 | 0.24 | 73 | 6102 |
| 55 | 0.12 | 0.24 | 73 | 6175 |
| 60 | 0.12 | 0.24 | 73 | 6249 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 2577 | 306 | 2271 | 2271 |
| 10 | 1395 | 306 | 1089 | 3360 |
| 15 | 588 | 306 | 282 | 3641 |
| 20 | 294 | 306 | -12 | 3629 |
| 25 | 294 | 306 | -12 | 3617 |
| 30 | 294 | 306 | -12 | 3605 |
| 35 | 220 | 306 | -86 | 3519 |
| 40 | 220 | 306 | -86 | 3434 |
| 45 | 147 | 306 | -159 | 3274 |
| 50 | 73 | 306 | -233 | 3042 |
| 55 | 73 | 306 | -233 | 2809 |
| 60 | 73 | 306 | -233 | 2577 |

**3641** Max Storage Required (CF)
Value goes to 10-Year StormTech Sheet

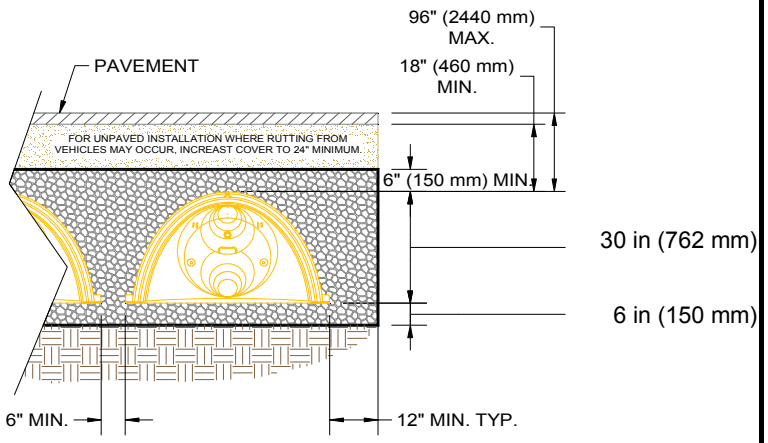
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 2 Year Storm - Basin 8 (Cayuse & Wolverine)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **8,323** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 112**

| | | |
|---|---|---|
| Approximate Bed Size Required | 4,608 | SF |
| Tons of Stone Required | 570 | Tons |
| Volume of Excavation | 853 | CY |
| Area of Filter Fabric | 1,655 | SY |
| # of End Caps Required | **4** | Each |
| Length of ISOLATOR ROW | **519.76** | FT |
| ISOLATOR FABRIC | **289** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **525** | FT |
| # of Chambers long | 73 | EA |
| # of Rows | 2 | EA |
| Actual Length | 523.36 | FT |
| Actual Width | 11.00 | FT |

1 of the chambers rows will contain only 39 chambers

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Cayuse & Wolverine*

2 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 15.95 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 4608 | SF (Enter per StormTech 2-Year Sheet) |
| Percolation Rate = | 25.00 | min/in |
| | 2.40 | in/hr |

$I = 8.0354T^{-0.653}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **2.60** | 0.22 | 0.22 | 2.60 |
| 10 | **1.87** | 0.31 | 0.10 | 1.20 |
| 15 | **1.46** | 0.37 | 0.05 | 0.60 |
| 20 | 1.20 | 0.40 | 0.04 | 0.48 |
| 25 | 1.03 | 0.43 | 0.03 | 0.36 |
| 30 | **0.90** | 0.45 | 0.02 | 0.24 |
| 35 | 0.80 | 0.47 | 0.02 | 0.24 |
| 40 | 0.73 | 0.49 | 0.02 | 0.24 |
| 45 | 0.66 | 0.50 | 0.01 | 0.12 |
| 50 | 0.61 | 0.51 | 0.01 | 0.12 |
| 55 | 0.56 | 0.51 | 0.01 | 0.12 |
| 60 | **0.52** | 0.52 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 2.60 | 12.44 | 3732 | 3732 |
| 10 | 1.20 | 5.74 | 1723 | 5455 |
| 15 | 0.60 | 2.87 | 861 | 6316 |
| 20 | 0.48 | 2.30 | 689 | 7005 |
| 25 | 0.36 | 1.72 | 517 | 7522 |
| 30 | 0.24 | 1.15 | 345 | 7867 |
| 35 | 0.24 | 1.15 | 345 | 8211 |
| 40 | 0.24 | 1.15 | 345 | 8556 |
| 45 | 0.12 | 0.57 | 172 | 8728 |
| 50 | 0.12 | 0.57 | 172 | 8900 |
| 55 | 0.12 | 0.57 | 172 | 9072 |
| 60 | 0.12 | 0.57 | 172 | 9245 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 3732 | 77 | 3656 | 3656 |
| 10 | 1723 | 77 | 1646 | 5301 |
| 15 | 861 | 77 | 785 | 6086 |
| 20 | 689 | 77 | 612 | 6698 |
| 25 | 517 | 77 | 440 | 7138 |
| 30 | 345 | 77 | 268 | 7406 |
| 35 | 345 | 77 | 268 | 7673 |
| 40 | 345 | 77 | 268 | 7941 |
| 45 | 172 | 77 | 95 | 8037 |
| 50 | 172 | 77 | 95 | 8132 |
| 55 | 172 | 77 | 95 | 8228 |
| 60 | 172 | 77 | 95 | 8323 |

**8323** Max Storage Required (CF)

Value goes to 2-Year StormTech Sheet

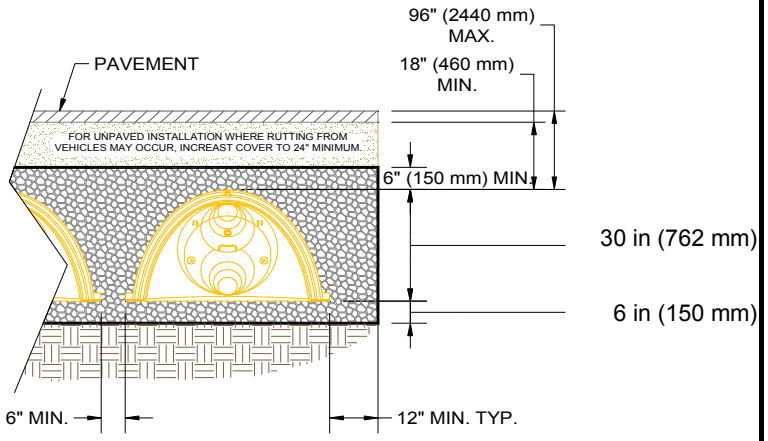
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 10 Year Storm - Basin 8 (Cayuse & Wolverine)
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **13,094** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




| | | |
|---|---|---|
| **Number of Chambers Required -** | **175** | |
| Approximate Bed Size Required | 7,810 | SF |
| Tons of Stone Required | 1,001 | Tons |
| Volume of Excavation | 1,446 | CY |
| Area of Filter Fabric | 3,119 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **1246** | FT |
| ISOLATOR FABRIC | **692** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **7** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **1250** | FT |
| # of Chambers long | 175 | EA |
| # of Rows | 1 | EA |
| Actual Length | 1,249.60 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres
*Cayuse & Wolverine*
10 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 15.95 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 7810 | SF (Enter per StormTech 10-Year Sheet) |
| Percolation Rate = | 25.00 | min/in |
| | 2.40 | in/hr |

$I = 13.744T^{-0.662}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **4.21** | 0.35 | 0.35 | 4.21 |
| 10 | **3.25** | 0.54 | 0.19 | 2.28 |
| 15 | **2.50** | 0.63 | 0.08 | 0.96 |
| 20 | 2.00 | 0.67 | 0.04 | 0.48 |
| 25 | 1.70 | 0.71 | 0.04 | 0.48 |
| 30 | **1.49** | 0.75 | 0.04 | 0.48 |
| 35 | 1.32 | 0.77 | 0.03 | 0.36 |
| 40 | 1.20 | 0.80 | 0.03 | 0.36 |
| 45 | 1.09 | 0.82 | 0.02 | 0.24 |
| 50 | 0.99 | 0.83 | 0.01 | 0.12 |
| 55 | 0.91 | 0.83 | 0.01 | 0.12 |
| 60 | **0.84** | 0.84 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 4.21 | 20.14 | 6043 | 6043 |
| 10 | 2.28 | 10.91 | 3273 | 9316 |
| 15 | 0.96 | 4.59 | 1378 | 10694 |
| 20 | 0.48 | 2.30 | 689 | 11384 |
| 25 | 0.48 | 2.30 | 689 | 12073 |
| 30 | 0.48 | 2.30 | 689 | 12762 |
| 35 | 0.36 | 1.72 | 517 | 13278 |
| 40 | 0.36 | 1.72 | 517 | 13795 |
| 45 | 0.24 | 1.15 | 345 | 14140 |
| 50 | 0.12 | 0.57 | 172 | 14312 |
| 55 | 0.12 | 0.57 | 172 | 14484 |
| 60 | 0.12 | 0.57 | 172 | 14656 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 6043 | 130 | 5913 | 5913 |
| 10 | 3273 | 130 | 3143 | 9056 |
| 15 | 1378 | 130 | 1248 | 10304 |
| 20 | 689 | 130 | 559 | 10863 |
| 25 | 689 | 130 | 559 | 11422 |
| 30 | 689 | 130 | 559 | 11981 |
| 35 | 517 | 130 | 387 | 12367 |
| 40 | 517 | 130 | 387 | 12754 |
| 45 | 345 | 130 | 214 | 12968 |
| 50 | 172 | 130 | 42 | 13010 |
| 55 | 172 | 130 | 42 | 13052 |
| 60 | 172 | 130 | 42 | 13094 |

**13094** Max Storage Required (CF)
Value goes to 10-Year StormTech Sheet

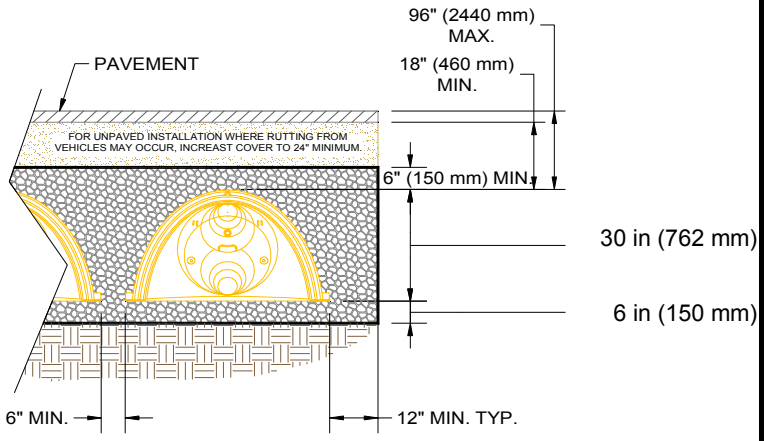
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 2 Year Storm - Combined Regional System
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **29,792** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




| | | |
|---|---|---|
| **Number of Chambers Required -** | **398** | |
| Approximate Bed Size Required | 17,734 | SF |
| Tons of Stone Required | 2,271 | Tons |
| Volume of Excavation | 3,284 | CY |
| Area of Filter Fabric | 7,075 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **2833.76** | FT |
| ISOLATOR FABRIC | **1,574** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **150** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **10000** | FT |
| # of Chambers long | 398 | EA |
| # of Rows | 1 | EA |
| Actual Length | 2,837.36 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres

*Combined Regional System*

2 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 89.35 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 17778 | SF (Enter per StormTech 2-Year Sheet) |
| Percolation Rate = | 3.00 | min/in |
| | 20.00 | in/hr |

$I = 8.0354T^{-0.653}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **2.60** | 0.22 | 0.22 | 2.60 |
| 10 | **1.87** | 0.31 | 0.10 | 1.20 |
| 15 | **1.46** | 0.37 | 0.05 | 0.60 |
| 20 | 1.20 | 0.40 | 0.04 | 0.48 |
| 25 | 1.03 | 0.43 | 0.03 | 0.36 |
| 30 | **0.90** | 0.45 | 0.02 | 0.24 |
| 35 | 0.80 | 0.47 | 0.02 | 0.24 |
| 40 | 0.73 | 0.49 | 0.02 | 0.24 |
| 45 | 0.66 | 0.50 | 0.01 | 0.12 |
| 50 | 0.61 | 0.51 | 0.01 | 0.12 |
| 55 | 0.56 | 0.51 | 0.01 | 0.12 |
| 60 | **0.52** | 0.52 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 2.60 | 69.69 | 20908 | 20908 |
| 10 | 1.20 | 32.17 | 9650 | 30558 |
| 15 | 0.60 | 16.08 | 4825 | 35383 |
| 20 | 0.48 | 12.87 | 3860 | 39243 |
| 25 | 0.36 | 9.65 | 2895 | 42137 |
| 30 | 0.24 | 6.43 | 1930 | 44067 |
| 35 | 0.24 | 6.43 | 1930 | 45997 |
| 40 | 0.24 | 6.43 | 1930 | 47927 |
| 45 | 0.12 | 3.22 | 965 | 48892 |
| 50 | 0.12 | 3.22 | 965 | 49857 |
| 55 | 0.12 | 3.22 | 965 | 50822 |
| 60 | 0.12 | 3.22 | 965 | 51787 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 20908 | 2469 | 18439 | 18439 |
| 10 | 9650 | 2469 | 7181 | 25619 |
| 15 | 4825 | 2469 | 2356 | 27975 |
| 20 | 3860 | 2469 | 1391 | 29366 |
| 25 | 2895 | 2469 | 426 | 29792 |
| 30 | 1930 | 2469 | -539 | 29252 |
| 35 | 1930 | 2469 | -539 | 28713 |
| 40 | 1930 | 2469 | -539 | 28174 |
| 45 | 965 | 2469 | -1504 | 26670 |
| 50 | 965 | 2469 | -1504 | 25166 |
| 55 | 965 | 2469 | -1504 | 23661 |
| 60 | 965 | 2469 | -1504 | 22157 |

**29792** Max Storage Required (CF)

Value goes to 2-Year StormTech Sheet

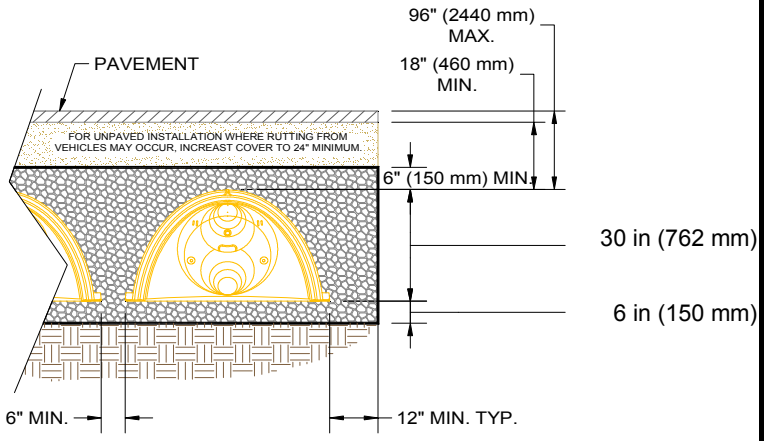
StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management℠

Units: **Imperial**

Project: TSA 10 Year Storm - Combined Regional System
By: Brandon Theis, PE
Point of Contact
Date: 5/4/2016

## System Requirements

| | | |
|---|---|---|
| Required Storage Volume | **47,996** | CF |
| Select Stormtech Chamber System | SC-740 | |
| Stone Porosity (Industry Standard = 40%) | **40%** | |
| Stone Foundation Depth | 6 | Inches |
| Storage Volume Per Chamber | 74.90 | CF |
| Avg Cover over Chambers (18 in min. & 96 in max.) | 24 | Inches |




**Number of Chambers Required - 641**

| | | |
|---|---|---|
| Approximate Bed Size Required | 28,547 | SF |
| Tons of Stone Required | 3,655 | Tons |
| Volume of Excavation | 5,286 | CY |
| Area of Filter Fabric | 11,386 | SY |
| # of End Caps Required | **2** | Each |
| Length of ISOLATOR ROW | **4563.92** | FT |
| ISOLATOR FABRIC | **2,536** | SY |

Is the limiting dimension for the bed the width or length? **length**

### Controlled by Width (Rows)

| | | |
|---|---|---|
| Width | **150** | FT |
| # of Chambers Long | - | EA |
| # of Rows | - | EA |
| Actual Length | - | FT |
| Actual Width | - | FT |

### Controlled by Length

| | | |
|---|---|---|
| Length | **10000** | FT |
| # of Chambers long | 641 | EA |
| # of Rows | 1 | EA |
| Actual Length | 4,567.52 | FT |
| Actual Width | 6.25 | FT |

## Material Estimate

**To use this sheet: Please enter data into the blue and green cells. If switching between Imperial and Metric units please check the correct units and data is input in the green cells.**

*Please call StormTech @ 888-892-2694 for conceptual cost estimates.*

Treasure State Acres
*Combined Regional System*
10 Year Infiltration Sizing - MDEQ Circular 8

| | | |
|---|---|---|
| Area = | 89.35 | Acres |
| C = | 0.30 | |
| Infiltration Footprint = | 28592 | SF (Enter per StormTech 10-Year Sheet) |
| Percolation Rate = | 3.00 | min/in |
| | 20.00 | in/hr |

$I = 13.744T^{-0.662}$

| Time (min) | Rainfall Intensity (in/hr) | Total Rainfall Amount (in) | Incremental Rainfall Amount (in) | Incremental Rainfall Intensity (in/hr) |
|---|---|---|---|---|
| 5 | **4.21** | 0.35 | 0.35 | 4.21 |
| 10 | **3.25** | 0.54 | 0.19 | 2.28 |
| 15 | **2.50** | 0.63 | 0.08 | 0.96 |
| 20 | 2.00 | 0.67 | 0.04 | 0.48 |
| 25 | 1.70 | 0.71 | 0.04 | 0.48 |
| 30 | **1.49** | 0.75 | 0.04 | 0.48 |
| 35 | 1.32 | 0.77 | 0.03 | 0.36 |
| 40 | 1.20 | 0.80 | 0.03 | 0.36 |
| 45 | 1.09 | 0.82 | 0.02 | 0.24 |
| 50 | 0.99 | 0.83 | 0.01 | 0.12 |
| 55 | 0.91 | 0.83 | 0.01 | 0.12 |
| 60 | **0.84** | 0.84 | 0.01 | 0.12 |

| Time (min) | Incremental Rainfall Intensity (in/hr) | Incremental Flow (cfs) | Incremental Volume (cf) | Total Volume (cf) |
|---|---|---|---|---|
| 5 | 4.21 | 112.85 | 33855 | 33855 |
| 10 | 2.28 | 61.12 | 18335 | 52189 |
| 15 | 0.96 | 25.73 | 7720 | 59909 |
| 20 | 0.48 | 12.87 | 3860 | 63769 |
| 25 | 0.48 | 12.87 | 3860 | 67629 |
| 30 | 0.48 | 12.87 | 3860 | 71489 |
| 35 | 0.36 | 9.65 | 2895 | 74384 |
| 40 | 0.36 | 9.65 | 2895 | 77279 |
| 45 | 0.24 | 6.43 | 1930 | 79209 |
| 50 | 0.12 | 3.22 | 965 | 80174 |
| 55 | 0.12 | 3.22 | 965 | 81139 |
| 60 | 0.12 | 3.22 | 965 | 82104 |

| Time (min) | Inflow Volume (cf) | Outflow Volume (cf) | Net Change (cf) | Storage Volume (cf) |
|---|---|---|---|---|
| 5 | 33855 | 3971 | 29884 | 29884 |
| 10 | 18335 | 3971 | 14364 | 44247 |
| 15 | 7720 | 3971 | 3749 | 47996 |
| 20 | 3860 | 3971 | -111 | 47885 |
| 25 | 3860 | 3971 | -111 | 47773 |
| 30 | 3860 | 3971 | -111 | 47662 |
| 35 | 2895 | 3971 | -1076 | 46586 |
| 40 | 2895 | 3971 | -1076 | 45510 |
| 45 | 1930 | 3971 | -2041 | 43469 |
| 50 | 965 | 3971 | -3006 | 40463 |
| 55 | 965 | 3971 | -3006 | 37457 |
| 60 | 965 | 3971 | -3006 | 34450 |

**47996** Max Storage Required (CF)
Value goes to 10-Year StormTech Sheet

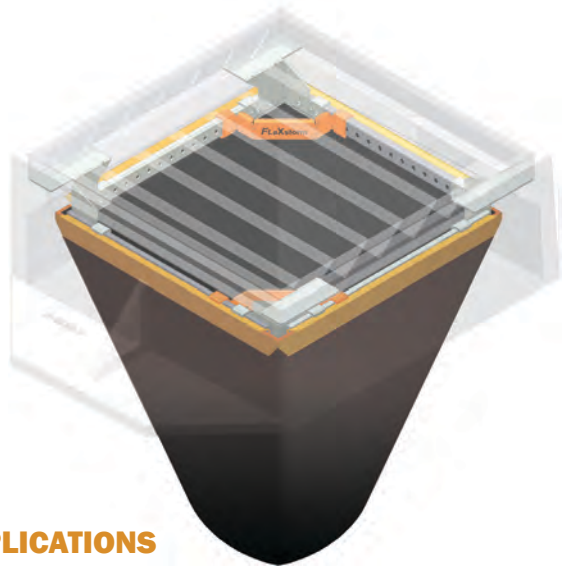
# Appendix D

## Materials Catalog Sheets – Filter Bags

FLEXSTORM INLET FILTERS™

# The Universal Solution for Storm Water Runoff Control

State DOTs and Municipalities across the country now have a universally accepted structural BMP to address the issue of storm sewer inlet protection. The FLEXSTORM system is inexpensive, configurable and adjustable and offers more versatility to fit the wide array of drainage structures throughout the United States while offering various levels of filtration. FLEXSTORM Inlet Filters are the preferred choice for inlet protection and storm water runoff control.

## APPLICATIONS

**DOT/Road Construction**
**Commercial/Parking Lots**
**Residential Developments**
**Industrial/Maintenance**

## FEATURES

- **Configurable**: Steel frames configured to fit ANY storm drainage structure
- **Adjustable**: Rectangular frames are adjustable in 1/2" increments up to 5" per side
- **Reusable**: Replaceable geotextile sediment bags de signed for construction or post construction applications
- **Affordable**: Low per-unit cost; installs in seconds; easily maintained with Universal Removal Tool (no machinery required)
- **Effective**: Works below grade; overflow feature allows streets to drain with full bag; prevents ponding

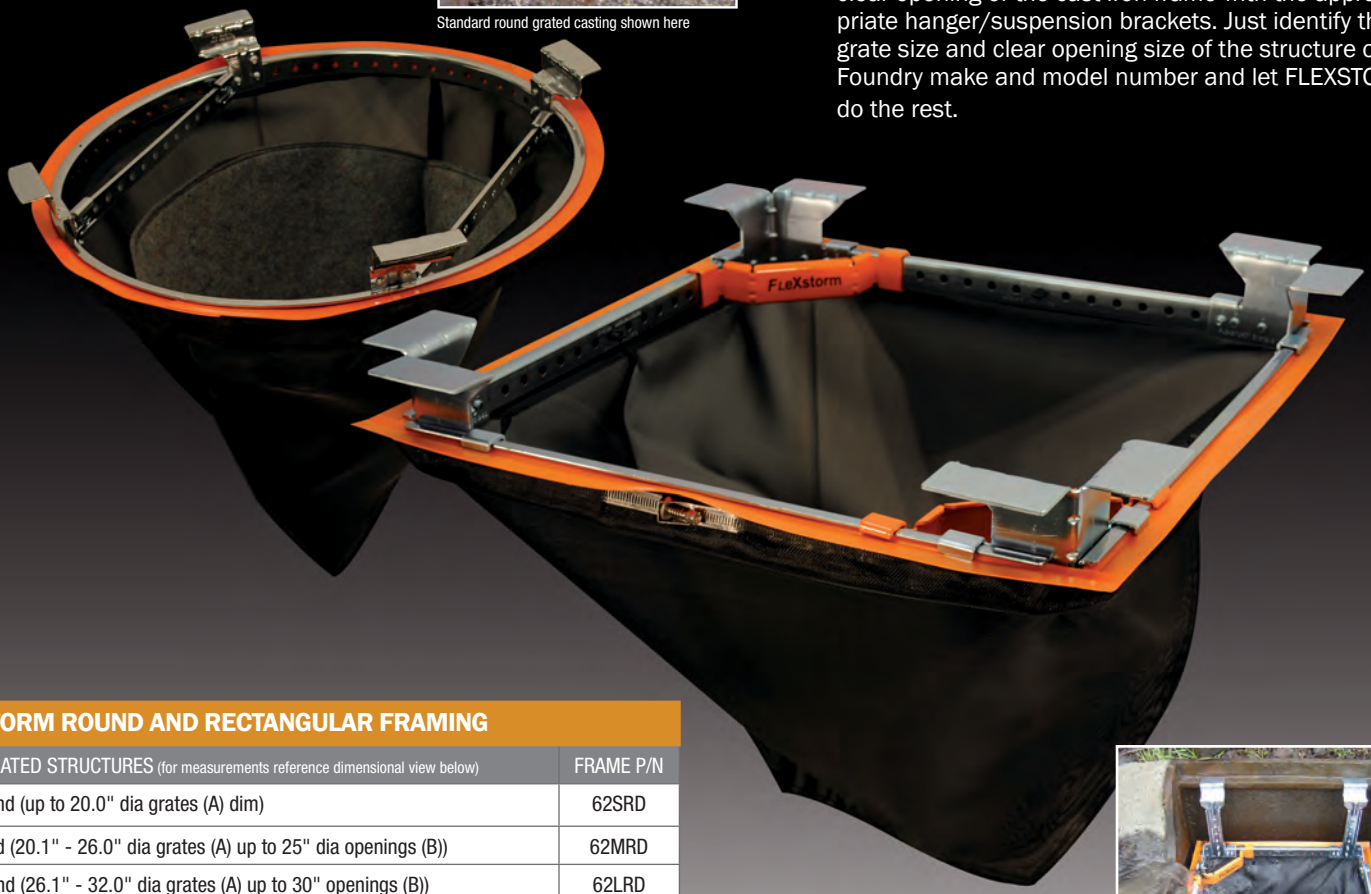
## CREATE YOUR OWN FLEXSTORM SOLUTION IN THREE EASY STEPS

1. IDENTIFY YOUR FRAME
2. CHOOSE YOUR FILTER BAG
3. CREATE YOUR PART NUMBER

Standard round grated casting shown here

# Grated Structures

FLEXSTORM Inlet Filters are well suited for Frame and Grate applications where there is a continuous framing lip upon which the grate rests. The FLEXSTORM assembly is shipped to the field to fit precisely into the clear opening of the cast iron frame with the appropriate hanger/suspension brackets. Just identify the grate size and clear opening size of the structure or the Foundry make and model number and let FLEXSTORM do the rest.




## FLEXSTORM ROUND AND RECTANGULAR FRAMING

| ROUND GRATED STRUCTURES (for measurements reference dimensional view below) | FRAME P/N |
|---|---|
| Small Round (up to 20.0" dia grates (A) dim) | 62SRD |
| Med Round (20.1" - 26.0" dia grates (A) up to 25" dia openings (B)) | 62MRD |
| Large Round (26.1" - 32.0" dia grates (A) up to 30" openings (B)) | 62LRD |
| XL Round (32.1" dia - 39" dia grates (A) up to 37" dia openings (B)) | 62XLRD |

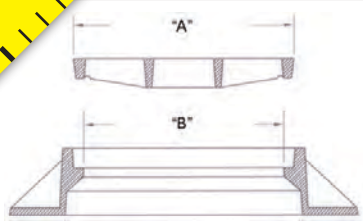
| RECTANGULAR GRATED STRUCTURES (for measurements reference dimensional view below) | FRAME P/N | COMBO INLET P/N* |
|---|---|---|
| Small Rect / Square (up to 16" (B) x 16" (D) openings or 64" perimeter) | 62SSQ | 62SCB |
| Med Rect / Square (up to 24" (B) x 24" (D) openings or 96" perimeter) | 62MSQ | 62MCB |
| Large Rect / Square (up to 36" (B) x 24" (D) openings or 120" perimeter) | 62LSQ | 62LCB |
| XL Rect / Square (side by side 2 pc set to fit up to 48" (B) x 36" (D) openings) | 62XLSQ | 62XLCB |

*Rigid backsplash option is available for combination inlets with open curb hoods. Ref P/N 62RIGCBFL

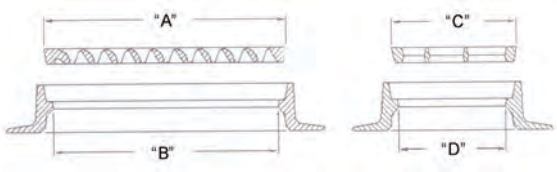
Adjustable hanger brackets make it possible to fit all rolled

Combination inlet with magnetic rear guard attachment

MEASURING




**Round Grated Structures**




**Rectangular Grated Structures**

## FLEXSTORM is the universal solution to fit any storm sewer

Round Inlet (metal or concrete frame)

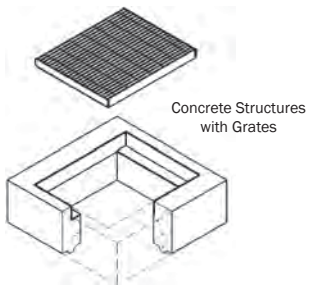
Rectangular Inlet (metal or concrete)

Rectangular Rolled Curb

Combination Inlets with Curb Hoods

## FITTING CONCRETE STRUCTURES

FLEXSTORM has developed special extended hanger brackets for Concrete Structures since there is considerable variance in the clear opening dimensions when compared to cast iron frames. It is important to identify the grate size along with concrete opening and location of the grate supports. NOTE: Sizing follows the same guidelines as the frame and grate designs based on the concrete clear opening dimensions.



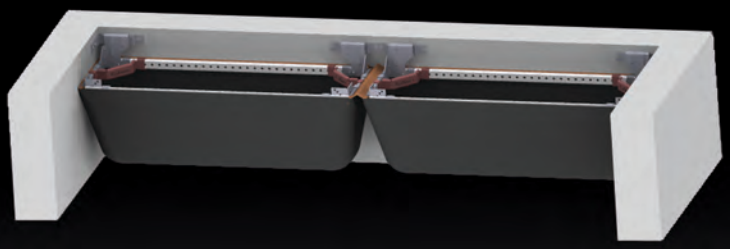
Concrete Structures with Grates

# Wall Mounted Structures

FLEXSTORM wall mount units are designed to mount easily inside open throat concrete structures beneath the curb opening. Maintenance is also simplified with the easy off hanger system. All stainless steel mounting hardware is provided.

**FLEXSTORM WALL MOUNT FOR OPEN THROAT CURB INLETS**

| CURB OPENING SIZE | FRAME P/N |
|---|---|
| Up to 4' curb openings (1 Filter and Mounting Hardware) | 62WM1 |
| Between 4' and 8' (2 Filters and Mounting Hardware) | 62WM2 |
| Between 8' and 12' (3 Filters and Mounting Hardware) | 62WM3 |
| Between 12' and 16' (4 Filters and Mounting Hardware) | 62WM4 |



# Nyloplast Castings

FLEXSTORM Filters for Nyloplast castings are comprised of stainless steel framing designed to fit all castings ranging from 12" to 30" diameter. FLEXSTORM Catch-ITs are now available specified with the FX or FX-S (short) filter bags.

**FLEXSTORM NYLOPLAST STAINLESS STEEL FRAMING**

| Nyloplast Casting Size | FRAME P/N |
|---|---|
| 12" diameter | 6212NY |
| 15" diameter | 6215NY |
| 18" diameter | 6218NY |
| 24" diameter | 6224NY |
| 30" diameter | 6230NY |

## FRAMING MATERIAL OPTIONS

Choosing the best framing material for your application is a matter of identifying the type of environment and the length of usage.

### Zinc Plated

FLEXSTORM STANDARD FRAMING

**Medium to long term applications with low to moderate levels of salt exposure**

### Chrome Plated

**Medium to Long term applications with moderate to high levels of salt exposure**

| FRAMING MATERIAL | P/N SUFFIX |
|---|---|
| Chrome Plated | CHR |

### Stainless Steel

**Permanant applications in harsh environments and/or high levels of salt or chemical exposure**

**Compliant in regions with stringent environmental regulations**

| FRAMING MATERIAL | P/N SUFFIX |
|---|---|
| Stainless Steel | SS |

# 2. CHOOSE YOUR FILTER BAG

## Silt, sand, gravel and Large partical filtration

The standard woven polypropylene bag has the highest flow rate in the industry. This durable geotextile resists clogging and cleans up easily. It is well suited for construction sites and heavy flow drainage areas. Provisions for hydrocarbon removal are offered as add-ons (see FX+ and FXO).

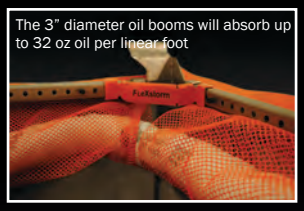
**FILTRATION EFFICIENCY = 82% †**

† Large scale, 3rd party testing per ASTM D 7351, Standard Test Method for Determination of Sediment Retention Device Effectiveness in Sheet Flow Application using 7% USDA Sandy Loam

### FX
Flexstorm standard woven bag for temporary or permanent applications


### FX+
Standard woven bag with MyCelx skimmer for low to moderate hydrocarbon removal


### FXO
Standard woven bag with oil boom for low to moderate hydrocarbon removal



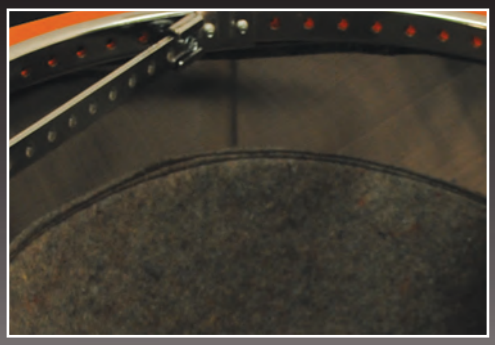

## Oil, grease, metals and Fine partical filtration

The FLEXSTORM PC 'Post Construction' line of inlet filters is designed to specifically target small particle and hydrocarbon removal from parking lots, industrial buildings, and other drainage hot spots.

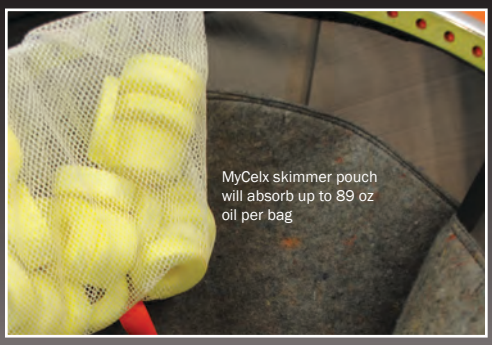
**TSS = 99%  TPH = 97% ‡**

‡ Large scale testing at 90 GPM. 3rd party results using US Silica OK-110 sand at 1750 mg/L measuring TSS per SM 2540D. TPH tested at 243 mg/L used motor oil using EPA Method 1664A.

### PC
For very fine particals with moderate levels of hydrocarbon runoff



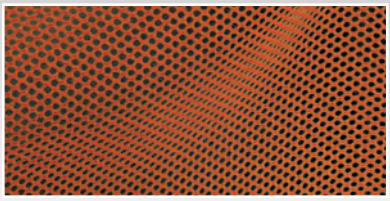
### PC+
For very fine particals with high levels of hydrocarbon runoff




| FLEXSTORM FILTER BAGS | STANDARD BAG P/N (22" depth) | SHORT BAG P/N (12" depth) |
|---|---|---|
| FX: Standard Woven Bag | FX | FX-S |
| FX+: Woven w/ MyCelx | FXP | FXP-S |
| FXO: Woven w/ Oil Boom | FXO | FXO-S |
| PC: Post Construction Bag | PC | PC-S |
| PC+: PC Bag w/ MyCelx | PCP | PCP-S |
| LL: Litter and Leaf Bag | LL | LL-S |
| IL: IDOT NonWoven Bag | IL | IL-S |

### SPECIALITY BAGS

#### LL - LITTER AND LEAF BAG
Polyester mesh bag designed to capture litter, leaves and large debris



#### IL - IDOT NONWOVEN
IDOT specified non-woven with polyester reinforcement mesh for temporary use

## FILTER BAG SPECIFICATIONS & CAPABILITES

| Bag Type (P/N) | Clean Water Flow Rate (GPM/SqFt) | Min A.O.S. (US Sieve) |
|---|---|---|
| Woven (FX) | 200 | 40 |
| Post Construction (PC) | 137 | 140 |
| NonWoven (IL) | 145 | 70 |
| Litter & Leaf Bag (LL) | High | 3.5 |

| Standard Bag Size§ | Solids Storage Capacity (CuFt) | Filtered Flow Rate at 50% Max (CFS) | | | Oil Retention (Oz) | |
|---|---|---|---|---|---|---|
| | | FX | PC | IL | PC* | PCP** |
| Small | 1.6 | 1.2 | 0.8 | 0.9 | 66 | 155 |
| Medium | 2.1 | 1.8 | 1.2 | 1.3 | 96 | 185 |
| Large | 3.8 | 2.2 | 1.5 | 1.6 | 120 | 209 |
| XL | 4.2 | 3.6 | 2.4 | 2.6 | 192 | 370 |

* PC filter bag at 50% max adsorption capacity
** PC filter bag at 50% capacity and MyCelx skimmer at 100% capacity
§ Standard bags are 22" in depth.  Short bags are 12" in depth, reducing solids storage capacity by approximately 50%.

# 3. CREATE YOUR PART NUMBER

| | | | |
|---|---|---|---|
| | | – | |

**FRAME P/N**
Enter your frame part number from step one.

**FILTER BAG P/N**
Enter your filter bag part number from step two.

**FRAMING MATERIAL**
Enter your framing material suffix from step one.*

*Zinc is standard framing and requires no suffix. Use CHR" for chrome and SS" for stainless steel.

Create your FLEXSTORM Inlet Filter part number combining your frame and bag part numbers. Framing upgrades are identified with a suffix. Please note that the specific casting foundry make and model number, DOT callout, or detailed dimensional form must be provided with any order so FLEXSTORM can configure your customized solution. All units are shipped to the field fully assembled to fit precisely into your identified drainage structure.

## Need help with your Part Number?

Use this part number guide to identify your frame and fiter bag part number, then add your framing material suffix.

**PART NUMBER GUIDE** — **FILTER BAG SELECTION** (Part Numbers are for Standard 22" depth bags. Short 12" depth bags are available for all types using -S Suffix)

FRAMING TYPE AND SIZE SELECTION

Choose your frame type and size below, then select your filter bag in the columns to the right to identify your part number. If upgrading from standard zinc framing, append your part number with either CHR" for chrome or SS" for stainless steel.

| | | Frame P/N: | FX: Woven Standard Bag<br>Bag P/N: FX | FX+: Woven w/ Mycelx Skimmer<br>Bag P/N: FXP | FXO: Woven w/ Oil Boom<br>Bag P/N: FXO | PC: Post Construction (Adsorb-it Lined)<br>Bag P/N: PC | PC+: PC bag w/ MyCelx Skimmer<br>Bag P/N: PCP | LL: Litter Leaf Bag<br>Bag P/N: LL | IL: IDOT Specified NonWoven Bag<br>Bag P/N: IL |
|---|---|---|---|---|---|---|---|---|---|
| ROUND | **Small Round** (up to 20.0" dia grates (A) dim) | **62SRD** | 62SRDFX | 62SRDFXP | 62SRDFXO | 62SRDPC | 62SRDPCP | 62SRDLL | 62SRDIL |
| ROUND | **Med Round** (20.1" - 26.0" dia grates (A) up to 25" dia openings (B)) | **62MRD** | 62MRDFX | 62MRDFXP | 62MRDFXO | 62MRDPC | 62MRDPCP | 62MRDLL | 62MRDIL |
| ROUND | **Large Round** (26.1" - 32.0" dia grates (A) up to 30" openings (B)) | **62LRD** | 62LRDFX | 62LRDFXP | 62LRDFXO | 62LRDPC | 62LRDPCP | 62LRDLL | 62LRDIL |
| ROUND | **XL Round** (32.1" dia - 39" dia grates (A) up to 37" dia openings (B)) | **62XLRD** | 62XLRDFX | 62XLRDFXP | 62XLRDFXO | 62XLRDPC | 62XLRDPCP | 62XLRDLL | 62XLRDIL |
| RECTANGULAR | **Small Rect** / Square (up to 16" (B) x 16" (D) openings or 64" perimeter) | **62SSQ** | 62SSQFX | 62SSQFXP | 62SSQFXO | 62SSQPC | 62SSQPCP | 62SSQLL | 62SSQIL |
| RECTANGULAR | **Med Rect** / Square (up to 24" (B) x 24" (D) openings or 96" perimeter) | **62MSQ** | 62MSQFX | 62MSQFXP | 62MSQFXO | 62MSQPC | 62MSQPCP | 62MSQLL | 62MSQIL |
| RECTANGULAR | **Large Rect** / Square (up to 36" (B) x 24" (D) openings or 120" perimeter) | **62LSQ** | 62LSQFX | 62LSQFXP | 62LSQFXO | 62LSQPC | 62LSQPCP | 62LSQLL | 62LSQIL |
| RECTANGULAR | **XL Rect** / Square (side by side 2 pc set to fit up to 48" (B) x 36" (D) openings) | **62XLSQ** | 62XLSQFX | 62XLSQFXP | 62XLSQFXO | 62XLSQPC | 62XLSQPCP | 62XLSQLL | 62XLSQIL |
| COMBO INLETS | **Small Rect** / Square (ref Rect sizing; shipped with Magnetic Curb Flaps) | **62SCB** | 62SCBFX | 62SCBFXP | 62SCBFXO | 62SCBPC | 62SCBPCP | 62SCBLL | 62SCBIL |
| COMBO INLETS | **Med Rect** / Square (ref Rect sizing; shipped with Magnetic Curb Flaps) | **62MCB** | 62MCBFX | 62MCBFXP | 62MCBFXO | 62MCBPC | 62MCBPCP | 62MCBLL | 62MCBIL |
| COMBO INLETS | **Large Rect** / Square (ref Rect sizing; shipped with Magnetic Curb Flaps) | **62LCB** | 62LCBFX | 62LCBFXP | 62LCBFXO | 62LCBPC | 62LCBPCP | 62LCBLL | 62LCBIL |
| COMBO INLETS | **XL Rect** / Square (ref Rect sizing; shipped with Magnetic Curb Flaps) | **62XLCB** | 62XLCBFX | 62XLCBFXP | 62XLCBFXO | 62XLCBPC | 62XLCBPCP | 62XLCBLL | 62XLCBIL |
| NYLOPLAST | **12"** diameter Nyloplast castings (Stainless Steel Framing standard) | **6212NY** | 6212NYFX | 6212NYFXP | 6212NYFXO | 6212NYPC | 6212NYPCP | 6212NYLL | 6212NYIL |
| NYLOPLAST | **15"** diameter Nyloplast castings (Stainless Steel Framing standard) | **6215NY** | 6215NYFX | 6215NYFXP | 6215NYFXO | 6215NYPC | 6215NYPCP | 6215NYLL | 6215NYIL |
| NYLOPLAST | **18"** diameter Nyloplast castings (Stainless Steel Framing standard) | **6218NY** | 6218NYFX | 6218NYFXP | 6218NYFXO | 6218NYPC | 6218NYPCP | 6218NYLL | 6218NYIL |
| NYLOPLAST | **24"** diameter Nyloplast castings (Stainless Steel Framing standard) | **6224NY** | 6224NYFX | 6224NYFXP | 6224NYFXO | 6224NYPC | 6224NYPCP | 6224NYLL | 6224NYIL |
| NYLOPLAST | **30"** diameter Nyloplast castings (Stainless Steel Framing standard) | **6230NY** | 6230NYFX | 6230NYFXP | 6230NYFXO | 6230NYPC | 6230NYPCP | 6230NYLL | 6230NYIL |
| WALL MOUNT | **Open Throat Gutters** - Curb Opening Size (Units shipped with Short 12" Depth Bags unless otherwise specified) | | | | | | | | |
| WALL MOUNT | **Up to 4' curb openings** (1 Filter and Mounting Hardware) | **62WM1** | 62WM1FX | 62WM1FXP | 62WM1FXO | 62WM1PC | 62WM1PCP | 62WM1LL | 62WM1IL |
| WALL MOUNT | **Between 4' and 8'** (2 Filters and Mounting Hardware) | **62WM2** | 62WM2FX | 62WM2FXP | 62WM2FXO | 62WM2PC | 62WM2PCP | 62WM2LL | 62WM2IL |
| WALL MOUNT | **Between 8' and 12'** (3 Filters and Mounting Hardware) | **62WM3** | 62WM3FX | 62WM3FXP | 62WM3FXO | 62WM3PC | 62WM3PCP | 62WM3LL | 62WM3IL |
| WALL MOUNT | **Between 12' and 16'** (4 Filters and Mounting Hardware) | **62WM4** | 62WM4FX | 62WM4FXP | 62WM4FXO | 62WM4PC | 62WM4PCP | 62WM4LL | 62WM4IL |

## Replacement Bags Available

Replacement bags are available for all units shipped complete with stainless steel clamping band. Size categories are for either round or rectangular framing. The original framing detail is required with each order.

| BAG SIZE | FX | FXP | FXO | PC | PCP | LL | IL |
|---|---|---|---|---|---|---|---|
| Small | 62SRBFX | 62SRBFXP | 62SRBFXO | 62SRBPC | 62SRBPCP | 62SRBLL | 62SRBIL |
| Medium | 62MRBFX | 62MRBFXP | 62MRBFXO | 62MRBPC | 62MRBPCP | 62MRBLL | 62MRBIL |
| Large | 62LRBFX | 62LRBFXP | 62LRBFXO | 62LRBPC | 62LRBPCP | 62LRBLL | 62LRBIL |
| XL | 62XLRBFX | 62XLRBFXP | 62XLRBFXO | 62XLRBPC | 62XLRBPCP | 62XLRBLL | 62XLRBIL |

## Accessories

**UNIVERSAL MAINTENANCE TOOL**
Dual purpose tool makes both grate and filter removal safe and fast


ALL PRODUCTS MANUFACTURED BY:

IPP
INLET & PIPE PROTECTION, INC

**www.inletfilters.com**

# ADS FLEXSTORM INLET FILTER SPECIFICATIONS

## IDENTIFICATION
The installer shall inspect the plans and/or worksite to determine the quantity of each drainage structure casting type. The foundry casting number, exact grate size and clear opening size, or other information will be necessary to finalize the FLEXSTORM part number and dimensions. The units are shipped to the field configured precisely to fit the identified drainage structure.

## MATERIAL AND PERFORMANCE
The FLEXSTORM Inlet Filter system is comprised of a corrosion resistant steel frame and a replaceable geotextile filter bag attached to the frame with a stainless steel locking band. The filter bag hangs suspended at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment. The standard Woven Polypropylene FX filter bags are rated for 200 gpm/sqft with a removal efficiency of 82% when filtering a USDA Sandy Loam sediment load. The Post Construction PC filter bags are rated for137 gpm/sqft and have been 3rd party tested at 99% TSS removal to 110 micron and 97% TPH removal of used motor oil hydrocarbon mix.

## INSTALLATION
Remove the grate from the casting or concrete drainage structure. Clean the ledge (lip) of the casting frame or drainage structure to ensure it is free of stone and dirt. Drop in the FLEXSTORM Inlet Filter through the clear opening and be sure the suspension hangers rest firmly on the inside ledge (lip) of the casting. Replace the grate and confirm it is elevated no more than 1/8", which is the thickness of the steel hangers. For wall mount units, follow instructions for attaching the stainless steel mounting brackets using the provided concrete fasteners.

## INSPECTION FREQUENCY
Construction site inspection should occur following each ½" or more rain event. Post Construction inspections should occur three times per year (every four months) in areas with mild year round rainfall and four times per year (every three months Feb-Nov) in areas with summer rains before and after the winter snowfall season. Industrial application site inspections (loading ramps, wash racks, maintenance facilities) should occur on a regularly scheduled basis no less than three times per year.

## MAINTENANCE GUIDELINES
Empty the filter bag if more than half filled with sediment and debris, or as directed by the Engineer. Remove the grate, engage the lifting bars or handles with the FLEXSTORM Removal Tool, and lift from the drainage structure. Dispose of the sediment or debris as directed by the Engineer or Maintenance Contract in accordance with EPA guidelines. As an alternative, an industrial vacuum may be used to collect the accumulated sediment. Remove any caked on silt from the sediment bag and reverse flush the bag with medium spray for optimal filtration. Replace the bag if torn or punctured to ½" diameter or greater on the lower half of the bag. Post Construction PC/PC+ Bags should be maintained prior to 50% oil saturation. The average 2' x 2' PC filter bag will retain approx 96 oz (5.4 lbs) of oil at which time it should be serviced or replaced. It can be centrifuged or passed through a wringer to recover the oils, and the fabric reused with 85% to 90% efficacy. It may also be recycled for its fuel value through waste to energy incineration. When utilizing the MyCelx Skimmer Pouches in the + bags, note that the skimmers start yellow in color and will gradually turn brown as they become saturated, indicating time for replacement. Each MyCelx skimmer pouch will absorb approximately 89 oz (5 lbs) of oil before requiring replacement. It may also be recycled for its fuel value through waste to energy incineration. Dispose of all oil contaminated products in accordance with EPA guidelines.

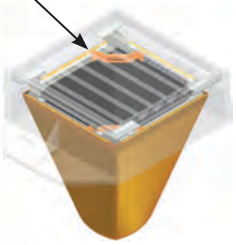
## FILTER BAG REPLACEMENT
Remove the bag by loosening or cutting off the clamping band. Take the new filter bag, which is equipped with a stainless steel worm drive clamping band, and use a screw driver to tighten the bag around the frame channel. Ensure the bag is secure and that there is no slack around the perimeter of the band.

**Lift Handles** ease installation and maintenance

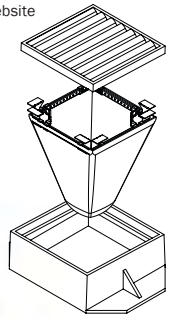
**Replaceable Sediment Bag**

1/8" thick steel hangers & channels; precision stampings **configured to fit each individual casting**

Rectangular frames are **adjustable** in 1/2" increments up to 5" per side



CAD drawings, work instructions and test reports on website



Patent Pending

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CPPA

# Appendix E

## Materials Catalog Sheets - StormTech® Chambers

# StormTech SC-740 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal applications.

StormTech®
*Detention • Retention • Recharge*
Subsurface Stormwater Management℠

**StormTech SC-740 Chamber**
(not to scale)

Nominal Chamber Specifications

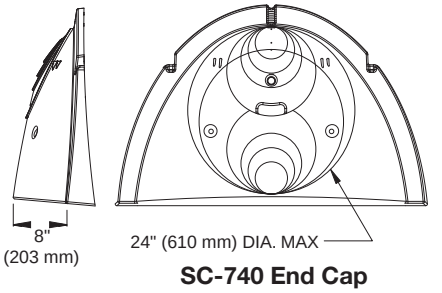
**Size** (L x W x H)
85.4" x 51.0" x 30.0"
(2170 x 1295 x 762 mm)

**Chamber Storage**
45.9 ft³ (1.30 m³)

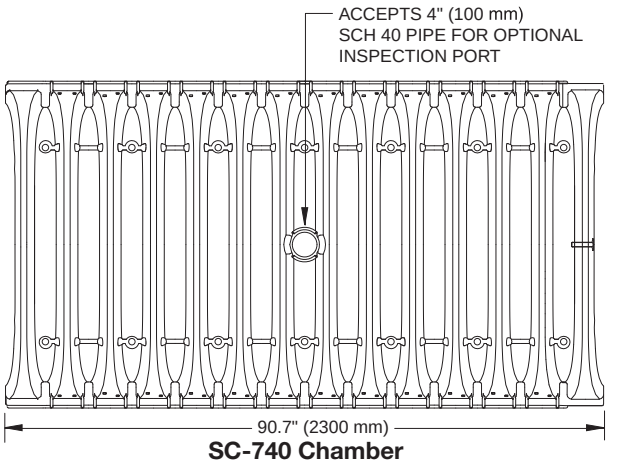
**Minimum Installed Storage***
74.9 ft³ (2.12 m³)

**Weight**
74.0 lbs (33.6 kg)

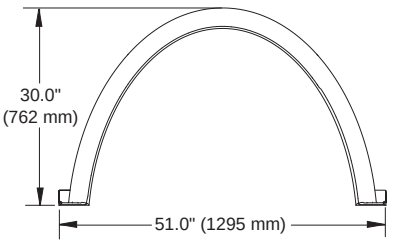
**Shipping**
30 chambers/pallet
60 end caps/pallet
12 pallets/truck

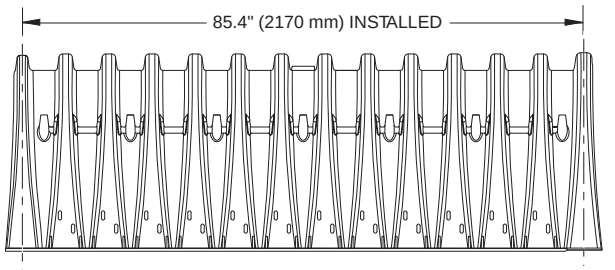



**SC-740 End Cap**

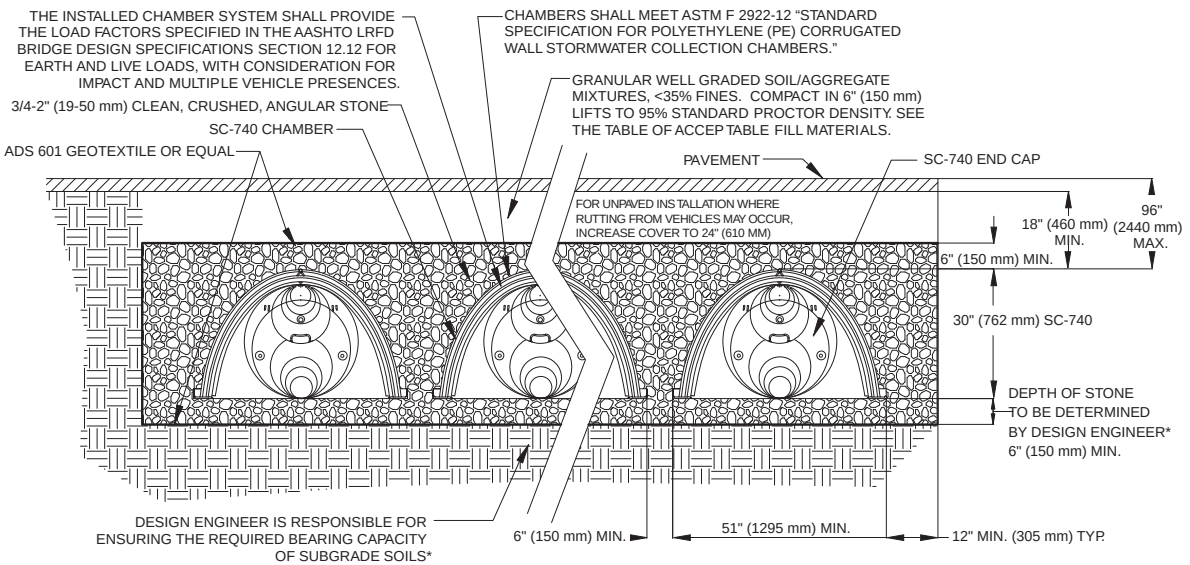



**SC-740 Chamber**




**Typical Cross Section Detail**
(not to scale)




THIS CROSS SECTION DETAILS THE REQUIREMENTS NECESSARY TO SATISFY THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS USING STORMTECH CHAMBERS

MADE IN THE U.S.A.

**SC-740 Cumulative Storage Volumes Per Chamber**

*Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (152 mm) Stone Base Under the Chambers.*

| Depth of Water in System Inches (mm) | Cumulative Chamber Storage Ft³ (m³) | Total System Cumulative Storage Ft³ (m³) |
|---|---|---|
| 42 (1067) | 45.90 (1.300) | 74.90 (2.121) |
| 41 (1041) | 45.90 (1.300) | 73.77 (2.089) |
| 40 (1016) | Stone 45.90 (1.300) | 72.64 (2.057) |
| 39 (991) | Cover 45.90 (1.300) | 71.52 (2.025) |
| 38 (965) | 45.90 (1.300) | 70.39 (1.993) |
| 37 (948) | 45.90 (1.300) | 69.26 (1.961) |
| 36 (914) | 45.90 (1.300) | 68.14 (1.929) |
| 35 (889) | 45.85 (1.298) | 66.98 (1.897) |
| 34 (864) | 45.69 (1.294) | 65.75 (1.862) |
| 33 (838) | 45.41 (1.286) | 64.46 (1.825) |
| 32 (813) | 44.81 (1.269) | 62.97 (1.783) |
| 31 (787) | 44.01 (1.246) | 61.36 (1.737) |
| 30 (762) | 43.06 (1.219) | 59.66 (1.689) |
| 29 (737) | 41.98 (1.189) | 57.89 (1.639) |
| 28 (711) | 40.80 (1.155) | 56.05 (1.587) |
| 27 (686) | 39.54 (1.120) | 54.17 (1.534) |
| 26 (660) | 38.18 (1.081) | 52.23 (1.479) |
| 25 (635) | 36.74 (1.040) | 50.23 (1.422) |
| 24 (610) | 35.22 (0.977) | 48.19 (1.365) |
| 23 (584) | 33.64 (0.953) | 46.11 (1.306) |
| 22 (559) | 31.99 (0.906) | 44.00 (1.246) |
| 21 (533) | 30.29 (0.858) | 41.85 (1.185) |
| 20 (508) | 28.54 (0.808) | 39.67 (1.123) |
| 19 (483) | 26.74 (0.757) | 37.47 (1.061) |
| 18 (457) | 24.89 (0.705) | 35.23 (0.997) |
| 17 (432) | 23.00 (0.651) | 32.96 (0.939) |
| 16 (406) | 21.06 (0.596) | 30.68 (0.869) |
| 15 (381) | 19.09 (0.541) | 28.36 (0.803) |
| 14 (356) | 17.08 (0.484) | 26.03 (0.737) |
| 13 (330) | 15.04 (0.426) | 23.68 (0.670) |
| 12 (305) | 12.97 (0.367) | 21.31 (0.608) |
| 11 (279) | 10.87 (0.309) | 18.92 (0.535) |
| 10 (254) | 8.74 (0.247) | 16.51 (0.468) |
| 9 (229) | 6.58 (0.186) | 14.09 (0.399) |
| 8 (203) | 4.41 (0.125) | 11.66 (0.330) |
| 7 (178) | 2.21 (0.063) | 9.21 (0.264) |
| 6 (152) | 0 | 6.76 (0.191) |
| 5 (127) | 0 | 5.63 (0.160) |
| 4 (102) | Stone Foundation 0 | 4.51 (0.125) |
| 3 (76) | 0 | 3.38 (0.095) |
| 2 (51) | 0 | 2.25 (0.064) |
| 1 (25) | 0 | 1.13 (0.032) |

*Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.*

**Storage Volume Per Chamber**

| | Bare Chamber Storage | Chamber and Stone Stone Foundation Depth in. (mm) | | |
|---|---|---|---|---|
| | ft³ (m³) | 6 (150) | 12 (305) | 18 (460) |
| **StormTech SC-740** | 45.9 (1.3) | 74.9 (2.1) | 81.7 (2.3) | 88.4 (2.5) |

*Note: Storage volumes are in cubic feet per chamber. Assumes 40% porosity for the stone plus the chamber volume.*

**Amount of Stone Per Chamber**

| | Stone Foundation Depth | | |
|---|---|---|---|
| ENGLISH TONS (CUBIC YARDS) | 6" | 12" | 18" |
| **StormTech SC-740** | 3.8 (2.8 yd³) | 4.6 (3.3 yd³) | 5.5 (3.9 yd³) |
| METRIC KILOGRAMS (METER³) | **150 mm** | **305 mm** | **460 mm** |
| **StormTech SC-740** | 3450 (2.1 m³) | 4170 (2.5 m³) | 4490 (3.0 m³) |

*Note: Assumes 6" (150 mm) of stone above, and between chambers.*

**Volume of Excavation Per Chamber**

| | Stone Foundation Depth | | |
|---|---|---|---|
| | 6" (150 mm) | 12" (305 mm) | 18" (460 mm) |
| **StormTech SC-740** | 5.5 (4.2) | 6.2 (4.7) | 6.8 (5.2) |

*Note: Volumes are in cubic yards (cubic meters) per chamber. Assumes 6" (150 mm) of separation between chamber rows and 18" (460 mm) of cover. The volume of excavation will vary as the depth of the cover increases.*

**STANDARD LIMITED WARRANTY OF STORMTECH LLC ("STORMTECH"): PRODUCTS**

(A) This Limited Warranty applies solely to the StormTech chambers and endplates manufactured by StormTech and sold to the original purchaser (the "Purchaser"). The chambers and endplates are collectively referred to as the "Products."

(B) The structural integrity of the Products, when installed strictly in accordance with StormTech's written installation instructions at the time of installation, are warranted to the Purchaser against defective materials and workmanship for one (1) year from the date of purchase. Should a defect appear in the Limited Warranty period, the Purchaser shall provide StormTech with written notice of the alleged defect at StormTech's corporate headquarters within ten (10) days of the discovery of the defect. The notice shall describe the alleged defect in reasonable detail. StormTech agrees to supply replacements for those Products determined by StormTech to be defective and covered by this Limited Warranty. The supply of replacement products is the sole remedy of the Purchaser for breaches of this Limited Warranty. StormTech's liability specifically excludes the cost of removal and/or installation of the Products.

(C) **THIS LIMITED WARRANTY IS EXCLUSIVE. THERE ARE NO OTHER WARRANTIES WITH RESPECT TO THE PRODUCTS, INCLUDING NO IMPLIED WARRANTIES OF MERCHANT-ABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.**

(D) This Limited Warranty only applies to the Products when the Products are installed in a single layer. **UNDER NO CIRCUMSTANCES, SHALL THE PRODUCTS BE INSTALLED IN A MULTI-LAYER CONFIGURATION.**

(E) No representative of StormTech has the authority to change this Limited Warranty in any manner or to extend this Limited Warranty. This Limited Warranty does not apply to any person other than to the Purchaser.

(F) Under no circumstances shall StormTech be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the Products, or the cost of other goods or services related to the purchase and installation of the Products. For this Limited Warranty to apply, the Products must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and StormTech's written installation instructions.

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SC-310/SC-740/DC-780

StormTech®
Detention • Retention • Water Quality
A division of ADS

# StormTech Construction Guide

## REQUIRED MATERIALS AND EQUIPMENT LIST

- Acceptable fill materials per **Table 1**
- Woven and non-woven geotextiles
- StormTech solid end caps and pre-cored end caps
- StormTech chambers
- StormTech manifolds and fittings

**IMPORTANT NOTES:**

**A. This installation guide provides the minimum requirements for proper installation of chambers. Non-adherence to this guide may result in damage to chambers during installation. Replacement of damaged chambers during or after backfilling is costly and very time consuming. It is recommended that all installers are familiar with this guide, and that the contractor inspects the chambers for distortion, damage and joint integrity as work progresses.**

**B. Use of a dozer to push embedment stone between the rows of chambers may cause damage to chambers and is not an acceptable backfill method. Any chambers damaged by using the "dump and push" method are not covered under the StormTech standard warranty.**

**C. Care should be taken in the handling of chambers and end caps. Avoid dropping, prying or excessive force on chambers during removal from pallet and initial placement.**

## Requirements for System Installation

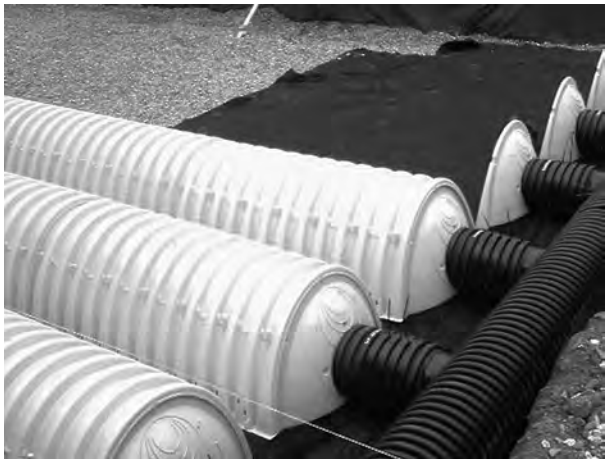
Excavate bed and prepare subgrade per engineer's plans.

Place non-woven geotextile over prepared soils and up excavation walls. Install underdrains if required.

Place clean, crushed, angular stone foundation 6" (150 mm) min. Compact to achieve a flat surface.

# Manifold, Scour Fabric and Chamber Assembly

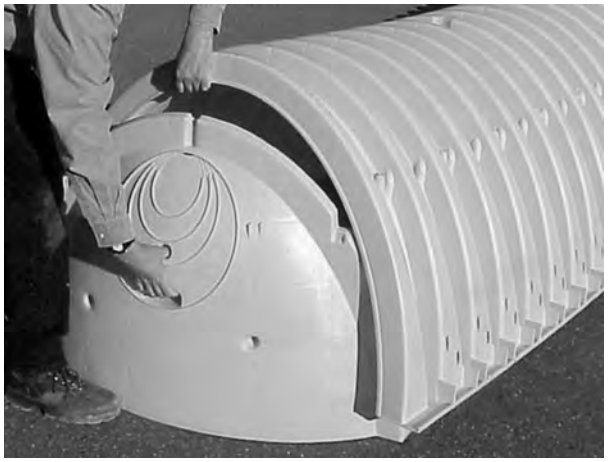
Install manifolds and lay out woven scour geotextile at inlet rows [min. 12.5 ft (3.8 m)] at each inlet end cap. Place a continuous piece (no seams, double layer) along entire length of Isolator® Row(s).



Align the first chamber and end cap of each row with inlet pipes. Contractor may choose to postpone stone placement around end chambers and leave ends of rows open for easy inspection of chambers during the backfill process.

Construct the chamber bed by overlapping the chambers lengthwise in rows. Attach chambers by overlapping the end corrugation of one chamber on to the end corrugation of the last chamber in the row. Be sure that the chamber placement does not exceed the reach of the construction equipment used to place the stone.

# Attaching the End Caps



Lift the end of the chamber a few inches off the ground. With the curved face of the end cap facing outward, place the end cap into the chamber's end corrugation.

# Prefabricated End Caps

24" (600 mm) inlets are the maximum size that can fit into a SC-740/DC-780 end cap and must be prefabricated with a 24" (600 mm) pipe stub. SC-310 chambers with a 12" (300 mm) inlet pipe must use a prefabricated end cap with a 12" (300 mm) pipe stub.

# Isolator Row

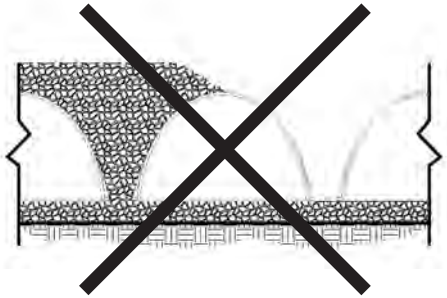
Drape a strip of ADS non-woven geotextile over the row of chambers (not required over DC-780). This is the same type of non-woven geotextile used as a separation layer around the angular stone of the StormTech system.

# Initial Anchoring of Chambers – Embedment Stone

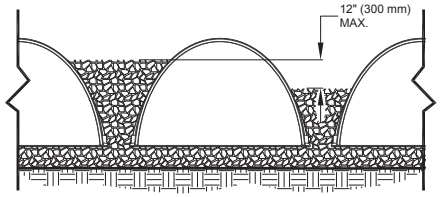
Initial embedment shall be spotted along the centerline of the chamber evenly anchoring the lower portion of the chamber. This is best accomplished with a stone conveyor or excavator reaching along the row.


No equipment shall be operated on the bed at this stage of the installation. Excavators must be located off the bed. Dump trucks shall not dump stone directly on to the bed. Dozers or loaders are not allowed on the bed at this time.

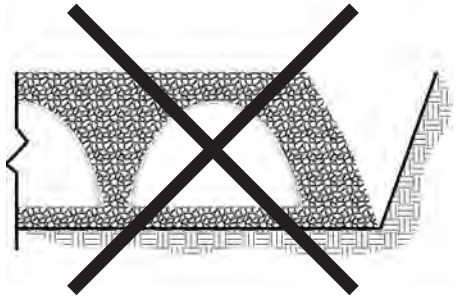
# Backfill of Chambers – Embedment Stone



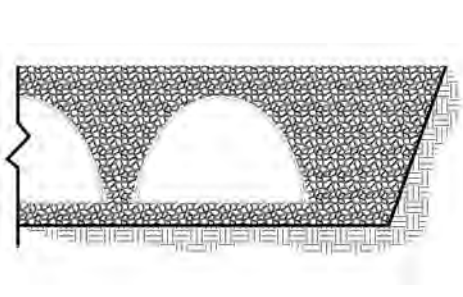
UNEVEN BACKFILL




EVEN BACKFILL



PERIMETER NOT BACKFILLED



PERIMETER FULLY BACKFILLED

Backfill chambers evenly. Stone column height should never differ by more than 12” (300 mm) between adjacent chamber rows or between chamber rows and perimeter.

Perimeter stone must be brought up evenly with chamber rows. Perimeter must be fully backfilled, with stone extended horizontally to the excavation wall.

# Backfill of Chambers – Embedment Stone and Cover Stone

Continue evenly backfilling between rows and around perimeter until embedment stone reaches tops of chambers. Perimeter stone must extend horizontally to the excavation wall for both straight or sloped sidewalls. **Only after chambers have been backfilled to top of chamber and with a minimum 6" (150 mm) of cover stone on top of chambers can small dozers be used over the chambers for backfilling remaining cover stone.**

Small dozers and skid loaders may be used to finish grading stone backfill in accordance with ground pressure limits in Table 2. They must push material parallel to rows only. Never push perpendicular to rows. StormTech recommends that the contractor inspect chambers before placing final backfill. Any chambers damaged by construction shall be removed & replaced.

# Final Backfill of Chambers – Fill Material

Install non-woven geotextile over stone. Geotextile must overlap 24" (600 mm) min. where edges meet. Compact each lift of backfill as specified in the site design engineer's drawings. Roller travel parallel with rows.

# StormTech Isolator Row Detail

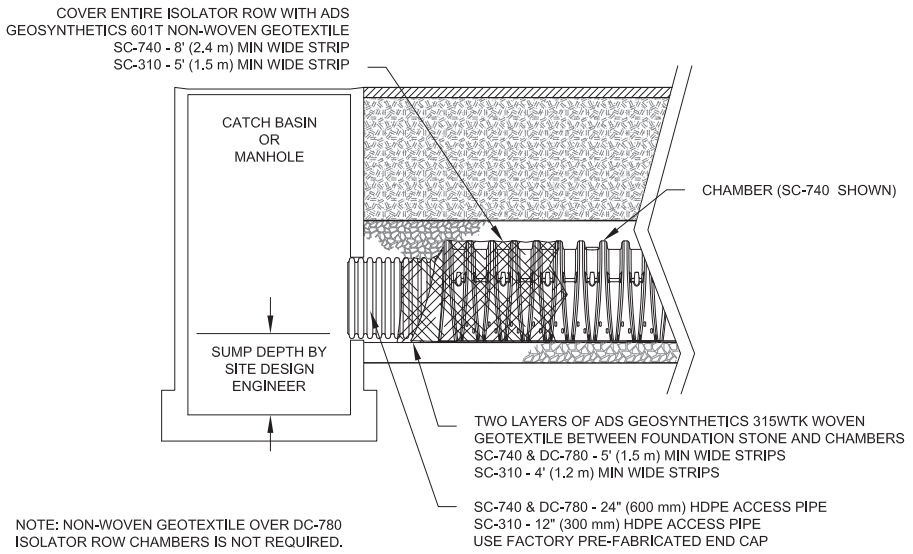


**Table 1 –** Acceptable Fill Materials

| Material Location | Description | AASHTO M43 Designation[1] | Compaction/Density Requirement |
|---|---|---|---|
| Ⓓ **Final Fill:** Fill Material for layer 'D' starts from the top of the 'C' layer to the bottom of flexible pavement or unpaved finished grade above. Note that the pavement subbase may be part of the 'D' layer. | Any soil/rock materials, native soils or per engineer's plans. Check plans for pavement subgrade requirements. | N/A | Prepare per site design engineer's plans. Paved installations may have stringent material and preparation requirements. |
| Ⓒ **Initial Fill:** Fill Material for layer 'C' starts from the top of the embedment stone ('B' layer) to 18" (450 mm) above the top of the chamber. Note that pavement subbase may be part of the 'C' layer. | Granular well-graded soil/aggregate mixtures, <35% fines or processed aggregate. Most pavement subbase materials can be used in lieu of this layer. | AASHTO M45 A-1, A-2-4, A-3 or AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10 | Begin compaction after min. 12" (300 mm) of material over the chambers is reached. Compact additional layers in 6" (150 mm) max. lifts to a min. 95% Proctor density for well-graded material and 95% relative density for processed aggregate materials. Roller gross vehicle weight not to exceed 12,000 lbs (53 kN). Dynamic force not to exceed 20,000 lbs (89 kN) |
| Ⓑ **Embedment Stone:** Embedment Stone surrounding chambers from the foundation stone to the 'C' layer above. | Clean, crushed, angular stone nominal size distribution | AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57 | No compaction required. |
| Ⓐ **Foundation Stone:** Foundation Stone below the chambers from the subgrade up to the foot (bottom) of the chamber. | Clean, crushed, angular stone, nominal size distribution | AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57 | Place and compact in 6" (150 mm) lifts using two full coverages with a vibratory compactor.[2,3] |

***PLEASE NOTE:***

1. ***The listed AASHTO designations are for gradations only. The stone must also be clean, crushed, angular. For example, a specification for #4 stone would state: "clean, crushed, angular no. 4 (AASHTO M43) stone".***
2. ***StormTech compaction requirements are met for 'A' location materials when placed and compacted in 6" (150 mm) (max) lifts using two full coverages with a vibratory compactor.***
3. ***Where infiltration surfaces may be comprised by compaction, for standard installations and standard design load conditions, a flat surface may be achieved by raking or dragging without compaction equipment. For special load designs, contact StormTech for compaction requirements.***

**Figure 1 –** Inspection Port Detail

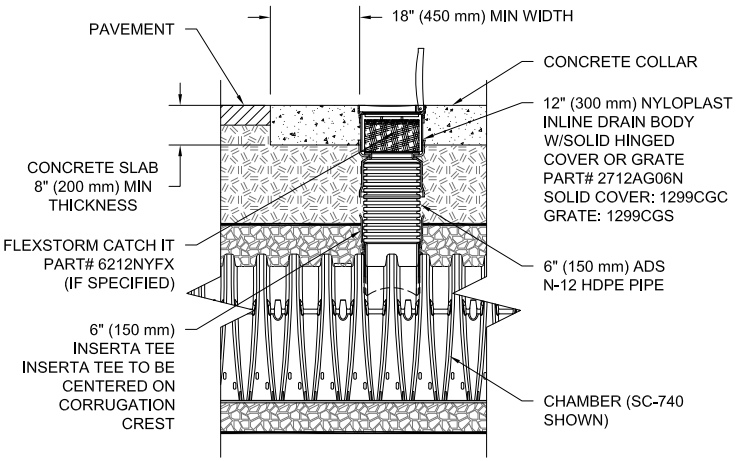
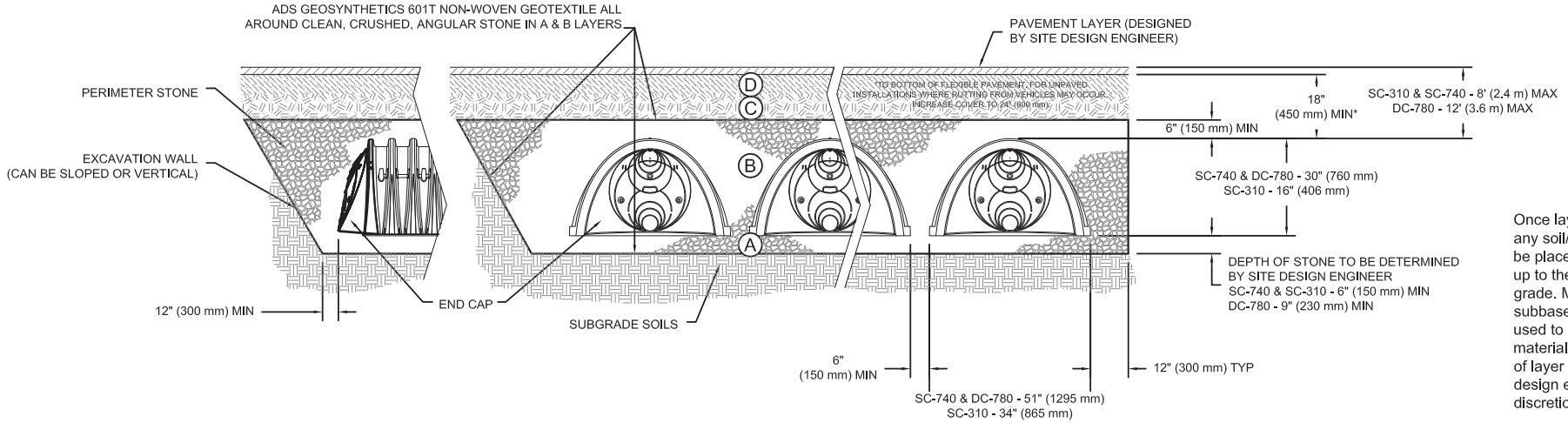



**Figure 2 –** Fill Material Locations




Once layer 'C' is placed any soil/material can be placed in layer 'D' up to the finished grade. Most pavement subbase soils can be used to replace the materials requirements of layer 'C' or 'D' at the design engineer's discretion.

***NOTES:***

1. *36" (900 mm) of stabilized cover materials over the chambers is required for full dump truck travel and dumping.*
2. *During paving operations, dump truck axle loads on 18" (450 mm) of cover may be necessary. Precautions should be taken to avoid rutting of the road base layer, to ensure that compaction requirements have been met, and that a minimum of 18" (450 mm) of cover exists over the chambers. Contact StormTech for additional guidance on allowable axle loads during paving.*
3. *Ground pressure for track dozers is the vehicle operating weight divided by total ground contact area for both tracks. Excavators will exert higher ground pressures based on loaded bucket weight and boom extension.*
4. *Mini-excavators (< 8,000lbs/3,628 kg) can be used with at least 12" (300 mm) of stone over the chambers and are limited by the maximum ground pressures in Table 2 based on a full bucket at maximum boom extension.*
5. *Storage of materials such as construction materials, equipment, spoils, etc. should not be located over the StormTech system. The use of equipment over the StormTech system not covered in Table 2 (ex. soil mixing equipment, cranes, etc) is limited. Please contact StormTech for more information.*
6. *Allowable track loads based on vehicle travel only. Excavators shall not operate on chamber beds until the total backfill reaches 3 feet (900 mm) over the entire bed.*

**Table 2 –** Maximum Allowable Construction Vehicle Loads[5]

| Material Location | Fill Depth over Chambers in. [mm] | Maximum Allowable Wheel Loads | | Maximum Allowable Track Loads[6] | | Maximum Allowable Roller Loads |
|---|---|---|---|---|---|---|
| | | Max Axle Load for Trucks lbs [kN] | Max Wheel Load for Loaders lbs [kN] | Track Width in. [mm] | Max Ground Pressure psf [kPa] | Max Drum Weight or Dynamic Force lbs [kN] |
| (D) Final Fill Material | 36" [900] Compacted | 32,000 [142] | 16,000 [71] | 12" [305]<br>18" [457]<br>24" [610]<br>30" [762]<br>36" [914] | 3420 [164]<br>2350 [113]<br>1850 [89]<br>1510 [72]<br>1310 [63] | 38,000 [169] |
| (C) Initial Fill Material | 24" [600] Compacted | 32,000 [142] | 16,000 [71] | 12" [305]<br>18" [457]<br>24" [610]<br>30" [762]<br>36" [914] | 2480 [119]<br>1770 [85]<br>1430 [68]<br>1210 [58]<br>1070 [51] | 20,000 [89] |
| | 24" [600] Loose/Dumped | 32,000 [142] | 16,000 [71] | 12" [305]<br>18" [457]<br>24" [610]<br>30" [762]<br>36" [914] | 2245 [107]<br>1625 [78]<br>1325 [63]<br>1135 [54]<br>1010 [48] | 20,000 [89]<br>Roller gross vehicle weight not to exceed 12,000 lbs. [53 kN] |
| | 18" [450] | 32,000 [142] | 16,000 [71] | 12" [305]<br>18" [457]<br>24" [610]<br>30" [762]<br>36" [914] | 2010 [96]<br>1480 [71]<br>1220 [58]<br>1060 [51]<br>950 [45] | 20,000 [89]<br>Roller gross vehicle weight not to exceed 12,000 lbs. [53 kN] |
| (B) Embedment Stone | 12" [300] | 16,000 [71] | NOT ALLOWED | 12" [305]<br>18" [457]<br>24" [610]<br>30" [762]<br>36" [914] | 1540 [74]<br>1190 [57]<br>1010 [48]<br>910 [43]<br>840 [40] | 20,000 [89]<br>Roller gross vehicle weight not to exceed 12,000 lbs. [53 kN] |
| | 6" [150] | 8,000 [35] | NOT ALLOWED | 12" [305]<br>18" [457]<br>24" [610]<br>30" [762]<br>36" [914] | 1070 [51]<br>900 [43]<br>800 [38]<br>760 [36]<br>720 [34] | NOT ALLOWED |

**Table 3 –** Placement Methods and Descriptions

| Material Location | Placement Methods/ Restrictions | Wheel Load Restrictions | Track Load Restrictions | Roller Load Restrictions |
|---|---|---|---|---|
| | | See Table 2 for Maximum Construction Loads | | |
| (D) Final Fill Material | A variety of placement methods may be used. All construction loads must not exceed the maximum limits in Table 2. | 36" (900 mm) minimum cover required for dump trucks to dump over chambers. | Dozers to push parallel to rows until 36" (900mm) compaced cover is reached.[4] | Roller travel parallel to rows only until 36" (900 mm) compacted cover is reached. |
| (C) Initial Fill Material | Excavator positioned off bed recommended. Small excavator allowed over chambers. Small dozer allowed. | Asphalt can be dumped into paver when compacted pavement subbase reaches 18" (450 mm) above top of chambers. | Small LGP track dozers & skid loaders allowed to grade cover stone with at least 6" (150 mm) stone under tracks at all times. Equipment must push parallel to rows at all times. | Use dynamic force of roller only after compacted fill depth reaches 12" (300 mm) over chambers. Roller travel parallel to chamber rows only. |
| (B) Embedment Stone | No equipment allowed on bare chambers. Use excavator or stone conveyor positioned off bed or on foundation stone to evenly fill around all chambers to at least the top of chambers. | No wheel loads allowed. Material must be placed outside the limits of the chamber bed. | No tracked equipment is allowed on chambers until a min. 6" (150 mm) cover stone is in place. | No rollers allowed. |
| (A) Foundation Stone | No StormTech restrictions. Contractor responsible for any conditions or requirements by others relative to subgrade bearing capacity, dewatering or protection of subgrade. | | | |

# Appendix F

## Allowed Bypass Analysis – Exhibits, Sizing Calculations, Cost Estimate and Product Information Sheets

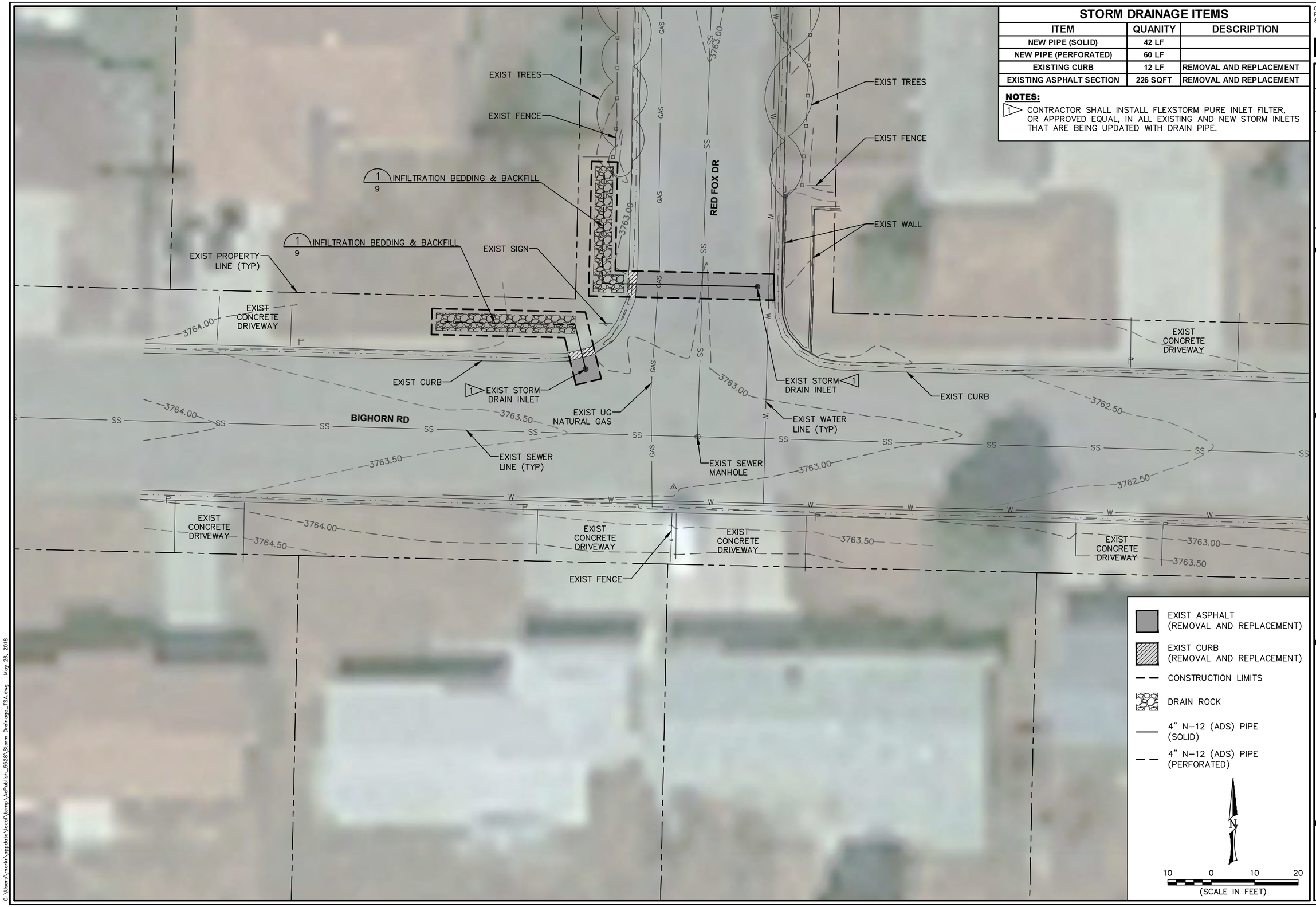
# Engineers Opinion of Probable Cost
# TREASURE STATE ACRES
## *ALLOWED BYPASS OPTION*

*Robert Peccia & Associates, Inc.*
*825 Custer Avenue * Helena * Montana * (406) 447-5000*
*102 Cooperative Way, Suite 300 * Kalispell * Montana * (406) 752-5025*

| Item No. | Quantity | Unit | Unit Description | Engineer's Estimate Unit Price (Figures) | Engineer's Estimate Total Price (Figures) |
|---|---|---|---|---|---|
| **Estimated Construction Costs** | | | | | |
| 1 | **80** | CY | 1 1/2" Drain Rock with Fabric | $50.00 | $4,000.00 |
| 2 | **715** | LF | Pipe - Buried: 4" Storm Drain - ADS N-12 | $35.00 | $25,025.00 |
| 3 | **14** | EA | Core Exisitng Inlet Structure | $100.00 | $1,400.00 |
| 4 | **2** | EA | 48" Slotted Drain Inlet with Drain Rock | $3,500.00 | $7,000.00 |
| 5 | **16** | EA | Inlet Filter Inserts | $500.00 | $8,000.00 |
| 6 | **686** | SF | Roadway Section Removal & Replacement (6-Feet Wide, 4" Asphalt, 12" Gravel) | $4.50 | $3,087.00 |
| 7 | **96** | LF | Curb & Gutter Removal & Replacement | $35.00 | $3,360.00 |
| 8 | **22** | LF | Fence Removal/Replacement | $10.00 | $220.00 |
| 9 | **8** | EA | Surface Restoration - Topsoil & Seeding (Per Intersection) | $1,000.00 | $8,000.00 |
| 10 | **3** | EA | Sign Removal/Relocation | $100.00 | $300.00 |
| 11 | **16** | DAY | Traffic Control | $250.00 | $4,000.00 |
| 12 | **1** | LS | Mobilization (10%) | $6,400.00 | $6,400.00 |
| 13 | **1** | LS | Project Contingency (25%) | $17,700.00 | $17,700.00 |
| | | | | *Subtotal =* | $88,492.00 |
| **Estimated Engineering Costs (25%)** | | | | | |
| 1 | **1** | LS | Preliminary Design Phase (2%) | $1,800.00 | $1,800.00 |
| 2 | **1** | LS | Design Phase (15%) | $13,300.00 | $13,300.00 |
| 3 | **1** | LS | Bid to Award Phase (4%) | $3,500.00 | $3,500.00 |
| 4 | **1** | LS | Construction Engineering Phase (4%) | $3,500.00 | $3,500.00 |
| | | | | *Subtotal =* | $22,100.00 |
| | | | | **TOTAL ESTIMATED PROJECT COST (ROUNDED) =** | **$110,600.00** |

Treasure State Acres
Allowed Bypass Option - Infiltation Bed Performance

| INTERSECTION | Infiltration Bed Percolation Rate (min/in) | Infiltration Bed Surface Area (square feet) | Water Volume Infiltrated in 60 minuets (cubic feet) | Water Volume Infiltrated in 60 minuets (gallons) | Sump Area Water Drawdown Time (hours) (10' x 10' area, 6 inches deep) | Instersection Area Water Drawdown Time (hours) (30' x 30' area, 3 inches deep) |
|---|---|---|---|---|---|---|
| Bighorn & Red Fox | 21.90 | 256 | 58 | 437 | 0.9 | 3.8 |
| Bighorn & Cougar | 12.50 | 256 | 102 | 766 | 0.5 | 2.2 |
| E Otter & Red Fox | 31.30 | 256 | 41 | 306 | 1.2 | 5.5 |
| Kodiak & Red Fox | 17.15 | 256 | 75 | 558 | 0.7 | 3.0 |
| Kodiak & Cougar | 17.15 | 256 | 75 | 558 | 0.7 | 3.0 |
| Cayuse & Red Fox | 3.00 | 256 | 427 | 3191 | 0.1 | 0.5 |
| Mustang & Red Fox | 3.00 | 256 | 427 | 3191 | 0.1 | 0.5 |
| Cayuse & Wolverine | 25.00 | 256 | 51 | 383 | 1.0 | 4.4 |




## STORM DRAINAGE ITEMS

| ITEM | QUANITY | DESCRIPTION |
|---|---|---|
| NEW PIPE (SOLID) | 42 LF | |
| NEW PIPE (PERFORATED) | 60 LF | |
| EXISTING CURB | 12 LF | REMOVAL AND REPLACEMENT |
| EXISTING ASPHALT SECTION | 226 SQFT | REMOVAL AND REPLACEMENT |

**NOTES:**

1. CONTRACTOR SHALL INSTALL FLEXSTORM PURE INLET FILTER, OR APPROVED EQUAL, IN ALL EXISTING AND NEW STORM INLETS THAT ARE BEING UPDATED WITH DRAIN PIPE.

EXIST ASPHALT (REMOVAL AND REPLACEMENT)

EXIST CURB (REMOVAL AND REPLACEMENT)

CONSTRUCTION LIMITS

DRAIN ROCK

4" N-12 (ADS) PIPE (SOLID)

4" N-12 (ADS) PIPE (PERFORATED)

N

10 0 10 20

(SCALE IN FEET)



RPA

| SYM | REVISION | BY | APPR. | DATE |
|---|---|---|---|---|
| | PRELIMINARY NOT FOR CONSTRUCTION | | | |

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R.MITCHELL CHECKED BY
MAY 2016 DATE
10501.018 PROJECT NO.
Storm Drainage_TSA FILE

PROJECT TITLE

**TREASURE STATE ACRES**
**STORM DRAINAGE PLANNING**
*Helena, Montana*

SHEET TITLE

**BIGHORN & RED FOX INTERSECTION**

SHEET

**1**

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## STORM DRAINAGE ITEMS

| ITEM | QUANITY | DESCRIPTION |
|---|---|---|
| NEW PIPE (SOLID) | 20 LF | |
| NEW PIPE (PERFORATED) | 60 LF | |
| EXISTING CURB | 12 LF | REMOVAL AND REPLACEMENT |
| EXISTING ASPHALT SECTION | 36 SQFT | REMOVAL AND REPLACEMENT |
| EXISTING FENCE | 22 LF | REMOVAL AND RESETTING |

**NOTES:**

1. CONTRACTOR SHALL INSTALL FLEXSTORM PURE INLET FILTER, OR APPROVED EQUAL, IN ALL EXISTING AND NEW STORM INLETS THAT ARE BEING UPDATED WITH DRAIN PIPE.

EXIST FENCE
EXIST CONCRETE DRIVEWAY
EXIST MAILBOX
EXIST CONCRETE SIDEWALK
1/9 INFILTRATION BEDDING & BACKFILL
EXIST PROPERTY LINE (TYP)
EXIST TREES
EXIST CURB
COUGAR DR
EXIST STORM DRAIN INLET
EXIST CONCRETE DRIVEWAY
BIGHORN RD
EXIST WATER LINE (TYP)
EXIST SEWER LINE (TYP)
EXIST SEWER MANHOLE
EXIST UG NATURAL GAS
EXIST FENCE
EXIST CONCRETE DRIVEWAY
EXIST CONCRETE SIDEWALK
EXIST CONCRETE DRIVEWAY
EXIST MAILBOX
1/9 INFILTRATION BEDDING & BACKFILL

3761.00 3761.50 3762.00 3762.50 3763.00 3763.50

SS W GAS P

EXIST ASPHALT (REMOVAL AND REPLACEMENT)
EXIST CURB (REMOVAL AND REPLACEMENT)
CONSTRUCTION LIMITS
DRAIN ROCK
4" N-12 (ADS) PIPE (SOLID)
4" N-12 (ADS) PIPE (PERFORATED)

N

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(SCALE IN FEET)



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**BIGHORN & COUGAR INTERSECTION**

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**2**

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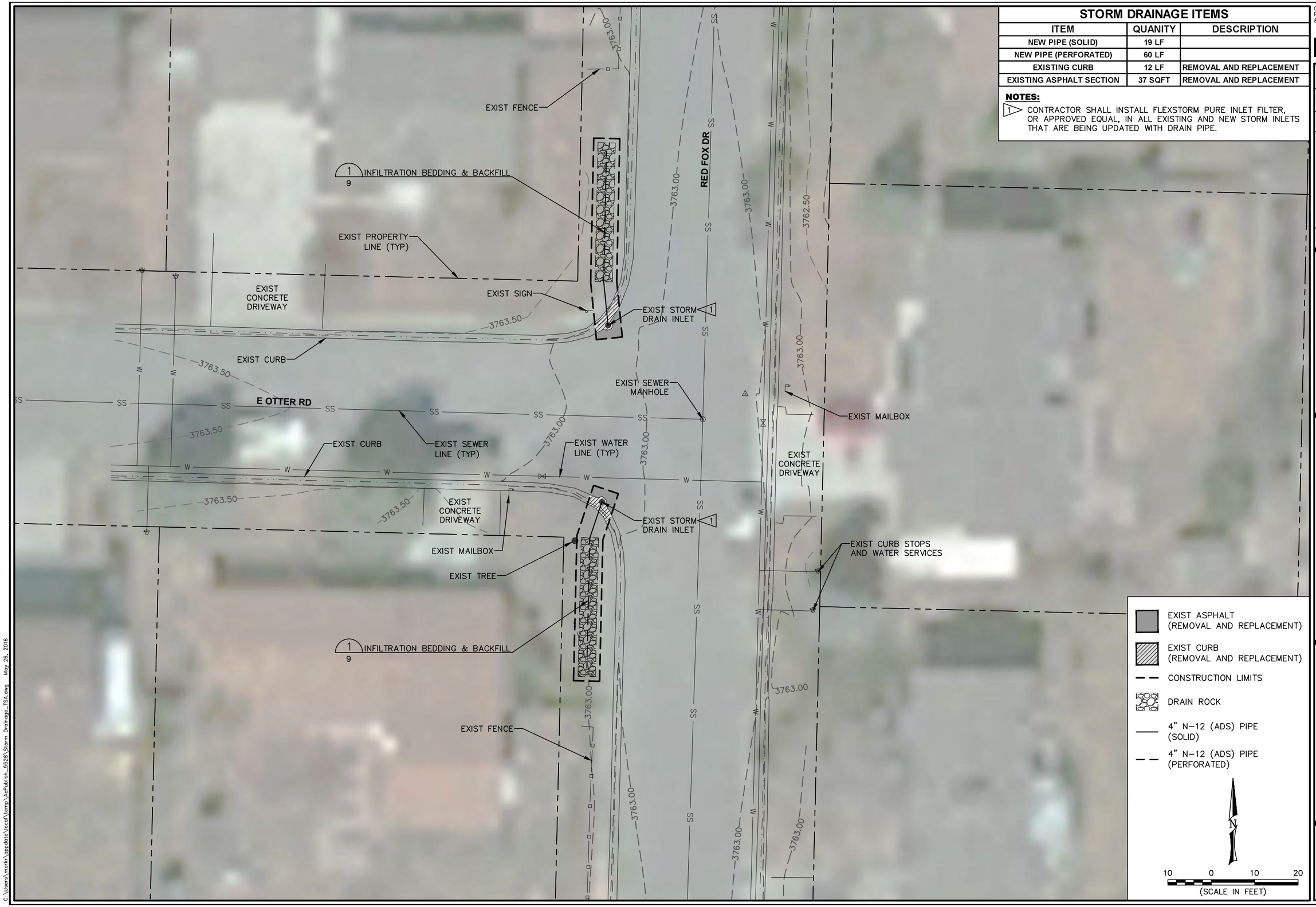


## STORM DRAINAGE ITEMS

| ITEM | QUANITY | DESCRIPTION |
|---|---|---|
| NEW PIPE (SOLID) | 19 LF | |
| NEW PIPE (PERFORATED) | 60 LF | |
| EXISTING CURB | 12 LF | REMOVAL AND REPLACEMENT |
| EXISTING ASPHALT SECTION | 37 SQFT | REMOVAL AND REPLACEMENT |

**NOTES:**

1. CONTRACTOR SHALL INSTALL FLEXSTORM PURE INLET FILTER, OR APPROVED EQUAL, IN ALL EXISTING AND NEW STORM INLETS THAT ARE BEING UPDATED WITH DRAIN PIPE.



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**3**

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## STORM DRAINAGE ITEMS

| ITEM | QUANITY | DESCRIPTION |
|---|---|---|
| NEW PIPE (SOLID) | 20 LF | |
| NEW PIPE (PERFORATED) | 60 LF | |
| EXISTING CURB | 12 LF | REMOVAL AND REPLACEMENT |
| EXISTING ASPHALT SECTION | 40 SQFT | REMOVAL AND REPLACEMENT |
| EXISTING SIGN | 1 | REMOVAL AND RESETTING |

**NOTES:**

1. CONTRACTOR SHALL INSTALL FLEXSTORM PURE INLET FILTER, OR APPROVED EQUAL, IN ALL EXISTING AND NEW STORM INLETS THAT ARE BEING UPDATED WITH DRAIN PIPE.

1 INFILTRATION BEDDING & BACKFILL 9

EXIST PROPERTY LINE (TYP)

EXIST CONCRETE DRIVEWAY

EXIST CURB

EXIST SIGN

EXIST STORM DRAIN INLET 1

RED FOX DR

EXIST FENCE

EXIST CONCRETE SIDEWALK

EXIST CONCRETE DRIVEWAY

KODIAK RD

EXIST SEWER LINE (TYP)

EXIST SEWER MANHOLE

EXIST WATER LINE (TYP)

EXIST CURB

EXIST STORM DRAIN INLET 1

EXIST MAILBOX

EXIST CONCRETE DRIVEWAY

EXIST MAILBOX

EXIST GRAVEL DRIVEWAY

EXIST CURB STOPS AND WATER SERVICES

1 INFILTRATION BEDDING & BACKFILL 9

EXIST FENCE

EXIST TREES

3761.00 3761.50 3762.00 3762.50 3760.50 3761.00

SS W P

EXIST ASPHALT (REMOVAL AND REPLACEMENT)

EXIST CURB (REMOVAL AND REPLACEMENT)

CONSTRUCTION LIMITS

DRAIN ROCK

4" N–12 (ADS) PIPE (SOLID)

4" N–12 (ADS) PIPE (PERFORATED)

N

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(SCALE IN FEET)

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**4**

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## STORM DRAINAGE ITEMS

| ITEM | QUANITY | DESCRIPTION |
|---|---|---|
| NEW INLET | 1 | |
| NEW PIPE (SOLID) | 52 LF | |
| NEW PIPE (PERFORATED) | 60 LF | |
| EXISTING CURB | 12 LF | REMOVAL AND REPLACEMENT |
| EXISTING ASPHALT SECTION | 203 SQFT | REMOVAL AND REPLACEMENT |

**NOTES:**

1. CONTRACTOR SHALL INSTALL FLEXSTORM PURE INLET FILTER, OR APPROVED EQUAL, IN ALL EXISTING AND NEW STORM INLETS THAT ARE BEING UPDATED WITH DRAIN PIPE.

EXIST MAILBOX
2/9 SLOTTED DRAIN INLET
EXIST CONCRETE DRIVEWAY
EXIST PROPERTY LINE (TYP)
EXIST CONCRETE SIDEWALK
EXIST CONCRETE DRIVEWAY
EXIST CONCRETE DRIVEWAY
EXIST CURB
KODIAK RD
EXIST CURB
EXIST GRAVE DRIVEWAY
EXIST CONCRETE DRIVEWAY
EXIST CONCRETE SIDEWALK
EXIST MAILBOX
EXIST CURB STOP AND WATER SERVICE
EXIST TREE
1/9 INFILTRATION BEDDING & BACKFILL
COUGAR DR
EXIST CONCRETE DRIVEWAY
EXIST MAILBOX
EXIST SEWER LINE (TYP)
EXIST SEWER MANHOLE
EXIST WATER LINE (TYP)
EXIST STORM DRAIN INLET 1
EXIST SIGN
EXIST CURB STOPS AND WATER SERVICES
EXIST MAILBOX
EXIST CONCRETE DRIVEWAY
3760.00
3759.50
3759.00
3758.50

EXIST ASPHALT (REMOVAL AND REPLACEMENT)
EXIST CURB (REMOVAL AND REPLACEMENT)
CONSTRUCTION LIMITS
DRAIN ROCK
4" N-12 (ADS) PIPE (SOLID)
4" N-12 (ADS) PIPE (PERFORATED)

N

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(SCALE IN FEET)

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| | PRELIMINARY NOT FOR CONSTRUCTION | | | |

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**KODIAK & COUGAR INTERSECTION**

SHEET
**5**

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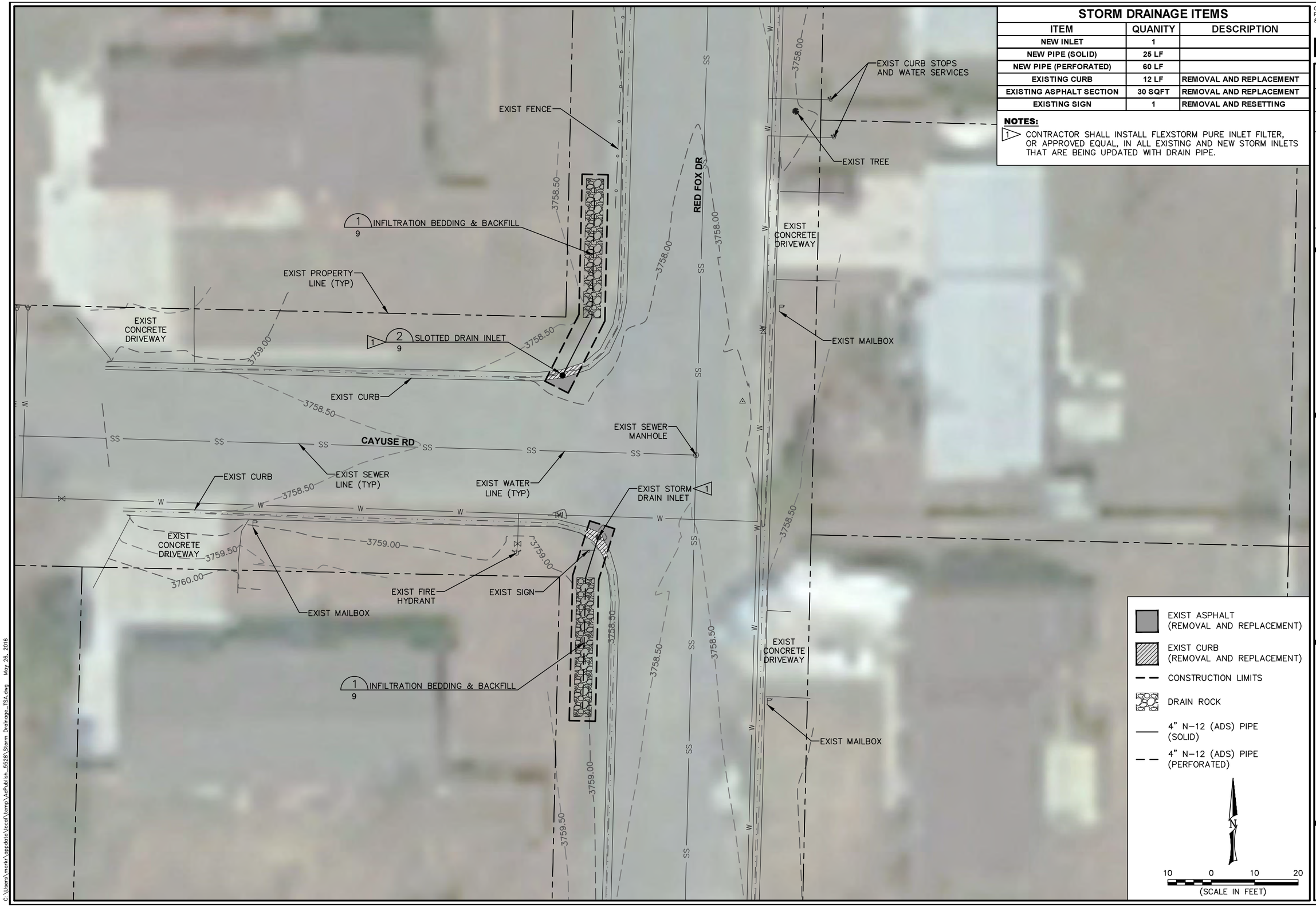


## STORM DRAINAGE ITEMS

| ITEM | QUANITY | DESCRIPTION |
|---|---|---|
| NEW INLET | 1 | |
| NEW PIPE (SOLID) | 25 LF | |
| NEW PIPE (PERFORATED) | 60 LF | |
| EXISTING CURB | 12 LF | REMOVAL AND REPLACEMENT |
| EXISTING ASPHALT SECTION | 30 SQFT | REMOVAL AND REPLACEMENT |
| EXISTING SIGN | 1 | REMOVAL AND RESETTING |

**NOTES:**

1. CONTRACTOR SHALL INSTALL FLEXSTORM PURE INLET FILTER, OR APPROVED EQUAL, IN ALL EXISTING AND NEW STORM INLETS THAT ARE BEING UPDATED WITH DRAIN PIPE.

EXIST ASPHALT (REMOVAL AND REPLACEMENT)

EXIST CURB (REMOVAL AND REPLACEMENT)

CONSTRUCTION LIMITS

DRAIN ROCK

4" N-12 (ADS) PIPE (SOLID)

4" N-12 (ADS) PIPE (PERFORATED)

N

10 0 10 20

(SCALE IN FEET)



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**CAYUSE & RED FOX INTERSECTION**

SHEET
**6**

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## STORM DRAINAGE ITEMS

| ITEM | QUANITY | DESCRIPTION |
|---|---|---|
| NEW PIPE (SOLID) | 23 LF | |
| NEW PIPE (PERFORATED) | 60 LF | |
| EXISTING CURB | 12 LF | REMOVAL AND REPLACEMENT |
| EXISTING ASPHALT SECTION | 36 SQFT | REMOVAL AND REPLACEMENT |
| EXISTING SIGN | 1 | REMOVAL AND RESETTING |

**NOTES:**

1. CONTRACTOR SHALL INSTALL FLEXSTORM PURE INLET FILTER, OR APPROVED EQUAL, IN ALL EXISTING AND NEW STORM INLETS THAT ARE BEING UPDATED WITH DRAIN PIPE.

EXIST CONCRETE DRIVEWAY
EXIST CURB STOP AND WATER SERVICE
EXIST PROPERTY LINE (TYP)
1/9 INFILTRATION BEDDING & BACKFILL
EXIST CONCRETE SIDEWALK
EXIST MAILBOX
EXIST CURB
1 EXIST STORM DRAIN INLET
EXIST SEWER MANHOLE
MUSTANG RD
EXIST SEWER LINE (TYP)
EXIST CURB
EXIST WATER LINE (TYP)
EXIST STORM DRAIN INLET 1
EXIST CONCRETE DRIVEWAY
EXIST MAILBOX
EXIST SIGN
EXIST TREE
EXIST CURB STOP AND WATER SERVICE
1/9 INFILTRATION BEDDING & BACKFILL
EXIST CONCRETE DRIVEWAY
RED FOX DR
EXIST CURB STOPS AND WATER SERVICES
EXIST CONCRETE DRIVEWAY
EXIST CURB STOP AND WATER SERVICE
EXIST TREES
EXIST ASPHALT DRIVEWAY
EXIST MAILBOX
3756.50
3757.00
3757.50
3758.00
3758.50

EXIST ASPHALT (REMOVAL AND REPLACEMENT)
EXIST CURB (REMOVAL AND REPLACEMENT)
CONSTRUCTION LIMITS
DRAIN ROCK
4" N–12 (ADS) PIPE (SOLID)
4" N–12 (ADS) PIPE (PERFORATED)

N

10 0 10 20
(SCALE IN FEET)

| SYM | REVISION | BY | APPR. | DATE |
|---|---|---|---|---|
| | PRELIMINARY NOT FOR CONSTRUCTION | | | |

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PROJECT TITLE
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**STORM DRAINAGE PLANNING**
*Helena, Montana*

SHEET TITLE
**MUSTANG & RED FOX INTERSECTION**

SHEET
**7**

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## STORM DRAINAGE ITEMS

| ITEM | QUANITY | DESCRIPTION |
|---|---|---|
| NEW PIPE (SOLID) | 34 LF | |
| NEW PIPE (PERFORATED) | 60 LF | |
| EXISTING CURB | 12 LF | REMOVAL AND REPLACEMENT |
| EXISTING ASPHALT SECTION | 38 SQFT | REMOVAL AND REPLACEMENT |

**NOTES:**

1. CONTRACTOR SHALL INSTALL FLEXSTORM PURE INLET FILTER, OR APPROVED EQUAL, IN ALL EXISTING AND NEW STORM INLETS THAT ARE BEING UPDATED WITH DRAIN PIPE.

WOLVERINE DR
CAYUSE RD
EXIST CONCRETE DRIVEWAY
EXIST CURB STOP AND WATER SERVICE
EXIST TREE
EXIST FENCE
EXIST PHONE PEDESTAL
EXIST CONCRETE SIDEWALK
EXIST MAILBOX
EXIST UG POWER
EXIST UG PHONE AND CABLE
EXIST SEWER MANHOLE
EXIST POWER PEDESTAL
EXIST STORM DRAIN INLET
EXIST PROPERTY LINE (TYP)
EXIST SEWER LINE (TYP)
EXIST WATER LINE (TYP)
EXIST CURB
EXIST UG PHONE
EXIST UG NATURAL GAS
EXIST SIGN
EXIST FIRE HYDRANT
1 9 INFILTRATION BEDDING & BACKFILL

EXIST ASPHALT (REMOVAL AND REPLACEMENT)
EXIST CURB (REMOVAL AND REPLACEMENT)
CONSTRUCTION LIMITS
DRAIN ROCK
4" N–12 (ADS) PIPE (SOLID)
4" N–12 (ADS) PIPE (PERFORATED)

10 0 10 20
(SCALE IN FEET)

| SYM | REVISION | BY | APPR. | DATE |
|---|---|---|---|---|
| | PRELIMINARY NOT FOR CONSTRUCTION | | | |

B.THEIS DESIGNED BY
MAY 2016 DATE
M.ROGERS DRAWN BY
10501.018 PROJECT NO.
R.MITCHELL CHECKED BY
Storm Drainage_TSA FILE

PROJECT TITLE
**TREASURE STATE ACRES STORM DRAINAGE PLANNING**
*Helena, Montana*

SHEET TITLE
**CAYUSE & WOLVERINE INTERSECTION**

SHEET
**8**

C:\Users\rmarker\appdata\local\temp\AcPublish_5528\Storm Drainage_TSA.dwg May 26, 2016

**NOTES:**

1. VERIFY THAT COMPACTION METHODS ARE COMPARABLE WITH PIPE MANUFACTURER'S RECOMMENDATIONS. ANY DAMAGE TO THE PIPE WILL BE THE CONTRACTOR'S RESPONSIBILITY.

2. TRENCH SHALL BE CONSTRUCTED TO OSHA SPECIFICATIONS FOR EXCAVATION. DRAWINGS DO NOT SHOW TRENCH DIMENSIONS OR BACKSLOPES THAT MAY BE REQUIRED. CONTRACTOR REQUIRED TO DETERMINE WHICH OSHA SPECIFICATIONS ARE APPLICABLE. CONTRACTOR SHALL BE RESPONSIBLE FOR TRENCH EXCAVATION AND SAFETY PER OSHA SPECIFICATIONS.

3. ALL SPOILS SHALL BE REMOVED AND DISPOSED OF AT AN APPROVED LOCATION.

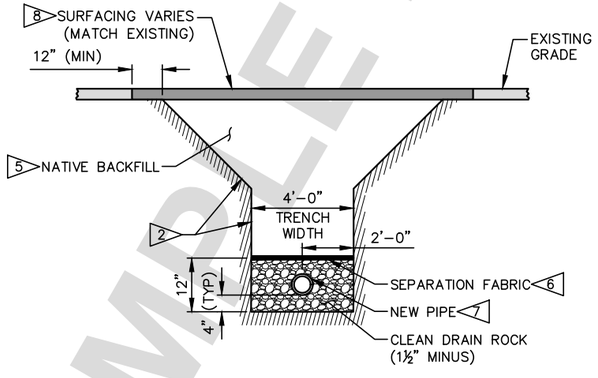
4. ALL ROCKS GREATER THAN 12" IN ANY DIMENSION SHALL BE HAULED OFF SITE AND DISPOSED OF PROPERLY.

5. NO ROCKS OR LUMPS LARGER THAN 2" IN ANY DIMENSION SHALL BE ALLOWED WITHIN 4" OF THE PIPE.

6. MIRAFI 180N GEOTEXTILE FABRIC, OR APPROVED EQUAL.

7. 4" N-12 PIPE, OR APPROVED EQUAL. CONTRACTOR SHALL USE PERFORATED PIPE IN TRENCH AREAS THAT INCLUDE 12" OF CLEAN DRAIN ROCK ON BOTTOM.

8. FINISHED GRADE MUST MATCH THE ORIGINAL EXISTING SURFACING AND GRADE WHERE PIPE IS INSTALLED UNLESS OTHERWISE NOTED.




## INFILTRATION BEDDING & BACKFILL (1)

SCALE: NONE

1-8

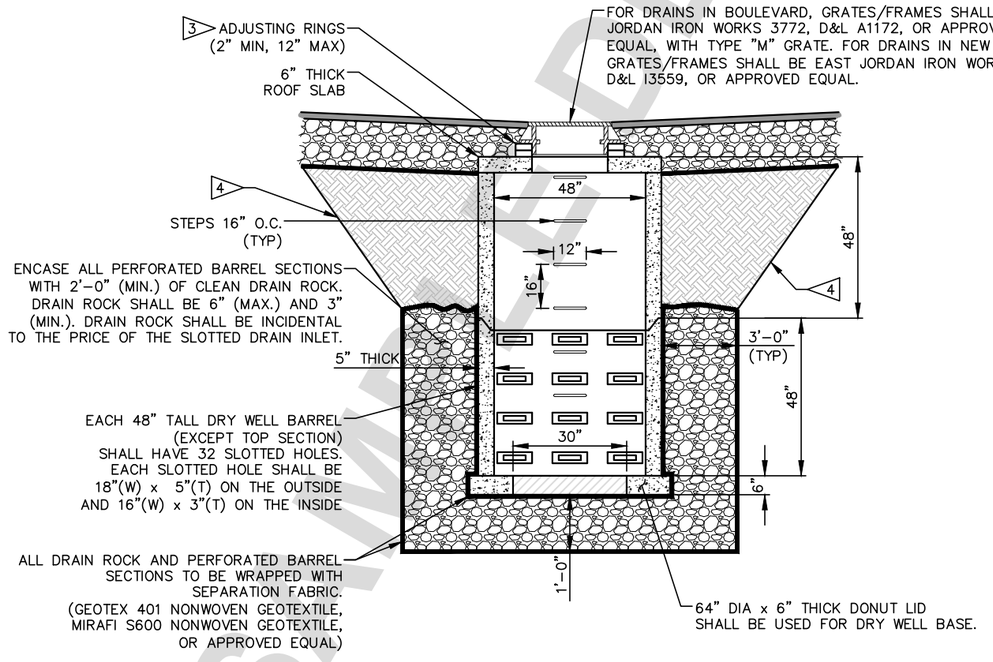
**NOTES:**

1. ALL HOLES IN NEW INLETS SHALL BE CAST OR CORED.

2. PRECAST REINFORCED CONCRETE SHALL CONFORM TO ASTM C-478.

3. FIELD SET ADJUSTMENT RINGS TO MATCH STREET/FINISHED GROUND.

4. TRENCH SHALL BE CONSTRUCTED TO OSHA SPECIFICATIONS FOR EXCAVATION. DRAWINGS DO NOT SHOW TRENCH DIMENSIONS OR BACKSLOPES THAT MAY BE REQUIRED. CONTRACTOR REQUIRED TO DETERMINE WHICH OSHA SPECIFICATIONS ARE APPLICABLE. CONTRACTOR SHALL BE RESPONSIBLE FOR TRENCH EXCAVATION AND SAFETY PER OSHA SPECIFICATIONS.




## SLOTTED DRAIN INLET (48") (2)

SCALE: NONE

5-6





RPA

| SYM | REVISION | BY | APPR. | DATE |
|---|---|---|---|---|
| | PRELIMINARY NOT FOR CONSTRUCTION | | | |

B.THEIS DESIGNED BY
M.ROGERS DRAWN BY
R.MITCHELL CHECKED BY
MAY 2016 DATE
10501.018 PROJECT NO.
Storm Drainage_TSA FILE

PROJECT TITLE
**TREASURE STATE ACRES STORM DRAINAGE PLANNING**
*Helena, Montana*

SHEET TITLE
**SAMPLE DETAILS**

SHEET
**9**

# Appendix G

## SK Geotechnical Report for the Treasure State Acres Subdivision, April 22, 2016

2511 Holman Avenue
P. O. Box 80190
Billings, Montana 59108-0190
p: 406.652.3930; f: 406.652.3944
www.skgeotechnical.com

April 22, 2016 Project 16-3444D

Mr. Eric Griffin
Public Works Director
Lewis and Clark County
3402 Cooney Drive
Helena, Montana 59602

Dear Mr. Griffin:

Re: Revised Soil Borings and Downhole Percolation Test Results, Treasure State Acres, Helena, Montana

The soil borings and downhole percolation tests you authorized on February 25, 2016, have been completed. The purpose of the soil borings and percolation tests was to assist Lewis and Clark County and their consultant, Robert Peccia & Associates (RPA), in evaluating storm water drainage improvements within the subdivision. These services were performed in general accordance with our Professional Services Contract signed in February 2016. The report was revised to include pavement sections on the boring logs.

## Project Information

Treasure State Acres is a residential subdivision located on the north side of Helena, Montana. Based on discussions with local community members, it is our understanding the roads through the subdivision experience flooding problems during significant storm events. RPA is completing storm water planning in the subdivision for Lewis and Clark County. The soil borings and downhole percolation tests were performed to assist RPA in evaluating potential infiltration systems.

## Field Procedures

RPA staked eight borings throughout the subdivision in groups of two: one boring to 15 feet to evaluate subsurface strata followed by a nearby shallower boring to run a downhole percolation test. The borings were generally performed at the staked locations, and these locations are shown on the attached Boring Location Sketch. The exception to this was Borings ST-1B and ST-2B, which had to be moved around the corner of the intersection due to utilities. The borings were performed on March 14 through 16, 2016, with our Diedrich D-120 drill rig. Penetration tests were conducted in the borings in accordance with the American Society for Testing and Materials (ASTM) Method of Test D 1586, "Standard Penetration Test and Split-Barrel Sampling of Soils."

While drilling, the soils encountered by the borings were visually and manually classified by a geotechnical engineering assistant. The classifications were performed in accordance with ASTM D 2488, "Standard Practice for Description and Identification of Soils (Visual – Manual Procedures)." A summary of the ASTM Classification system is attached.

After completing a deeper boring to evaluate subsurface conditions and faster percolation rate soils, a nearby boring was then performed for downhole percolation test. The percolation tests were performed in general accordance with the Montana Department of Environmental Quality (MDEQ) Circular 4, 2013 Edition, and the results are provided later in the report. The tests were performed at depths ranging from 2 1/2 to 5 feet below our 4 1/4-inch I.D. hollow-stem auger, which basically served as casing. The advantage is borings disturb significantly less pavement than test pits. We would drill to the desired test depth, then back the auger up by 6 to 8 inches, and place 2 inches of gravel in the bottom. The test hole was then saturated. After saturating, water was routed in the auger and allowed to infiltrate the underlying soils while the drop in water level was measured. The test was run with a 6-inch head.

In addition to the percolation tests, we also obtained a sample of the subsurface soils directly above the percolation test depth. These samples were returned to our laboratory for classification tests.

## Laboratory Procedures

Laboratory moisture content tests were performed on samples obtained from the borings. A moisture content profile was determined for the deeper borings. Moisture content tests were also performed on the classification sample from the percolation test boring. The classification tests consisted of a sieve/hydrometer test. The results of the moisture content and classification tests are shown on the attached Log of Boring sheets and graphs.

## Results

**General.** Log of Boring sheets indicating the depth and identification of the various soil strata, penetration resistances, laboratory test data, and water level information are attached. It should be noted, the depths shown as boundaries between the strata are only approximate. The actual changes may be transitions and the depths of the changes may vary between the borings. Geologic origins presented for each stratum on the Log of Boring sheets are based on the soil types, blows per foot, and the available common knowledge of the depositional history of the site. Because of the complex glacial and post-glacial depositional environments, geologic origins are frequently difficult to ascertain. A detailed evaluation of the geologic history of the site was not performed.

**Pavement.** The borings encountered 3 3/4 to 5 1/4 inches of asphalt pavement over 2 1/2 to 5 inches of base course. The average pavement section is as follows.

| | |
|---|---|
| Asphalt Pavement | 4 1/2" |
| Base Course | 4" |
| **Total Pavement Section** | **8 1/2"** |

**Soils.** Borings ST-1B and ST-2B were performed near the intersection of Wolverine Drive and Cayuse Road. The general soil profile encountered in these two borings was 2 to 2 1/2 feet of clayey sand and sandy lean clay fill followed by silty sand with gravel to depths of 15 1/2 feet. Penetration resistances in these soils indicated the upper sandy lean clay had a medium consistency, the clayey sand was medium dense, and the silty sand with gravel was medium dense to very dense.

Borings ST-3 and ST-4 were performed near the intersection of Cayuse Road and Red Fox Drive. The general soil profile encountered in these borings was 1 1/2 feet of clayey gravel fill followed by poorly graded gravel with sand to depths between 2 1/2 and 3 1/2 feet over poorly graded sand with silt and gravel to 15 1/2 feet. Penetration resistances recorded in these soils indicated the upper clayey gravel fill was loose, the poorly graded gravel with sand alluvium was medium dense, and the poorly graded sand with silt was medium dense to dense.

Borings ST-5 and ST-6 were performed near the intersection of Otter Road and Red Fox Drive. The general soil profile encountered in these borings was 3 1/2 feet of lean clay with sand fill followed by silty sand with gravel alluvium to 12 feet. One-foot layers of sandy lean clay, clayey sand, and silt were then encountered to the borings' termination depth of 15 1/2 feet. Based on penetration resistances recorded, the lean clay with sand fill had a medium consistency, the silty sand with gravel was medium dense to very dense, the sandy lean clay alluvium was rather stiff, and the clayey sand and silt alluvium were loose.

Borings ST-7 and ST-8 were performed near the intersection of Big Horn Road and Cougar Drive. The general soil profile encountered in these borings was 2 feet of lean clay with sand fill followed by 1 1/2 to 2 feet of clayey sand with gravel. Silty sand with gravel was then encountered to 8 1/2 feet followed by a silty sand to 11 feet. Silty gravel with sand was then encountered to 14 1/2 feet followed by a 1 foot thick layer of clayey sand. The penetration resistances recorded in the borings indicated the lean clay with sand fill was soft, the clayey sand, silty sand, and silty gravel alluvium were loose, and the silty sand with gravel was medium dense to dense.

**Groundwater Observations.** Groundwater was encountered in Boring ST-3 near the intersection of Cayuse Road and Red Fox Drive. The depth of the groundwater was 13.1 feet from the surface of the boring. We anticipate groundwater levels could fluctuate several feet during the wetter months of the year.

**Laboratory Tests.**

***Moisture Content Tests.*** Moisture content tests were performed on the penetration test samples obtained in all borings. The results of these tests are shown on the attached Log of Boring sheets. The moisture contents of the clayey gravel, clayey sand, sandy lean clay, clayey gravel, and lean clay with sand ranged from about 3 to 17 1/2 percent, but primarily ranged from about 13 to 17 percent. These values indicated the soils were rather dry to wet, but primarily moist to wet. The moisture contents of the silty sand with gravel, poorly graded sand with silt and gravel, poorly graded gravel with sand, silty gravel with sand, and silt ranged from about 2 1/2 to 20 percent. These values indicated the cohesionless soils were rather dry to wet (waterbearing).

***Sieve/Hydrometer Tests.*** Sieve/hydrometer tests were performed on four soil samples from the percolation test borings, just above the depth of the downhole percolation test. The depths of these samples ranged from 1 1/2 to 3 1/2 feet. Based on these test results, the percolation test samples classified as either silty sand with gravel or poorly graded sand with silt and gravel, Unified Soil Classification System (USCS) symbols SM and SP-SM, respectively. Results of these classification tests are summarized in Table 1 below.

**Table 1. Summary of Laboratory Tests**

| Boring | Depth (feet) | USCS Soil Description | Moisture Content (%) | USCS Grain Size Analysis Results | | | |
|---|---|---|---|---|---|---|---|
| | | | | % Gravel | % Sand | % Clay | % Silt |
| ST-1B | 2 1/2 | Silty Sand with Gravel | 3.3 | 41.7 | 44.8 | 10.2 | 3.3 |
| ST-4 | 5 | Poorly Graded Sand with Silt and Gravel | 3.2 | 31.0 | 58.6 | 8.2 | 2.2 |
| ST-6 | 5 | Silty Sand with Gravel | 4.7 | 34.6 | 46.8 | 15.2 | 3.4 |
| ST-8 | 4 1/2 | Silty Sand with Gravel | 3.8 | 42.7 | 43.0 | 11.3 | 3.0 |

## Analysis and Recommendations

In addition to the downhole percolation rates, a range of percolation rates were also found by classifying soils using the United States Department of Agriculture (USDA) classifications and correlating appropriate percolation rates from Table 2.1-1 of the MDEQ Circular 4. These percolation rates, as well as the downhole percolation rates are presented in Table 2 below. Additionally, our recommended percolation rate for each location is marked with an asterisk.

**Table 2. Percolation Test Results**

| Boring | Depth of Percolation Test (feet) | Soil Description | USCS Classification | USDA Classification | 2013 MDEQ Circular 4 Percolation Rate (min/in) | Table 2.1-1 Percolation Rate based on USDA Classifications (min/in) |
|---|---|---|---|---|---|---|
| ST-1B | 2 1/2 | Silty Sand with Gravel | SM | Sand | 25.0* | 3 or less |
| ST-4 | 5 | Poorly Graded Sand with Silt and Gravel | SP-SM | Sand | 1.3 | 3*or less |
| ST-6 | 5 | Silty Sand with Gravel | SM | Loamy Sand | 31.3* | 3 – 6 |
| ST-8 | 4 1/2 | Silty Sand with Gravel | SM | Sand | 12.5* | 3 or less |

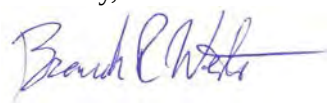
*Recommended value for design. Average of recommended values = 18 mpi.

As indicated above, downhole percolation rates in the alluvial sands ranged from 1.3 to 31.3 minutes per inch (mpi). These are very fast to moderately fast rates, and we anticipate they will be suitable for multiple types and styles of infiltration system to improve storm water management.

## General

Thank you for using SK Geotechnical. If you have any questions regarding this report, or require our services during the construction phase of this project, please call either Brandon Western or Greg Staffileno at (406) 652-3930.

Sincerely,



Brandon R. Western, EI
Engineer Intern

Gregory T. Staffileno, PE
Principal, Geotechnical Engineer

Attachment:
Boring Location Sketch
Descriptive Terminology
Log of Boring Sheets
Grain Size Analysis Curves
Percolation Test Results

Copy: Mr. Tom Cavanaugh
Robert Peccia & Associates
Via Email: tom@rpa-hln.com


SK GEOTECHNICAL

**BORING LOCATION SKETCH**
Treasure State Acres
Helena, Montana

| | | | |
|---|---|---|---|
| Drawn by: | BRW | Date | 4/12/16 |
| Project: | 16-3444D | | |
| Scale: | None | | FIGURE |
| Sheet | 1 of 1 | | |

# Descriptive Terminology

## Standard D 2487
## Classification of Soils for Engineering Purposes
## (Unified Soil Classification System)

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A] | | | | Soil Classification | |
|---|---|---|---|---|---|
| | | | | Group Symbol | Group Name [B] |
| Coarse-Grained Soils More than 50% retained on No. 200 sieve | Gravels More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels Less than 5% fines [C] | $C_U \geq 4$ and $1 \leq C_C \leq 3$ [E] | GW | Well graded gravel [F] |
| | | | $C_U < 4$ and/or $1 > C_C > 3$ [E] | GP | Poorly graded gravel [F] |
| | | Gravels with Fines More than 12% fines [C] | Fines classify as ML or MH | GM | Silty gravel [F, G, H] |
| | | | Fines classify as CL or CH | GC | Clayey gravel [F, G, H] |
| | Sands 50% or more of coarse fraction passes No. 4 sieve | Clean Sands Less than 5% fines [D] | $C_U \geq 6$ and $1 \leq C_C \leq 3$ [E] | SW | Well graded sand [I] |
| | | | $C_U < 6$ and/or $1 > C_C > 3$ [E] | SP | Poorly graded sand [I] |
| | | Sands with Fines More than 12% fines [D] | Fines classify as ML or MH | SM | Silty sand [G, H, I] |
| | | | Fines classify as CL or CH | SC | Clayey sand [G, H, I] |
| Fine-Grained Soils 50% or more passes the No. 200 sieve | Silts and Clays Liquid Limit less than 50 | Inorganic | PI > 7 and plots on or above "A" line [J] | CL | Lean clay [K, L, M] |
| | | | PI < 4 or plots below "A" line [J] | ML | Silt [K, L, M] |
| | | Organic | Liquid limit – oven dried / Liquid limit – not dried < 0.75 | OL | Organic clay [K, L, M, N] Organic silt [K, L, M, O] |
| | Silts and Clays Liquid limit 50 or more | Inorganic | PI plots on or above "A" line | CH | Fat clay [K, L, M] |
| | | | PI plots below "A" line | MH | Elastic silt [K, L, M] |
| | | Organic | Liquid limit – oven dried / Liquid limit – not dried < 0.75 | OH | Organic clay [K, L, M, P] Organic silt [K, L, M, Q] |
| Highly Organic Soils | | Primarily organic matter, dark in color, and organic odor | | PT | Peat |

[A] Based on the material passing the 3" (75 mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols.
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $C_U = D_{50} / D_{10}$
$C_C = (D_{30})^2 / (D_{10} \times D_{50})$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

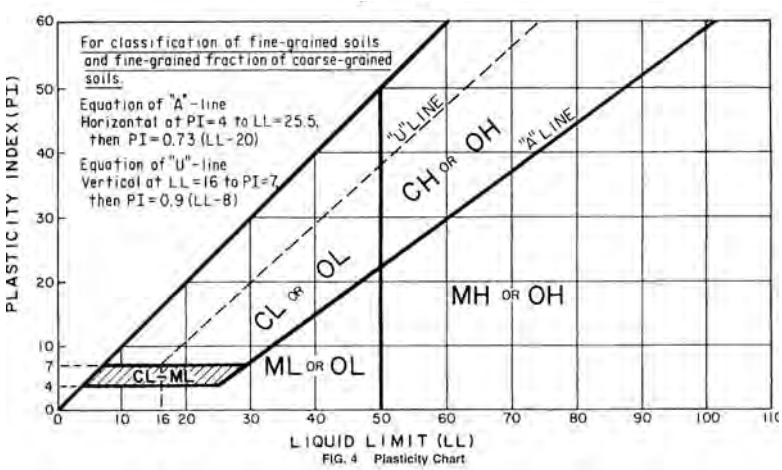


FIG. 4 Plasticity Chart

### Laboratory Tests

| | | | |
|---|---|---|---|
| DD | Dry density, pcf | OC | Organic content, % |
| WD | Wet density, pcf | $P_{200}$ | % passing 200 sieve |
| LL | Liquid limit | PL | Plastic limit |
| PI | Plasticity index | MC | Natural moisture content, % |
| qu | Unconfined compressive strength, psf | | |
| qp | Pocket penetrometer strength, tsf | | |

### Particle Size Identification

| | |
|---|---|
| Boulders | over 12" |
| Cobbles | 3" to 12" |
| Gravel | |
| coarse | 3/4" to 3" |
| fine | No. 4 to 3/4" |
| Sand | |
| coarse | No. 4 to No. 10 |
| medium | No. 10 to No. 40 |
| fine | No. 40 to No. 200 |
| Silt | No. 200 to .005 mm |
| Clay | less than .005 mm |

### Relative Density of Cohesionless Soils

| | |
|---|---|
| very loose | 0 to 4 BPF |
| loose | 5 to 10 BPF |
| medium dense | 11 to 30 BPF |
| dense | 31 to 50 BPF |
| very dense | over 50 BPF |

### Consistency of Cohesive Soils

| | |
|---|---|
| very soft | 0 to 1 BPF |
| soft | 2 to 3 BPF |
| rather soft | 4 to 5 BPF |
| medium | 6 to 8 BPF |
| rather stiff | 9 to 12 BPF |
| stiff | 13 to 16 BPF |
| very stiff | 17 to 30 BPF |
| hard | over 30 BPF |

### Moisture Content (MC) Description

| | |
|---|---|
| rather dry | MC less than 5%, absence of moisture, dusty |
| moist | MC below optimum, but no visible water |
| wet | Soil is over optimum MC |
| waterbearing | Granular or low plasticity soil with free water, typically near or below groundwater table |
| saturated | Cohesive soil, typically near or below groundwater table |

### Drilling Notes

Standard penetration test borings were advanced by 3¼" or 4¼" ID hollow-stem augers, unless noted otherwise. Standard penetration test borings are designated by the prefix "ST" (split tube). Hand auger borings were advanced manually with a 2 to 3" diameter auger to the depths indicated. Hand auger borings are indicated by the prefix "HA."

**Sampling.** All samples were taken with the standard 2" OD split-tube sampler, except where noted. TW indicates thin-walled tube sample. CS indicates California tube sample.

**BPF.** Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they were separated by backslash (/). In very dense/hard strata, the depth driven in 50 blows is indicated.

**WH.** WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

**Note.** All tests were run in general accordance with applicable ASTM standards.

October 13, 2014

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

# LOG OF BORING

PROJECT: 16-3444D
**SOIL BORNGS AND DOWNHOLE PERCOLATION TESTS**
Treasure State Acres
Helena, Montana

BORING: **ST-1B**

LOCATION:
Boring moved 5'NW of ST-2B, see Boring Location Sketch.

DRILLED BY: M. Luce | METHOD: 3 1/4" HSA, Automatic | DATE: 3/15/16 | SCALE: 1" = 2'

| Elev. | Depth | Symbol | Description of Materials | BPF | WL | MC (%) | Remarks |
|---|---|---|---|---|---|---|---|
| | 0.0 | | | | | | |
| | 0.4 | | 0 to 4 1/4" Asphalt Pavement | | | | |
| | 0.7 | | 4 1/4" to 7 3/4" Crushed Base Course | | | | |
| | | | FILL: Clayey Sand with Gravel, fine- to coarse-grained, low plasticity, brown, moist, medium dense. | | | | |
| | 2.0 | | | | | | |
| | | SM | SILTY SAND with GRAVEL, fine- to coarse-grained, tan, rather dry, very dense. (Alluvium) | 53 | | 3.3 | |
| | 3.5 | | | | | | |
| | | | END OF BORING | | | | Percolation Rate = 25 mpi |
| | | | Water not observed with 3 1/2' of hollow-stem auger in the ground. | | | | |
| | | | See Percolation Test Results. | | | | |
| | | | Boring then backfilled. | | | | |

BORING BPF WL MC 3444.GPJ LAGNNN06.GDT 4/22/16

SK GEOTECHNICAL
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P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

# LOG OF BORING

PROJECT: 16-3444D
**SOIL BORNGS AND DOWNHOLE PERCOLATION TESTS**
Treasure State Acres
Helena, Montana

BORING: **ST-2B**

LOCATION:
Boring moved 35'NW from intersection along Wolverine Drive, see Boring Location Sketch.

DRILLED BY: M. Luce | METHOD: 3 1/4" HSA, Automatic | DATE: 3/15/16 | SCALE: 1" = 2'

| Elev. | Depth | Symbol | Description of Materials | BPF | WL | MC (%) | Remarks |
|---|---|---|---|---|---|---|---|
| | 0.0 | | | | | | |
| | 0.4 | | 0 to 4 1/4" Asphalt Pavement | | | | |
| | 0.7 | | 4 1/4" to 7 3/4" Crushed Base Course | | | | |
| | | | FILL: Sandy Lean Clay, low plasticity, brown, moist, medium. | 6 | | 19.5 | |
| | 1.5 | | FILL: Clayey Sand, nonplastic, brown, rather dry, medium dense. | | | | |
| | 2.5 | | SILTY SAND with GRAVEL, fine- to coarse-grained, cobbles, tan, rather dry to moist, medium dense to very dense. (Alluvium) | 9/9 | | 3.8 | |
| | | | | 70 | | 1.8 | |
| | | | | 34 | | 2.9 | |
| | | SM | | 47 | | 2.1 | |
| | | | | 69 | | 1.9 | Water not observed with 15' of hollow-stem auger in the ground. Water not observed to dry cave-in depth of 4.5' immediately after withdrawal of auger. Boring then backfilled. |
| | | | | 49 | | 5.5 | |
| | 15.5 | | END OF BORING | | | | |

BORING BPF WL MC 3444.GPJ LAGNNN06.GDT 4/22/16

SK GEOTECHNICAL
2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

# LOG OF BORING

PROJECT: 16-3444D
**SOIL BORNGS AND DOWNHOLE PERCOLATION TESTS**
Treasure State Acres
Helena, Montana

BORING: **ST-3**

LOCATION:
See Boring Location Sketch.

DRILLED BY: M. Luce | METHOD: 3 1/4" HSA, Automatic | DATE: 3/15/16 | SCALE: 1" = 2'

| Elev. | Depth | Symbol | Description of Materials | BPF | WL | MC (%) | Remarks |
|---|---|---|---|---|---|---|---|
| | 0.0 | | | | | | |
| | 0.3 | | 0 to 3 3/4" Asphalt Pavement | | | | |
| | 0.7 | | 3 3/4" to 8 3/4" Crushed Base Course | | | | |
| | | | FILL: Clayey Gravel with Sand, fine- to coarse-grained, low plasticity, light brown, rather dry, loose. | 6 | | 3.0 | |
| | 1.5 | | POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, tan, moist, medium dense. (Alluvium) | 22 | | 5.4 | |
| | | GP | | | | | |
| | 3.5 | | POORLY GRADED SAND with SILT and GRAVEL, fine- to coarse-grained, brown, rather dry to waterbearing, medium dense to dense. (Alluvium) | 33 | | 2.7 | An open triangle in the water level (WL) column indicates the depth at which groundwater was first observed while drilling. |
| | | | | 36 | | 2.2 | |
| | | SP SM | | 39 | | 2.5 | |
| | | | | 48 | ▽ | 3.6 | Water down 13.1' with 15' of hollow-stem auger in the ground. Water not observed to dry cave-in depth of 4.1' immediately after withdrawal of auger. Boring then backfilled. |
| | | | | 25 | | 8.3 | |
| | 15.5 | | END OF BORING | | | | |

BORING BPF WL MC 3444.GPJ LAGNNN06.GDT 4/22/16

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Fax: 406.652.3944

# LOG OF BORING

| | |
|---|---|
| PROJECT: 16-3444D<br>**SOIL BORNGS AND DOWNHOLE PERCOLATION TESTS**<br>Treasure State Acres<br>Helena, Montana | BORING: **ST-4**<br>LOCATION:<br>See Boring Location Sketch. |
| DRILLED BY: M. Luce / METHOD: 3 1/4" HSA, Automatic | DATE: 3/16/16 / SCALE: 1" = 2' |

| Elev. | Depth | Symbol | Description of Materials | BPF | WL | MC (%) | Remarks |
|---|---|---|---|---|---|---|---|
| | 0.0 | | | | | | |
| | 0.3 | | 0 to 3 3/4" Asphalt Pavement | | | | |
| | 0.7 | | 3 3/4" to 8 3/4" Crushed Base Course | | | | |
| | | | FILL: Clayey Gravel with Sand, fine- to coarse-grained, low plasticity, light brown, moist, loose. | | | | |
| | 1.5 | GP | POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, tan, moist, medium dense. (Alluvium) | | | | |
| | 2.5 | SP SM | POORLY GRADED SAND with SILT and GRAVEL, fine- to coarse-grained, brown, rather dry, medium dense. (Alluvium) | 31 | | 3.2 | Percolation Rate = 1.3 mpi |
| | 4.5 | | END OF BORING<br><br>Water not observed with 5' of hollow-stem auger in the ground.<br><br>See Percolation Test Results.<br><br>Boring then backfilled. | | | | |

BORING BPF WL MC 3444.GPJ LAGNNN06.GDT 4/22/16

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Fax: 406.652.3944

# LOG OF BORING

PROJECT: 16-3444D
**SOIL BORNGS AND DOWNHOLE PERCOLATION TESTS**
Treasure State Acres
Helena, Montana

BORING: **ST-5**

LOCATION:
See Boring Location Sketch.

DRILLED BY: M. Luce | METHOD: 3 1/4" HSA, Automatic | DATE: 3/14/16 | SCALE: 1" = 2'

| Elev. | Depth | Symbol | Description of Materials | BPF | WL | MC (%) | Remarks |
|---|---|---|---|---|---|---|---|
| | 0.0 | | | | | | |
| | 0.4 | | 0 to 4 3/4" Asphalt Pavement | | | | |
| | 0.8 | | 4 3/4" to 9 1/2" Crushed Base Course | | | | |
| | | | FILL: Lean Clay with Sand, low to medium plasticity, brown, moist, medium. | 6 | | 13.3 | |
| | | | | 6 | | 17.5 | |
| | 3.5 | | SILTY SAND with GRAVEL, fine- to coarse-grained, cobbles, dark brown, rather dry to moist, medium dense to very dense. (Alluvium) | | | | |
| | | | | 17 | | 6.1 | |
| | | SM | | 58 | | 2.5 | |
| | | | | 46 | | 2.1 | |
| | 12.0 | | | | | | |
| | | CL | SANDY LEAN CLAY, low plasticity, brown, moist, rather stiff. (Alluvium) | 9 | | 14.1 | Water not observed with 15' of hollow-stem auger in the ground. Water not observed to dry cave-in depth of 8' 5" immediately after withdrawal of auger. Boring then backfilled. |
| | 13.5 | | | | | | |
| | | SC | CLAYEY SAND, fine- to coarse-grained, low plasticity, brown, moist to wet, loose. (Alluvium) | | | | |
| | 14.5 | | | | | | |
| | | ML | SILT, nonplastic, olive, wet, loose. (Alluvium) | 5/4 | | 19.3 | |
| | 15.5 | | | | | | |
| | | | END OF BORING | | | | |

BORING BPF WL MC 3444.GPJ LAGNNN06.GDT 4/22/16

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# LOG OF BORING

PROJECT: 16-3444D
**SOIL BORNGS AND DOWNHOLE PERCOLATION TESTS**
Treasure State Acres
Helena, Montana

BORING: **ST-6**

LOCATION:
See Boring Location Sketch.

DRILLED BY: M. Luce | METHOD: 3 1/4" HSA, Automatic | DATE: 3/16/16 | SCALE: 1" = 2'

| Elev. | Depth | Symbol | Description of Materials | BPF | WL | MC (%) | Remarks |
|---|---|---|---|---|---|---|---|
| | 0.0 | | | | | | |
| | 0.4 | | 0 to 4 3/4" Asphalt Pavement | | | | |
| | 0.8 | | 4 3/4" to 9 1/2" Crushed Base Course | | | | |
| | | | FILL: Lean Clay with Sand, low to medium plasticity, brown, moist, medium. | | | | |
| | 3.5 | | | | | | |
| | | SM | SILTY SAND with GRAVEL, fine- to coarse-grained, brown, rather dry, medium dense. (Alluvium) | 25 | | 4.7 | Percolation Rate = 31.3 mpi |
| | 5.5 | | END OF BORING<br><br>Water not observed with 5 1/2' of hollow-stem auger in the ground.<br><br>See Percolation Test Results.<br><br>Boring then backfilled. | | | | |

BORING BPF WL MC 3444.GPJ LAGNNN06.GDT 4/22/16

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# LOG OF BORING

| | |
|---|---|
| PROJECT: 16-3444D<br>**SOIL BORNGS AND DOWNHOLE PERCOLATION TESTS**<br>Treasure State Acres<br>Helena, Montana | BORING: **ST-7**<br>LOCATION:<br>See Boring Location Sketch. |
| DRILLED BY: M. Luce / METHOD: 3 1/4" HSA, Automatic | DATE: 3/14/16 / SCALE: 1" = 2' |

| Elev. | Depth | Symbol | Description of Materials | BPF | WL | MC (%) | Remarks |
|---|---|---|---|---|---|---|---|
| | 0.0 | | 0 to 5 1/4" Asphalt Pavement | | | | |
| | 0.4 | | 5 1/4" to 7 3/4" Crushed Base Course | | | | |
| | 0.6 | | FILL: Lean Clay with Sand, medium plasticity, trace gravels/roots, olive, moist, soft. | 4 | | 17.9 | |
| | 2.0 | SC | CLAYEY SAND with GRAVEL, fine- to coarse-grained, low plasticity, olive, moist, loose. (Alluvium) | 6 | | 16.9 | |
| | 4.0 | SM | SILTY SAND with GRAVEL, fine- to coarse-grained, with cobbles, tan, rather dry, medium dense to dense. (Alluvium) | 25 | | 4.9 | |
| | 8.5 | SM | SILTY SAND, fine- to coarse-grained, trace gravels, with lenses of silt, tan, moist, loose. (Alluvium) | 44 | | 2.5 | |
| | 11.0 | GM | SILTY GRAVEL with SAND, fine- to coarse-grained, nonplastic, tan, moist to wet, loose. (Alluvium) | 8 | | 19.7 | |
| | 14.5 | SC | CLAYEY SAND, fine- to coarse-grained, low plasticity, brown, moist, medium dense. (Alluvium) | 8 | | 12.7 | Water not observed with 14' of hollow-stem auger in the ground. Water not observed to dry cave-in depth of 8' 8" immediately after withdrawal of auger. Boring then backfilled. |
| | 15.5 | | END OF BORING | 12 | | 17.5 | |

BORING BPF WL MC 3444.GPJ LAGNNN06.GDT 4/22/16

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# LOG OF BORING

PROJECT: 16-3444D
**SOIL BORNGS AND DOWNHOLE PERCOLATION TESTS**
Treasure State Acres
Helena, Montana

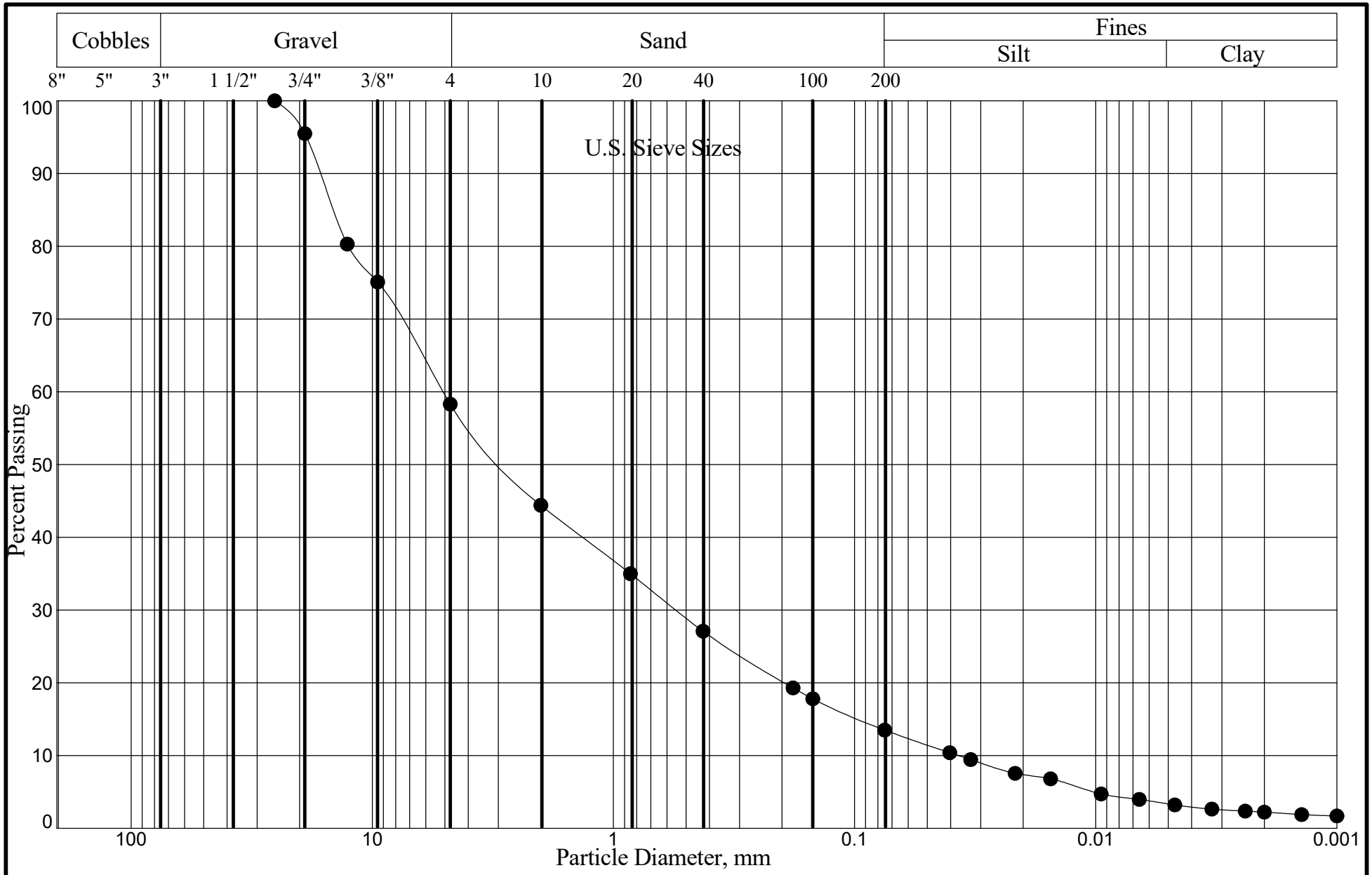
BORING: **ST-8**

LOCATION:
See Boring Location Sketch.

DRILLED BY: M. Luce | METHOD: 3 1/4" HSA, Automatic | DATE: 3/16/16 | SCALE: 1" = 2'

| Elev. | Depth | Symbol | Description of Materials | BPF | WL | MC (%) | Remarks |
|---|---|---|---|---|---|---|---|
| | 0.0 | | | | | | |
| | 0.4 | | 0 to 5 1/4" Asphalt Pavement | | | | |
| | 0.6 | | 5 1/4" to 7 3/4" Crushed Base Course | | | | |
| | | | FILL: Lean Clay with Sand, medium plasticity, trace gravels and roots, olive, moist, soft. | | | | |
| | 2.0 | SC | CLAYEY SAND with GRAVEL, fine- to coarse-grained, low plasticity, olive, moist, loose. (Alluvium) | | | | |
| | 3.5 | SM | SILTY SAND with GRAVEL, fine- to coarse-grained, dark brown, rather dry, dense. (Alluvium) | 38 | | 3.8 | Percolation Rate = 12.5 mpi |
| | 5.5 | | END OF BORING<br><br>Water not observed with 5 1/2' of hollow-stem auger in the ground.<br><br>See Percolation Test Results.<br><br>Boring then backfilled. | | | | |

BORING BPF WL MC 3444.GPJ LAGNNN06.GDT 4/22/16

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## Grain Size Analysis Curve

Project Number: 16-3444D

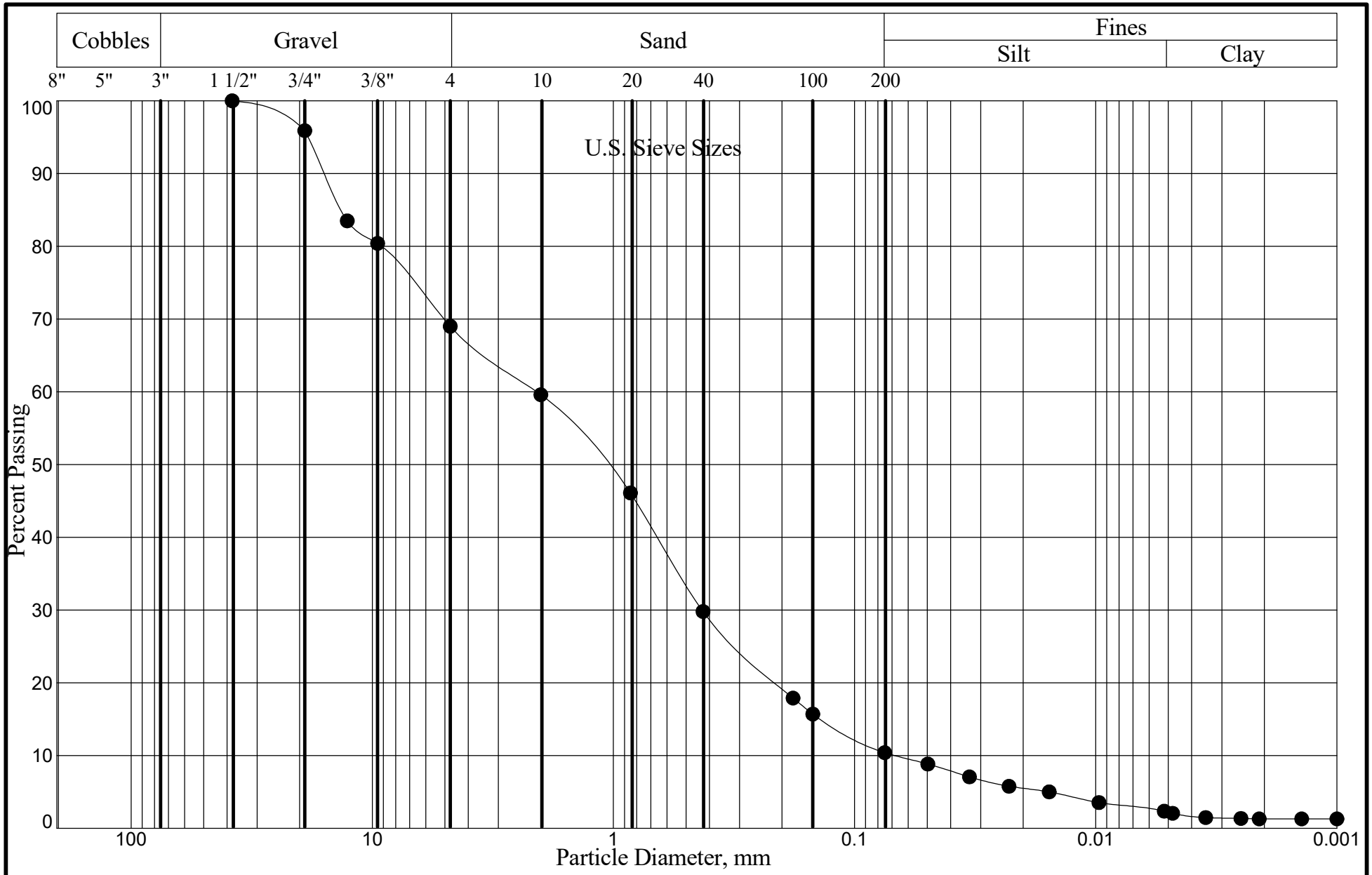
Treasure State Acres

Helena, Montana

| | |
|---|---|
| Boring No.: | ST-1B |
| Sample No: | Jar 29B |
| Depth: | 3' |
| Date Received: | 03/18/2016 |

4/13/16

| | | | |
|---|---|---|---|
| % Gravel: | 41.7 | LL: | |
| % Sand: | 44.8 | PL: | |
| % Silt: | 10.2 | PI: | |
| % Clay: | 3.3 | MC: | 3.3% |
| Class: | | SG: | 2.600 |

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## Grain Size Analysis Curve

Project Number: 16-3444D

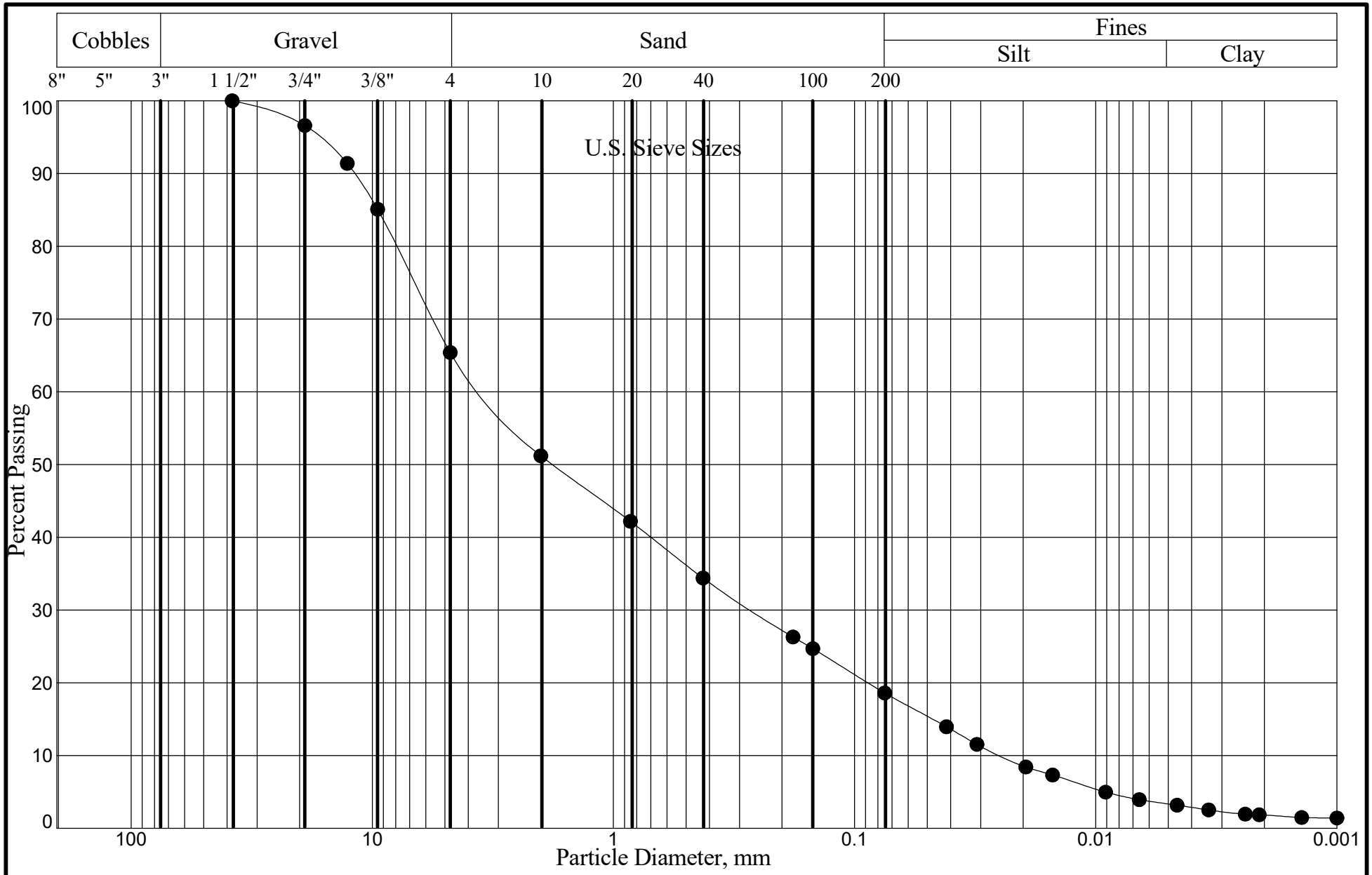
Treasure State Acres

Helena, Montana

| | |
|---|---|
| Boring No.: | ST-4 |
| Sample No: | Jar 31B |
| Depth: | 4' |
| Date Received: | 03/18/2016 |

4/13/16

| | | | |
|---|---|---|---|
| % Gravel: | 31.0 | LL: | |
| % Sand: | 58.6 | PL: | |
| % Silt: | 8.2 | PI: | |
| % Clay: | 2.2 | MC: | 3.2% |
| Class: | | SG: | 2.600 |

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## Grain Size Analysis Curve

Project Number: 16-3444D

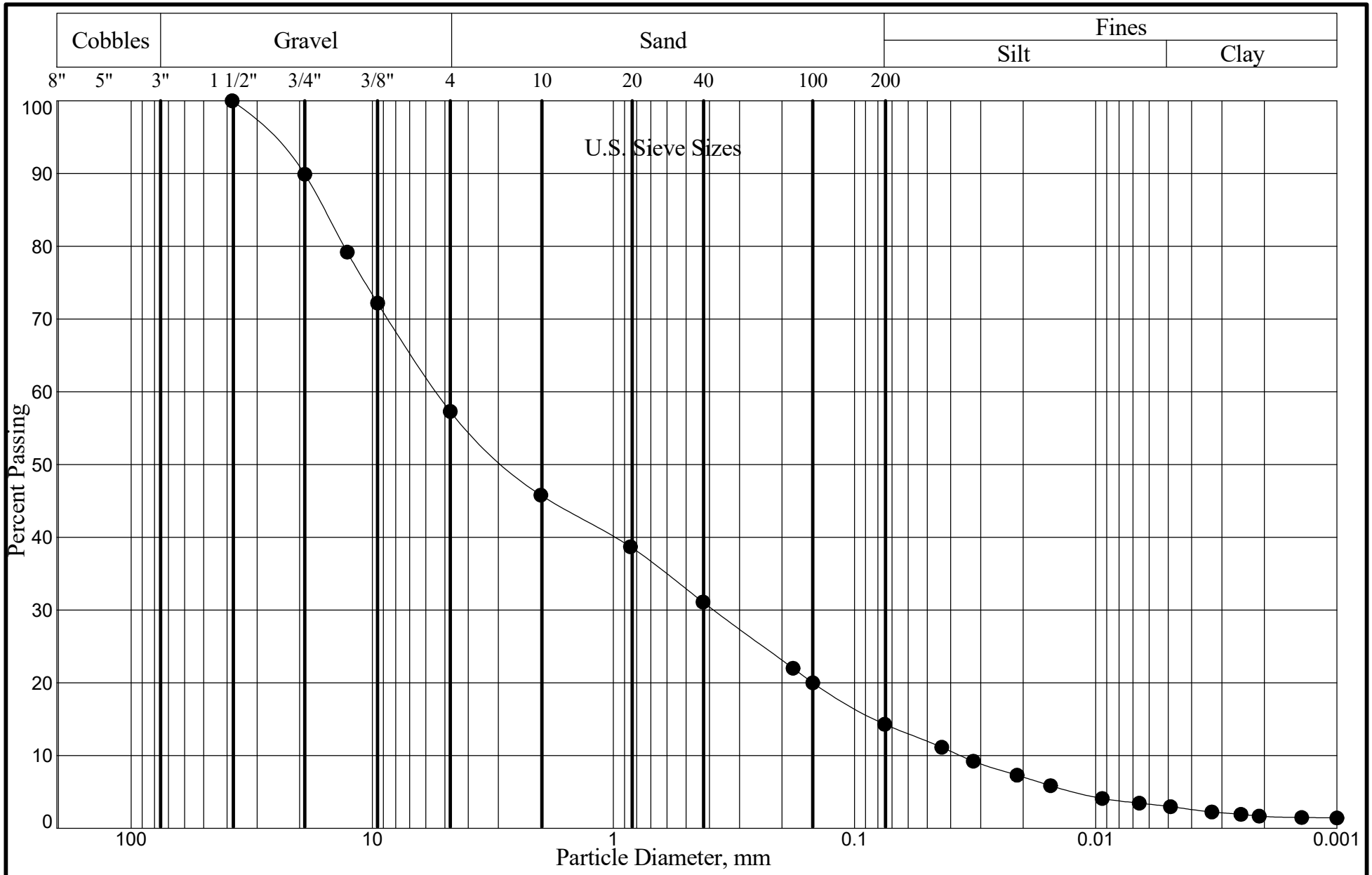
Treasure State Acres

Helena, Montana

| | |
|---|---|
| Boring No.: | ST-6 |
| Sample No: | Jar 30B |
| Depth: | 5' |
| Date Received: | 03/18/2016 |

4/13/16

| | | | |
|---|---|---|---|
| % Gravel: | 34.6 | LL: | |
| % Sand: | 46.8 | PL: | |
| % Silt: | 15.2 | PI: | |
| % Clay: | 3.4 | MC: | 4.7% |
| Class: | | SG: | 2.600 |

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## Grain Size Analysis Curve

Project Number: 16-3444D

Treasure State Acres

Helena, Montana

| | |
|---|---|
| Boring No.: | ST-8 |
| Sample No: | Jar 32B |
| Depth: | 5' |
| Date Received: | 03/18/2016 |

4/13/16

| | | | |
|---|---|---|---|
| % Gravel: | 42.7 | LL: | |
| % Sand: | 43.0 | PL: | |
| % Silt: | 11.3 | PI: | |
| % Clay: | 3.0 | MC: | 3.8% |
| Class: | | SG: | 2.600 |

# Montana Department of Environmental Quality
# Percolation Test Form

Owner Name: Lewis and Clark County

Project Name: Treasure State Acres, Helena, Montana

Lot or Tract Number: ST-6 Test Number: P-2

Diameter of Test Hole: 4" Depth of Test Hole: 5'

Date and Time Soak Period Began: 3/16/2016, 9:11 a.m. Ended: 3/16/2016, 2:04 p.m.

Date Test Began: 3/16/2016

Distance of the reference point above the bottom of the hole: 4.57'

| Depth, inches | Soil Description |
|---|---|
| 0 – 42 | Lean Clay with Sand Fill |
| 42 – 144 | Silty Sand with Gravel Alluvium |
| 144 – 162 | Sandy Lean Clay Alluvium |

**Test Results**

| Start Time of Day | End Time of Day | Time Interval (minutes) | Initial Distance Below Reference Point | Final Distance Below Reference Point | Drop in Water Level (inches) | Percolation Rate (minutes/inch) |
|---|---|---|---|---|---|---|
| 15:46 | 16:01 | 15 | 4.05' | 4.18' | 1.56 | 9.6 |
| 16:04 | 16:19 | 15 | 3.91' | 4.08' | 2.04 | 7.4 |
| 16:24 | 16:39 | 15 | 4.02' | 4.07' | 0.60 | 25.0 |
| 16:42 | 16:57 | 15 | 4.07' | 4.11' | 0.48 | 31.3 |
| | | | | | | |
| | | | | | | |

Percolation Rate: 31.25 minutes per inch (based on final reading)

I certify that this percolation test was done by a qualified site evaluator in accordance with DEQ-4, Section 1.2.68, and Appendix A.

| Brandon R. Western | | 4/13/2016 |
|---|---|---|
| Name (printed) | Signature | Date |

SK Geotechnical Corporation, 2511 Holman Avenue, Billings, Montana 59102, (406) 652-3930

# Montana Department of Environmental Quality
# Percolation Test Form

| | | | |
|---|---|---|---|
| Owner Name | Lewis and Clark County | | |
| Project Name | Treasure State Acres, Helena, Montana | | |
| Lot or Tract Number | ST-4 | Test Number | P-3 |
| Diameter of Test Hole | 4" | Depth of Test Hole | 5' |
| Date and Time Soak Period Began | 3/16/2016, 9:55 a.m. | Ended | 3/16/2016, 10:32 a.m. |
| Date Test Began | 3/16/2016 | | |
| Distance of the reference point above the bottom of the hole | 4.8' | | |

| Depth, inches | Soil Description |
|---|---|
| 0 – 18 | Clayey Gravel with Sand Fill |
| 18 – 42 | Poorly Graded Gravel with Sand Alluvium |
| 42 – 186 | Poorly Graded Sand with Silt and Gravel Alluvium |

**Test Results**

| Start Time of Day | End Time of Day | Time Interval (minutes) | Initial Distance Below Reference Point | Final Distance Below Reference Point | Drop in Water Level (inches) | Percolation Rate (minutes/inch) |
|---|---|---|---|---|---|---|
| 9:55 | 10:10 | 15 | 3.8' | 4.8' | 12 | 1.25 |
| 10:16 | 10:32 | 16 | 3.8' | 4.8' | 12 | 1.33 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Percolation Rate: 1.30 minutes per inch (based on final reading)

I certify that this percolation test was done by a qualified site evaluator in accordance with DEQ-4, Section 1.2.68, and Appendix A.

| Brandon R. Western | | 4/13/2016 |
|---|---|---|
| Name (printed) | Signature | Date |

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# Montana Department of Environmental Quality
# Percolation Test Form

Owner Name: Lewis and Clark County

Project Name: Treasure State Acres, Helena, Montana

Lot or Tract Number: ST-1B  Test Number: P-1

Diameter of Test Hole: 4"  Depth of Test Hole: 2 1/2'

Date and Time Soak Period Began: 3/15/2016, 1:20 p.m.  Ended: 3/15/2016, 3:53 p.m.

Date Test Began: 3/15/2016

Distance of the reference point above the bottom of the hole: 4'

| Depth, inches | Soil Description |
|---|---|
| 0 – 18 | Clayey Sand with Gravel Fill |
| 18 – 186 | Silty Sand with Gravel Alluvium |
| | |

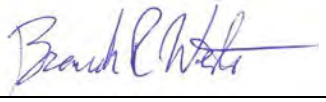
**Test Results**

| Start Time of Day | End Time of Day | Time Interval (minutes) | Initial Distance Below Reference Point | Final Distance Below Reference Point | Drop in Water Level (inches) | Percolation Rate (minutes/inch) |
|---|---|---|---|---|---|---|
| 15:55 | 16:10 | 15 | 5.45' | 5.50' | 0.6 | 25 |
| 16:10 | 16:25 | 15 | 5.50' | 5.55' | 0.6 | 25 |
| 16:27 | 16:42 | 15 | 5.45' | 5.50' | 0.6 | 25 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Percolation Rate: 25 minutes per inch (based on final reading)

I certify that this percolation test was done by a qualified site evaluator in accordance with DEQ-4, Section 1.2.68, and Appendix A.

Brandon R. Western
Name (printed)


Signature

4/13/2016
Date

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# Montana Department of Environmental Quality
# Percolation Test Form

Owner Name: Lewis and Clark County

Project Name: Treasure State Acres, Helena, Montana

Lot or Tract Number: ST-8 Test Number: P-4

Diameter of Test Hole: 4" Depth of Test Hole: 4 1/2'

Date and Time Soak Period Began: 3/16/2016, 11:40 a.m. Ended: 3/16/2016, 3:00 p.m.

Date Test Began: 3/16/2016

Distance of the reference point above the bottom of the hole: 4'

| Depth, inches | Soil Description |
|---|---|
| 0 – 24 | Lean Clay with Sand Fill |
| 24 – 42 | Clayey Sand with Gravel Alluvium |
| 42 – 102 | Silty Sand with Gravel Alluvium |

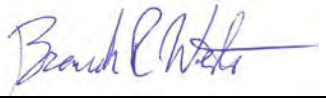
**Test Results**

| Start Time of Day | End Time of Day | Time Interval (minutes) | Initial Distance Below Reference Point | Final Distance Below Reference Point | Drop in Water Level (inches) | Percolation Rate (minutes/inch) |
|---|---|---|---|---|---|---|
| 16:44 | 16:59 | 15 | 3.50' | 3.85' | 4.2 | 3.6 |
| 16:59 | 17:15 | 16 | 3.50' | 3.67' | 2.04 | 8.0 |
| 17:15 | 17:31 | 16 | 3.50' | 3.60' | 1.2 | 12.5 |
| 17:31 | 17:46 | 15 | 3.50' | 3.60' | 1.2 | 12.5 |
| | | | | | | |
| | | | | | | |

Percolation Rate: 8.0 minutes per inch (based on final reading)

I certify that this percolation test was done by a qualified site evaluator in accordance with DEQ-4, Section 1.2.68, and Appendix A.

Brandon R. Western
Name (printed)


Signature

4/13/2016
Date

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