Appendix

I

Feasibility Evaluation: Infiltration and Rainwater Harvesting/Use

The purpose of this guidance is to assist project applicants and agency staff in determining whether it is feasible or infeasible for individual projects to treat the full water quality design flow or volume of stormwater runoff, as specified in MRP Provision C.3.d, using infiltration or rainwater harvesting and use[1]. Where this is infeasible, biotreatment will be allowed. The information presented in this guidance is based on the "Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report (Feasibility Report prepared by the Bay Area Stormwater Management Agencies Association (BASMAA) and submitted to the Regional Water Board on April 29, 2011.[2]

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[1] Provision C.3.c of the MRP requires that the C.3.d amount or runoff be treated with infiltration, evapotranspiration, or harvesting and use, or, where this is infeasible, biotreatment. Evapotranspiration will occur in all landscape-based treatment and was incorporated in modeling of infiltration and rainwater harvesting/use conducted for the Feasibility Report.

[2] This report is available on the Countywide Program's website (www.flowstobay.org – click on "Business", then "New Development", then scroll down to the heading "Stormwater Requirements for New Development/ Redevelopment", and click on the link to the Feasibility Report.

- Attachment 3: Excerpts from the Feasibility Report (Maps Showing Soil Hydraulic Conductivity, Tables 8 through 11, and curves from the report's Appendix F).

I1. General Approach

BASMAA's member agencies have collaborated to develop worksheets to assist project applicants and municipal staff in evaluating the feasibility and infeasibility of infiltration or rainwater harvesting and use, and determining the project's eligibility for Special Project LID treatment reduction credits. The steps in this process are shown in the flow chart (Figure I-1) and listed below:

- ***Step 1:*** Complete the Infiltration/Harvesting and Use Feasibility Screening worksheet (screening worksheet), to evaluate whether the project may potentially fall into one of the following categories:
    a. Is it potentially a Special Project? (If so, complete the Special Projects Worksheet in Step 2)
    b. Is it infeasible to infiltrate the full C.3.d amount of runoff? (If not, complete the Infiltration Feasibility Worksheet in Step 2.)
    c. Is it infeasible to harvest and use the full C.3.d amount of runoff? (If not, complete the Rainwater Harvesting Feasibility Worksheet in Step 2.)
- ***Step 2:*** Either complete the applicable worksheet(s) or, if no further analysis is needed, go to Step 3d.
- ***Step 3:*** Depending on which additional worksheet(s) is/are completed, any of the following outcomes may result:
    a. If the project is a Special Project that receives 100 percent LID treatment reduction, up to 100 percent of the C.3.d amount of stormwater runoff may be treated with media filters and/or manufactured tree well filters, if the applicant meets the requirement, described in Appendix J, to document that LID treatment is infeasible.
    b. If infiltration of the C.3.d amount of runoff (or the remainder after deducting any Special Projects LID treatment reduction credit) is found to be feasible, then the project must infiltrate the required amount of runoff, unless it is harvested and used.
    c. If rainwater harvesting and use of the C.3.d amount of runoff (or the remainder after deducting any Special Projects LID treatment reduction credit) is found to be feasible, then the project must harvest and use the required amount of runoff, unless it is infiltrated.
    d. If the required amount of runoff cannot be infiltrated or harvested and used, implement biotreatment, except for any Special Project LID treatment reduction that may be allowed. Where conditions allow, the biotreatment measures should maximize infiltration.

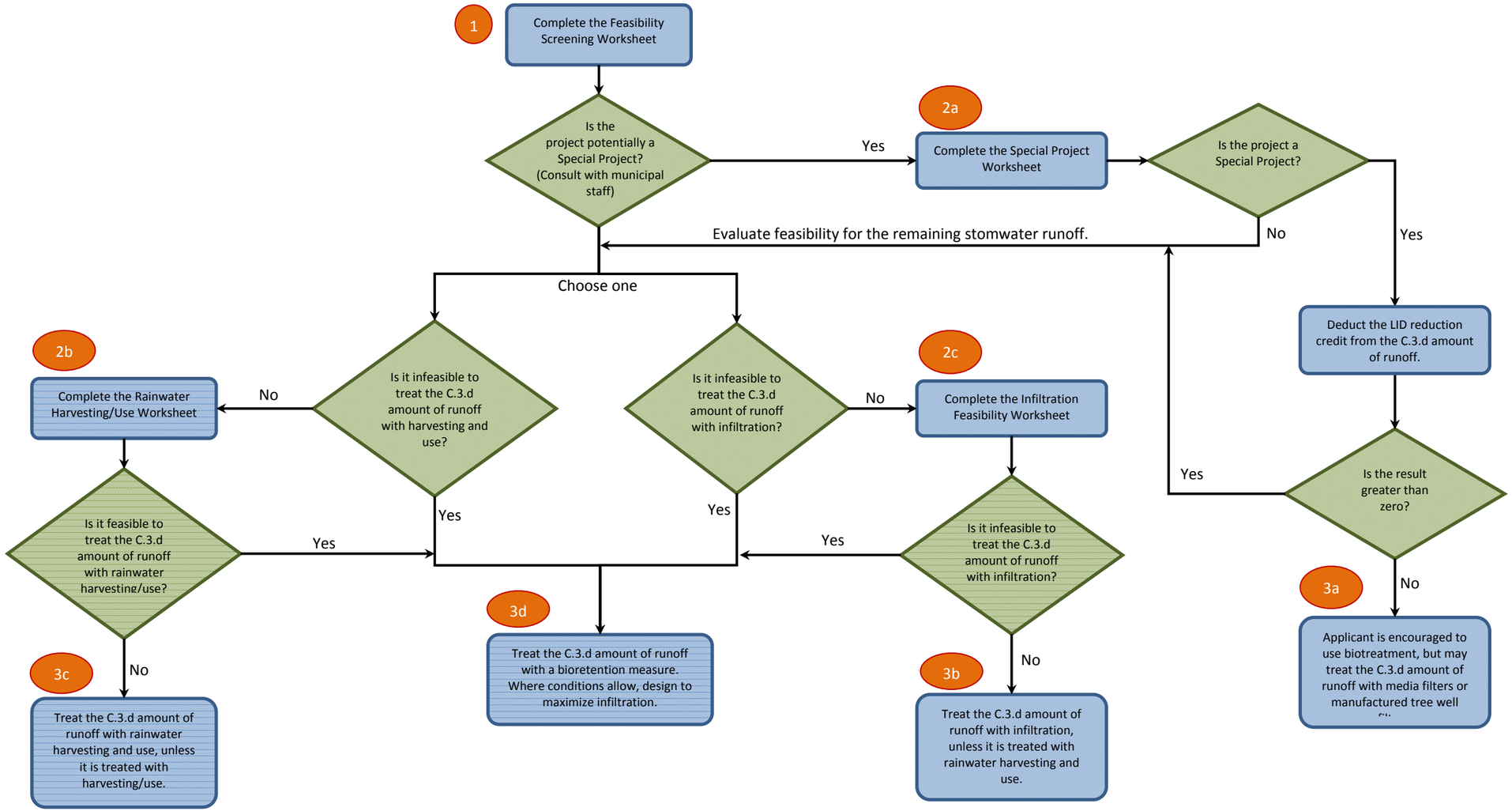

Figure I-1: Flow chart of feasibility and infeasibility evaluation process

I2. Rainwater Harvesting/Use and Infiltration Feasibility Screening Worksheet Guidance

Many projects will complete only the screening worksheet, and will not have to complete any of the other worksheets related to feasibility. This worksheet screens out from further evaluation projects that clearly cannot infiltrate or harvest and use the C.3.d amount of runoff. The worksheet is organized around the following topics:

- Special Projects pre-screening,
- Feasibility screening for infiltration,
- Recycled water use
- Calculate the potential rainwater capture area for rainwater harvest and use
- Use of biotreatment, and
- Results of screening analysis.

Special Projects Pre-Screening

The instructions under the worksheet title on page 1 instruct the applicant to contact municipal staff to determine whether the project meets the criteria for Special Projects. To make this determination, municipal staff may use the Special Projects Worksheet (to be included at the end of this appendix after it is completed) and refer to the Special Projects criteria in Appendix J. If the project qualifies as a Special Project (including the requirement to provide narrative documentation that 100 percent LID treatment is infeasible) LID treatment may be required for a specified percentage of the C.3.d amount of stormwater runoff from the project. The following guidance applies if the project is found to be a Special Project:

- If the Special Project receives 100 percent LID treatment reduction, the project is allowed to treat the entire C.3.d amount of stormwater runoff with high flow-rate tree box filters or high flow rate media filters. There is no need to fill out the screening form.
- If the Special Project receives less than 100 percent LID reduction, the project must evaluate the feasibility of infiltrating or harvesting and using the remaining C.3.d amount of stormwater runoff. To do this, complete Sections 1, 2, 3 and 7 of the screening form to evaluate infiltration feasibility and identify any use of recycled water. Then fill out the Rainwater Harvesting and Use Feasibility Worksheet to evaluate the feasibility of treating the remaining percentage of the C.3.d amount of runoff with harvesting and use. Information about using these forms is provided below.

Screening Worksheet Section 2: Feasibility Screening for Infiltration

This question is based on the how efficiently soils at the project site can infiltrate water. Where possible, base your response on information in a project-specific soils report.

- If the soils report includes the saturated hydraulic conductivity (Ksat) for onsite soils, use this as the basis for determining feasibility of infiltration. The Feasibility Report found that infiltration of the C.3.d amount of runoff is infeasible where soils have a Ksat of less than 1.6 inches/hour.

- If the site-specific soil report does not include the Ksat, but does include the soil type, then base the feasibility determination on soil type. If the soils at the project site consist of Type C or Type D, then infiltration of the C.3.d amount of runoff is infeasible.
- If the above information is unavailable for the project site, then base the feasibility determination on the Ksat value shown on the map included in Attachment 3. You can also obtain Natural Resource Conservation Service soil survey data (the basis for the attached maps) at the following website: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. Where possible, this information should be confirmed with site-specific data.

Screening Worksheet Section 3: Recycled Water Use

If the project will install and use a recycled water system for non-potable water use, then rainwater harvesting is considered to be infeasible, and you can skip to Section 6 of this form. It would not be cost effective for a project to be required to install two plumbing systems for non-potable water. Recycled water is given priority over rainwater for non-potable water use because of the year-round availability and consistent quality of recycled water, the municipalities' investments in recycled water infrastructure, and the requirement for wastewater treatment facilities to find reliable uses for recycled water.

Screening Worksheet Section 4: Potential Rainwater Capture Area

If a recycled water system is not used, further evaluation of rainwater harvesting/use feasibility is based on whether there is sufficient demand for the amount of rainwater that would potentially be captured by the project. The first step in this evaluation is to identify the potential rainwater capture area for the entire project area. Please note that this section, and Section 5, should not be completed for Special Projects that receive less than 100 percent LID treatment reduction. This form is not designed to take Special Projects treatment reductions into account. The Rainwater Harvesting and Use Feasibility Form does account for these reductions and should be used to evaluate the feasibility of harvest and use based on demand.

After the worksheet is completed for the entire project, if rainwater harvesting and use is infeasible, AND, if the project includes one or more buildings with a roof area of 10,000 square feet or more, then Sections 4 and 5 should be completed for each individual roof that has an area of 10,000 square feet or more.[3]

- ***Table 1: Calculation of the Potential Rainwater Capture Area.*** The purpose of completing this table is to identify the area from which rainwater could potentially be captured and stored for use.

- ***Question 4.2: "50 Percent Rule."*** When evaluating the entire project, indicate whether the amount of any impervious surface that is replaced by the project is at least 50 percent, but less than 100 percent, of the existing impervious surface at the project site.

[3] The Feasibility Report indicated that rainwater harvesting/use feasibility would be determined on a drainage management area (DMA) basis. BASMAA has identified roofs of this size as the appropriate level of analysis for determining rainwater harvesting feasibility on a DMA basis.

- If the area of impervious surface to be replaced is at least 50 percent but less than 100 percent of the existing impervious surface, then the stormwater runoff from all the existing impervious surface will be included in the Potential Rainwater Capture Area. (This is referred to as "the 50 percent rule.")
- If the amount to be replaced is less than 50 percent of the existing impervious surface, then only the stormwater runoff from the new and/or replaced impervious surface will need to be treated.

- ***Questions 4.3 and 4.4: Potential Rainwater Capture Area:*** After taking the "50 percent rule" into consideration, enter the total area (in square feet) that will need to receive stormwater treatment. This is the potential rainwater capture area. This result then needs to be converted to acres, since some criteria that will be used to evaluate rainwater harvesting feasibility are per acre of impervious surface.

Screening Worksheet Section 5: Screening for Rainwater Harvest/Use

- ***Question 5.1: Feasibility of Irrigation use.*** Respond to this question if the project includes landscaping. This is based on a screening criterion derived from Table 11 in the Feasibility Report (included in Attachment 3 of this guidance), which presents ratios of "Effective Irrigated Area to Impervious Area" (EIATIA) for each of the rain gauge areas that were evaluated in the report. The multiplier shown in the Question 5.1 applies to areas of turf landscaping in the Palo Alto rain gauge area, which is the lowest EIATIA for the county.

- ***Question 5.2a: Residential toilet flushing.*** Answer this question only for projects that consist entirely of residential use, and for the residential portion of mixed use projects that include some residential use. This question is based on a screening criterion derived from Attachment 2: Toilet-Flushing Demand for Harvested Rainwater. The threshold number of dwelling units per acre shown in Question 5.2a specifically applies to toilet flushing demand in the Palo Alto rain gauge area, which is the lowest demand threshold for residential toilet flushing feasibility in the county.

- ***Question 5.2b: Commercial/Institutional/Industrial Toilet Flushing.*** Answer this question only for projects that consist entirely of commercial and/or institutional and/or industrial use, and for the commercial portion of mixed commercial and residential use projects. This question is based on screening criteria derived from California Plumbing Code building occupancy load factors and Table 10 in the Feasibility Report, which identifies the required toilet flushing demand based on employees per impervious acre (Table 10 is included in Attachment 3). The feasibility threshold in Question 5.2b is provided in terms of square feet of interior floor area per acre of impervious surface. This threshold indicates that, at this ratio of interior floor area to impervious surface, rainwater harvesting and use for non-residential and non-school toilet flushing is feasible in the Palo Alto rain gauge area. The Palo Alto rain gauge threshold is the lowest demand threshold for non-residential and non-school toilet flushing feasibility in the county.

- ***Question 5.2c: School Toilet Flushing.*** Answer this question only for school projects. This question is based on screening criteria derived from California Plumbing

Code building occupancy load factors and Table 10 in the Feasibility Report (see Attachment 3), which identifies the required toilet flushing demand based on employees per impervious acre. The feasibility threshold in Question 5.2c is provided in terms of square feet of interior floor area per acre of impervious surface. This threshold indicates that, at this ratio of interior floor area to impervious surface, rainwater harvesting and use for school toilet flushing is feasible in the Palo Alto rain gauge area. The Palo Alto rain gauge threshold is the lowest demand threshold for school toilet flushing feasibility in the county.

- ***Item 5.2d: Mixed Commercial and Residential Use Projects.*** This item provides instructions to separately evaluate the commercial and residential portions of a mixed use project, as described above under Questions 5.2a and 5.2b.

- ***Question 5.2e: Industrial Projects.*** Answer this question only for industrial projects. If the project will include an industrial processing use for non-potable water, identify the demand for this use. This question is based on the required cistern volume and demand, for the maximum allowable drawdown time, to capture the C.3.d amount of runoff shown in Table 9 of the Feasibility Report (see Attachment 3). The required demand in gallons per day per acre of impervious area in Question 5.2d applies to the required demand in the Palo Alto rain gauge area, the lowest industrial non-potable water demand threshold for harvesting and use feasibility in the county.

  If the project's industrial non-potable water demand is MORE than 2,900 gallons a day, refer to the curves from Appendix F of the Feasibility Report (see Attachment 3) to evaluate the feasibility of harvesting and using the C.3.d amount of runoff for industrial use. Find the page that shows curves corresponding to the closest rain gauge to your project. The applicant can select any combination of drawdown time and cistern size that achieves at least 80 percent capture of runoff on the Y-axis of the graphs. The required demand in gallons per day per impervious acre is calculated by dividing the cistern volume by the drawdown time (converted to days).

Screening Worksheet Section 6: Biotreatment

Section 6 of the worksheet indicates whether, based on results of the screening evaluation, the project is allowed to implement biotreatment.

Screening Worksheet Section 7: Results of Screening Analysis

Section 7 of the screening worksheet lists the possible outcomes that may result from the screening analysis. If the project is allowed to implement biotreatment, check the biotreatment box only. If further analysis is required, check all boxes that apply, based on the results of evaluations in the previous sections.

I.3 Infiltration Feasibility Worksheet Guidance

Fill out this worksheet if soils at the project site have a Ksat of 1.6 or greater, or are Type A or B soils. This worksheet will help determine if conditions at the site would prohibit infiltration.

Feasibility of Infiltration Facilities

A "yes" answer to any of the questions from 2.1 through 2.3 indicates that site conditions prohibit the use of both infiltration measures (indirect infiltration, including unlined bioretention areas and infiltration trenches that are wider than they are deep) and infiltration devices (direct infiltration, including infiltration trenches and basins that are deeper than they are wide). A "yes" answer to any of these questions means that infiltration must be avoided altogether. In these situations, appropriate biotreatment systems may consist of a concrete-lined flow through planter, or a bioretention area with a waterproof liner. As soon as you answer "yes" to any of these questions, stop filling out the form, and indicate in Section 3 that infiltration is infeasible. If the answers to Questions 2.1 through 2.3 are all "no", then the use of infiltration measures (indirect infiltration) is feasible. Continue filling out the form to determine whether the use of infiltration devices (direct infiltration) is feasible.

Feasibility of Infiltration Devices

A "yes" answer to any of the questions from 2.4 through 2.8 indicates that the use of infiltration devices (direct infiltration) is infeasible. Examples of infiltration devices include any infiltration trench or basin, dry welll, or French drain that is deeper than it is wide. Requirements for infiltration devices (direct infiltration) are more stringent, because the design of infiltration devices causes stormwater runoff to bypass surface soils. This means that groundwater resources are more vulnerable to contamination than would be the case if infiltration measures (indirect infiltration) were used.

A "yes" answer for any question from 2.4 through 2.8 would not change the feasibility of infiltration measures (indirect infiltration); it would mean only that the use of infiltration devices (direct infiltration) is prohibited.

I.4 Rainwater Harvesting/Use Feasibility Worksheet Guidance

Complete this worksheet if the project's feasibility screening worksheet indicated that further analysis of rainwater harvesting and use is needed. Section 7 of the screening worksheet will indicate whether further analysis is needed for the entire project, or just one or more roofs that each individually have an area of 10,000 square feet or more. Fill out the rainwater harvesting and use worksheet separately for either the entire project, or for just one roof. The worksheet is organized around the following topics:

- Enter project data;
- Calculate area of self-treating areas, self-retaining areas, and areas contributing to self-retaining areas;
- Subtract credit for self-treating/self-retaining areas from area requiring treatment;
- Determine feasibility of use for toilet flushing based on demand;
- Determine feasibility of harvesting and use based on factors other than demand; and
- Results of feasibility determination.

The worksheet is provided in Excel, with pre-set formulas that perform various calculations automatically. The open cells shaded in blue are for you to enter data. Open cells without shading include the pre-set formulas.

RWH Feasibility Worksheet Section 1: Enter Project Data

The following data must be entered in this section and will form the basis for evaluating the feasibility of using the full C.3.d amount of runoff for toilet flushing:

- Project type,
- Number of dwelling units (for a residential or mixed use project),
- Square footage of non-residential interior floor area (for a non-residential or mixed use project), and
- Potential rain capture area (obtain from the screening worksheet).

If you are filling out this form for a project with a potential non-potable use of stormwater other than toilet flushing, skip sections 2 through 4, and go directly to Section 5.

RWH Feasibility Section 2: Calculate self-treating and self-retaining areas

You may exclude the following from the calculation of the potential rain capture area: 1) runoff from self-treating areas; 2) runoff from self-retaining areas; 3) the areas of impervious surface that drain to self-retaining areas. This is because, if the project includes such areas, they have been designed to infiltrate the C.3.d amount of runoff. In Section 2 of the form, enter the area (in square feet) of the project that consists of self-treating or self-retaining areas, and the impervious surface area that drains to self-retaining areas.

RWH Feasibility Section 3: Subtract self-treating and self-retaining areas

This section includes pre-set formulas that will automatically subtract from the area that is being evaluated (adjusted to account for any Special Project LID treatment reduction) the total square footage of self-treating and self-retaining areas, as well as the square footage of impervious surface that drain to self-retaining areas. The result is the potential rainwater capture area. A pre-set formula then converts the potential rainwater capture area from square feet to acres.

RWH Feasibility Section 4: Feasibility of use for toilet flushing based on demand

- ***Steps 4.1 and 4.2: Identify project density:*** In these steps, you will identify (for residential projects) the dwelling units per acre of potential rainwater capture area. For non-residential projects, you will identify the non-residential interior floor area (in square feet) per acre of potential rain capture area. These ratios will be used to represent the anticipated toilet flushing demand for the project. The worksheet includes pre-set formulas to help you do this. Please note: ***If you are evaluating a mixed use project***, do not use these pre-set formulas. For mixed use projects, evaluate the residential toilet flushing demand based on the dwelling units per acre for the residential portion of the project (using a prorated acreage, based on the percentage of the project dedicated to residential use). Then evaluate the commercial toilet flushing demand per acre for the commercial portion of the project (using a prorated acreage, based on the percentage of the project dedicated to commercial use).

- ***Steps 4.3 and 4.4: Identify applicable density thresholds.*** In these steps, you will identify the density thresholds at which there would be sufficient toilet flushing demand to use the full C.3.d amount of stormwater runoff, for the applicable rain gauge area. Refer to the tables in Attachment 2 to locate the applicable density threshold for the rain gauge that is located nearest to your project. The density threshold for residential projects is in terms of dwelling units per impervious acre. The density threshold for non-residential projects is in terms of interior floor area (in square feet) per acre of impervious surface.

- ***Steps 4.5 and 4.6: Feasibility of use based on toilet flushing demand.*** In these steps, you will compare the project density(ies) from steps 4.1 and/or 4.2 with the density thresholds from steps 4.3 and 4.4. If the project density(ies) LESS than the threshold(s), then there is sufficient demand to harvest and use the C.3.d amount of runoff for toilet flushing. If the answer to the applicable question(s) is yes, then rainwater harvesting and use is infeasible, and you can skip to Section 6. If either question results in a "no" answer, then continue to Section 5 to see if there are other constraints that would make it infeasible.

RWH Feasibility Worksheet: Section 5: Factors other than demand

Complete this section if there was a "yes" answer to Questions 4.5 and/or 4.6, or if you are evaluating non-toilet flushing uses of rainwater. The questions in this section will help you determine whether there are site-specific factors, such as steep slope or lack of available space for a cistern, which would make rainwater harvesting and use infeasible.

I.5 Worksheets and Attachments

The following pages include the worksheets and attachments listed below. To download electronic versions of the worksheets, visit www.flowstobay.org, click on "Business", then "New Development", and scroll down to the section titled "Stormwater Requirements for New Development/Redevelopment:".

- Feasibility Screening Worksheet
- Infiltration Feasibility Worksheet
- Rainwater Harvesting and Use Feasibility Worksheet
- Special Projects Worksheet [[=Placeholder pending worksheet completion=]]
- Attachment 1: Glossary
- Attachment 2: Toilet-Flushing Demand for Harvested Rainwater
- Attachment 3: Excerpts from the Feasibility Report (Map of Soil Hydraulic Conductivity and Rain Gauge Areas, Tables 8 through 11 and curves from the report's Appendix F)