

## APPENDIX E

**OPERATING AGREEMENT BETWEEN THE JACKSONVILLE DISTRICT OF THE U.S.  
ARMY CORPS OF ENGINEERS, THE FLORIDA DEPARTMENT OF ENVIRONMENTAL  
PROTECTION,  
NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT THE SOUTH FLORIDA  
WATER MANAGEMENT DISTRICT,  
THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT,  
THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT, AND THE  
SUWANNEE RIVER WATER MANAGEMENT DISTRICT CONCERNING REGULATORY  
PROGRAMS FOR ACTIVITIES IN WETLANDS AND OTHER SURFACE WATERS,  
INCLUDING WATERS OF THE UNITED STATES**

### **I. PARTIES, PURPOSE AND GOALS**

#### **A. The Parties**

The Parties to this Agreement are the Jacksonville District of the United States Army Corps of Engineers (Corps), Florida Department of Environmental Protection (Department), Northwest Florida Water Management District (NFWMD), South Florida Water Management District (SFWMD), St. Johns River Water Management District (SJRWMD), Southwest Florida Water Management District (SWFWMD), and Suwannee River Water Management District (SRWMD) (collectively referred to as "Districts"). Where the Department or a District has delegated responsibilities to a local government in accordance with section 373.441, Florida Statutes (F.S.), this Agreement shall also apply to those local governments that have been delegated such authority as of the effective date of this Agreement.

#### **B. Purpose**

The purpose of this Agreement is to coordinate the permitting, compliance and enforcement programs of the Parties concerning regulation of activities that affect waters of the United States (WOUS) under the jurisdiction of the Corps, and wetlands and other surface waters under the jurisdiction of the Department or the Districts within the state of Florida. This Agreement shall apply to Department of the Army permits ("DA Permits") issued by the Corps pursuant to Section 404 of the Clean Water Act, Section 10 of the Rivers and Harbors Act of 1899 or Section 103 of the Marine Protection, Research and Sanctuaries Act and to permits issued by the Districts or the Department pursuant to part IV of chapter 373, F.S. ("State permits"). This Agreement describes the interaction between the Parties and is subject to the respective laws and implementing regulations and policies of the Parties.

This Agreement supersedes the Agreement entered on November 30, 1998, entitled "Operating Agreement Between the U.S. Army Corps of Engineers, the Florida Department of Environmental Protection, the South Florida Water Management District, the St. Johns River Water Management District, the Southwest Florida Water Management District, and the Suwannee River Water Management District Concerning Regulatory Programs for Activities in Wetlands

and Other Surface Waters.”

### **C. Goals**

It is a goal of the Parties to this Agreement to effectuate efficient, streamlined regulatory programs that govern activities affecting wetlands and other surface waters, including jurisdictional WOUS. Towards this goal, the Parties have established joint application forms and agree, where possible, to coordinate the distribution and review of information received during the permit application review process. Other streamlining measures to be explored and further developed by the Parties include joint field inspections and pre-application meetings, coordinated, complementary enforcement efforts, and the Corps's state programmatic and regional general permits. Additionally, in order to further streamline the permitting process, the agencies agree to continue to jointly review the wetland delineation methodologies of the state and the Corps to identify any differences and explore ways to further resolve or overcome these differences. Further, the Parties may explore methods to integrate the principles of ecosystem management within their existing legal authority in order to achieve more effective environmental protection.

## **II. WATER QUALITY CERTIFICATION**

By letter dated January 15, 1998, to the Secretary of the Department of Environmental Protection, the Governor of the State of Florida, under the authority in 33 U.S.C., Sections 1341 and 1362 (the Clean Water Act), and 40 C.F.R. 121.1(e), designated the Department as the agency responsible for certifying compliance with applicable state water quality standards for federal licenses or permits issued by the Corps under Section 404 of the Clean Water Act, 33 U.S.C. 1344. That letter granted the Department the authority to issue, deny, or waive certification of compliance with water quality standards, the authority to identify categories of activities for which water quality certification is waived, and the authority to establish categories of State permits or other authorizations for which the issuance (or denial) of the permit or authorization constitutes a certification (or denial of certification) that the permitted or authorized activity complies with (or fails to comply with) applicable state water quality standards. By letter dated February 2, 1998, to the Administrator of the Environmental Protection Agency, the Secretary of the Department of Environmental Protection, as delegated by the Governor of the State of Florida, designated certain permits under part IV of chapter 373, F.S., and other authorizations as constituting state certification of compliance with state water quality standards unless the permit or other authorization specifically states otherwise, established categories of activities for which water quality certification is waived, and delegated concurrent authority to issue, deny or waive water quality certifications to a District created under section 373.069, F.S., or to the head of a county, municipality or local government local pollution control program where such county, municipality, or local government pollution control program has received delegation of the permitting authority from the Department or a District under section 373.441, F.S. In accordance with these letters, the Parties agree to the following regarding water quality certification.

## **A. Grants or Waivers of Water Quality Certification**

1. Each of the following will constitute the granting of water quality certification by the Department or Districts, unless a State permit is issued pursuant to the net improvement provisions for water quality provided by section 373.414(1)(b), F.S., or unless otherwise specifically stated in the State permit or authorization.
  - (a) Noticed general environmental resource permits and wetland resource general permits under part IV of chapter 373, F.S.
  - (b) Standard, general, standard general, individual, or conceptual approval environmental resource permits, and individual wetland resource permits issued under part IV of chapter 373, F.S.
  - (c) Management and storage of surface waters permits for agricultural activities or agricultural water management systems issued under part IV of chapter 373, F.S.
  - (d) Joint coastal permits issued under section 161.055 and part IV of chapter 373, F.S.
  - (e) Individual and conceptual mitigation bank permits issued under part IV of chapter 373, F.S.
  - (f) A written final order granting "certification" under one of the following siting acts by the Governor and Cabinet as the Siting Board, the Florida Land and Water Adjudicatory Commission, or by the Department of Environmental Protection, as appropriate:
    - (1) The Florida Electric Power Plant Siting Act, sections 403.501- .519, F.S. (2011), as amended;
    - (2) The Florida Transmission Line Siting Act, sections 403.501 - .5365, F.S., together with sections 403.537-.539, F.S. (2011), as amended; or
    - (3) The Natural Gas Transmission Pipeline Siting Act, sections 403.9401-.9425, F.S. (2011), as amended.
  - (g) Consent decrees, orders, or agreements issued by the Department, a District, or a delegated local government under section 373.441, F.S. (hereinafter the term "Department or District" shall also include local governments delegated in accordance with Section 373.441, F.S.), where such consent decree, order, or agreement authorizes activities which would otherwise require a permit under part IV of chapter 373, F.S.
2. Water quality certification will be considered waived for the following:

- (a) Activities, other than agricultural activities or agricultural water management systems, exempt by rule or statute from the requirement to obtain an environmental resource permit and a wetland resource permit under part IV of chapter 373, F.S., including activities that fall below permitting thresholds;
- (b) Agricultural activities or agricultural water management systems exempt by rule or statute from the requirement to obtain an environmental resource permit and a management and storage of surface waters permit under part IV of chapter 373, F.S., including activities that fall below permitting thresholds;
- (c) Activities permitted or authorized, as described in Sections II. A. 1(a) through (g), when the permit or authorization is issued pursuant to the net improvement provisions for water quality provided by paragraph 373.414(1)(b), F.S.;
- (d) Activities permitted or authorized in Sections II. A. 1(a) through (g) when the permit or authorization expressly waives water quality certification.

**B. Denial of Water Quality Certification**

Unless otherwise stated in the denial document, the denial of the State permit or authorization, listed in Section II.A.1. of this Agreement shall constitute denial of the state water quality certification. Where a final Department or District action on an application for a permit listed in Section II.A.1. of this Agreement cannot be made within the time frames specified in Section II.C. of this Agreement and the application otherwise does not meet the criteria for issuance of a permit, the Department or District may deny water quality certification for the activity described in the permit application in order to meet the time clock requirements in Section II.C.

**C. Time Frames**

Once the Department or the District determines that an application for a permit listed under Section II.A.1. of this Agreement is complete, the Department or District shall have 365 days to act on the certification, or the certification shall be considered waived.

**D. Corps Nationwide Permits**

For nationwide permits that have received water quality certification by the Department, or where water quality certification has been waived by the Department or District, no individual water quality certification is necessary. For those Corps nationwide permits that were conditioned upon individual review of the water quality certification by the Department or District, or that have been denied water quality certification by the Department or District, state water quality certification for an individual proposed activity shall be made in accordance with

Sections II. A - C.

### **III. COASTAL ZONE CONSISTENCY CONCURRENCE (CZCC)**

In accordance with section 373.428, F.S., final agency action by the Department or District on a permit application submitted under part IV of chapter 373, F.S., that is subject to a consistency review under section 380.23, F.S., shall constitute the state's determination as to whether the activity is consistent with the federally approved Coastal Management Program. The Parties agree to the following procedures regarding coastal zone consistency determinations.

#### **A. Determination of Concurrence**

The following will constitute a finding of concurrence with the state's coastal zone management program for the activity authorized thereby:

1. Noticed general environmental resource permits and wetland resource general permits under part IV of chapter 373, F.S.;
2. Standard, general, standard general, individual, or conceptual approval environmental resource permits and individual wetland resource permits issued under part IV of chapter 373, F.S.;
3. Joint coastal permits issued under section 161.055 and part IV of chapter 373, F.S.;
4. Individual and conceptual mitigation bank permits issued under section 161.055 and part IV of chapter 373, F.S.; and
5. Management and storage of surface waters permits for agricultural activities or agricultural water management systems issued under part IV of chapter 373, F.S.

#### **B. Determination of Inconsistency**

The denial of a permit listed in Section III. A. of this Agreement shall constitute a finding that the activity is inconsistent with the state's coastal zone management program.

#### **C. Time Frames**

The time frame for a coastal zone concurrence begins upon a determination by the Department or the District that an application for a permit listed in Section III.A. of this Agreement is complete. The coastal zone consistency decision must be made within 180 days after the application is considered complete by the Department or District and in accordance with the procedures in 15 C.F.R. 930

Subpart D. At the end of 180 days, if a determination of coastal zone consistency has not been made, concurrence will be conclusively presumed, unless the applicant and the Department or District have agreed to waive the 180-day time clock pursuant to 15 C.F.R. 930.60(b).

#### **D. Corps Nationwide Permits**

For nationwide permits that have been determined to be consistent with the state's coastal zone management program, no individual coastal zone consistency concurrence determination is necessary. For those Corps nationwide permits where consistency with the state coastal zone management program is conditioned upon individual review of the coastal zone management consistency by the state of Florida, or has been denied by Florida, the final consistency concurrence determination for a proposed activity shall be made in accordance with Sections III A - C.

#### **E. Exemptions**

Pursuant to section 380.23(7), F.S., applications for federally permitted or licensed activities that qualify for an exemption under section 373.406 or 403.813(1), F.S., are not eligible to be reviewed for federal consistency with part IV of chapter 373, F.S. For purposes of this Agreement, the Corps or any designated Federal, State or local agency administering general permits on behalf of the Corps under 33 C.F.R. § 325.2(b)(2) may presume CZCC by operation of Section 380.23(7), F.S., for such exempt activities, provided the activity receives the applicable authorization to use and occupy state-owned submerged lands under chapter 253, F.S., and, as applicable, chapter 258, F.S., and the rules of the Florida Administrative Code adopted thereunder. For purposes of this agreement, the Corps or any designated Federal, State or local agency administering general permits on behalf of the Corps shall not be precluded from acting on the DA permit before the applicable authorization under chapter 253, F.S., and, as applicable, chapter 258, F.S., is obtained or granted, because it is understood such authorization must be obtained prior to persons using or occupying state-owned submerged lands.

### **IV. PERMIT APPLICATION COORDINATION**

#### **A. Joint Application Forms**

The Parties have developed comprehensive, integrated joint permit application forms to initiate processing of permit applications required by each of the Parties. For activities that require a DA Permit and an environmental resource permit under part IV of chapter 373, F.S., the "Joint Application for Environmental Resource Permit/Authorization to Use State Lands/Federal Dredge and Fill Permit," the "Application for a Joint Coastal Permit," or the "Joint Application Forms and Instructions for Wetland Resource Alterations (Dredging & Filling) in the Waters of Florida" will be used. For activities that require a DA Permit and a wetland resource permit under the provisions of Section 373.4145(6) or

373.414(11) - (16), F.S., the "Joint Application For Works in the Waters of Florida" and the "Notice of Intent to Construct Works Pursuant to a Wetland Resource General Permit" will be used.

## **B. Processing of Applications**

Except as provided below for E-permitting, for activities that do not qualify for processing as "green" under the State Programmatic General Permit, once a joint application, a request for permit modification, or a request for verification of exempt status is submitted by an applicant to the Department or District, the responsible agency (in accordance with the division of responsibilities in the Operating Agreements in effect between the Department and Districts) will, forward the following information to the Corps office with responsibility for processing the corresponding DA Permit application. All forwarded materials will include a Department or District application processing number

### **1. Forwarding Received Applications;**

Within five working days of receipt, the Department or District, as applicable, will forward to the Corps, either by mail or electronically via a mutually agreed upon protocol:

- (a) For WRP applications, a copy of the application, all submitted maps, drawings, and any other information accompanying the application or request;
- (b) For ERP applications, including mitigation banks, that have one or more of the following items provided or identified, one copy of the Notice of Receipt of the Application (Section C of the Joint Application) with its accompanying maps, drawings and any other information accompanying the application or request:
  - (1) A completed Corps' Data Entry Sheet;
  - (2) Any indication in the application that work is occurring, or appears to be occurring, in, on, or over wetlands and other surface waters.
  - (3) A type of DA Permit or enforcement action is requested or is identified as pending, issued or denied at the location of the activity. The Corps number starts with an "SAJ" and the four digit year (prior to 1990 the number started with a two digit year); the number also may include staff initials.
  - (4) An indication in the application that a member of the Corps has attended a pre-application meeting.

### **2. Forwarding of Applications and Material Received During Processing:**

- (a) For WRP and ERP applications, including mitigation banks, that meet the criteria of IV.B.1., the Department or District, as applicable, will, within five working days of sending to the applicant, forward one copy of all Requests for Additional Information (RAIs) to the Corps.
  - (b) For those applications not copied to the Corps in which either state or federal wetlands within the proposed activity or future phases are discovered during the evaluation, the Department or District, as applicable, will, within five working days of this discovery, forward the Corps one copy of the Notice of Receipt of the Application (Section C of the Joint Application) with its accompanying maps, drawings, and activity descriptions, together with a copy of any RAIs that have been generated.
  - (c) A copy of materials subsequently submitted. Individual Corps offices will coordinate with individual Department and District offices to identify the manner in which the Corps wants such documents forwarded to it.
3. Forwarding Modifications and Materials:
- Within five working days of receipt of a modification request, the Department or District, as applicable, will forward to the Corps, either by mail or electronically via a mutually agreed upon protocol, a copy of the request with all attached maps, drawings, and any other information accompanying the request.
4. E-Permitting — For Department or District offices that electronically post applications, RAIs, modifications, and related materials to the Internet, an .ftp site, or another site accessible to the Corps, the Department or District shall first coordinate with the Corps to ensure the electronic posting procedure is compatible with the needs of the Corps. If the Department or the District's electronic posting procedure is not compatible with the Corps's requirements, the Department or District shall continue to mail materials to the Corps.
5. In those cases where the Corps receives a copy of the joint application, an application to modify a permit, a notice to use a noticed general permit, a request to verify qualification for an exemption, or a request to verify that an activity does not require a permit directly from an applicant, the Corps shall retain one copy of the application and all accompanying materials and send all other copies and materials to the appropriate office of the Department or District. The Corps shall include its processing number with this information.
6. The Department or District shall not be obligated to forward documents or materials to the Corps that are confidential under chapter 119, F.S. In such cases the Corps will request the applicant, permittee, or sponsor to provide such information directly to the Corps as needed.
7. In those cases where the Corps has made a "no permit required" (NPR) determination on an application that is under review by the Department or District,

the Corps will furnish a copy of the determination to the Department or District. The Corps will include the applicant's name, location, brief project name/description, and, if known, the Department or District application file number. The Department or District will no longer be required to provide information to the Corps subsequent to receiving this notification unless the project is modified to include additional impacts to wetlands or other surface waters.

**C. Mitigation Bank and In-lieu Fee Review**

**1. Interagency Review Team**

Interagency review of mitigation bank applications and establishment of in-lieu fee programs is required by 33 C.F.R. § 332.8(b) and serves to facilitate a more efficient and effective review of such applications. The Corps's District Engineer will establish an Interagency Review Team (IRT) to review documentation for the establishment and management of mitigation banks and in-lieu fee programs. He or his designated representative serves as Chair of the IRT. In cases where a mitigation bank or in-lieu fee program involves an activity that is proposed to satisfy state statutory requirements, it may be appropriate for either the Department or District to serve as Co-Chair of the IRT. For purposes of this Agreement, the "administering agency" is defined as a member of either the Department or the applicable District. The IRT may include representatives from tribal, state, and local regulatory and resource agencies when such agencies have authorities or mandates directly affecting, or affected by, the establishment, operation, or use of the mitigation bank or in-lieu fee program. The District Engineer will give full consideration to any comments and advice received within time limits specified at 33 C.F.R. § 332.8. The Department and the Districts will give full consideration to any comments and advice received within the time limits specified in chapter 120, F.S. The District Engineer retains final authority for the approval of the instruments and other documentation required by the Corps. The Department and the Districts retain final authority for the approval of state permits or other documentation required by the state.

**2. Team Coordination**

An application to the Department or Districts for a mitigation bank shall be coordinated with the Corps in accordance with the Permit Application Coordination section IV. B. of this Agreement. When the Corps receives a mitigation bank or in-lieu-fee prospectus or draft prospectus, copies shall be provided to the Department or applicable District, along with other IRT members. In addition, the IRT shall coordinate, review, and take action on the items required by 33 C.F.R. § 332.8.

**D. Distribution of Agency Actions**

For applications that meet the criteria of section IV.B.1, IV.B.2, or IV.B.3 above,

the Department or District, as applicable, will, within five working days of sending to the applicant/permittee, forward to the Corps a copy of all final permitting actions, including copies of permits, formal or major permit modifications, permit denials, application withdrawals, exemption verification letters, and the cover letter for formal determinations.

The Corps shall forward to the Department or Districts, as appropriate, copies of notices of intent to issue standard permits, final actions on standard permits, and "no permit required" determinations within five working days of taking such actions.

## **V. MITIGATION FINANCIAL ASSURANCE**

- A. When the type and amount of the financial assurance obtained or required by the Department or District for compensatory mitigation, including mitigation banks, as part of a permit issued under part IV of chapter 373, F.S., adequately addresses the financial assurance requirements of the Corps, the Corps may determine that additional financial assurance is not necessary for that compensatory mitigation project or mitigation bank.
- B. The Corps's concurrence with the Department's or District's financial assurance mechanism shall be subject to the applicant, sponsor, or permittee agreeing to the following requirements:
  - 1. The Corps shall notify the Department or District in all cases where the Corps is relying on the financial assurance mechanism accepted by the Department or District so that the Department or District can coordinate with the Corps prior to modification, amendment, partial release, termination, or revocation of the financial assurance instrument.
  - 2. The financial assurance instrument shall be in place prior to commencement of the permitted activity.
  - 3. Disbursements from these financial assurance instruments can only be made with direction and approval of the Department or District as applicable after prior notice has been given to the Corps in accordance with 4., below.
  - 4. The Corps permit shall require that the permittee shall provide the Corps written notice at least 120 days in advance of any termination or revocation of any financial assurance instrument by the financial institution, and notice at least 30 days in advance of modifications, amendments, and partial releases.
- C. If, at any time, the Corps determines that the type or amount of the financial assurance mechanism being proposed for a State permit under part IV of chapter 373, F.S., is not sufficient to meet the Corps' requirements for a DA Permit or a mitigation banking instrument or in-lieu fee instrument and those requirements are

within the scope of such state permit, the Corps may require the applicant, sponsor, or permittee for the DA Permit to request that the Department or District modify the permit under part IV of chapter 373, F.S., as applicable, to require an additional amount or alternative type of financial assurance mechanism to meet the Corps' requirements. In such a case:

1. The financial assurance instrument shall be in place prior to commencing the permitted activity;
2. Prior to any disbursements under the financial assurance instruments, the Department or District shall coordinate with the Corps at least 30 days prior to such disbursement being made, but the final decision on the disbursement shall be made by the Department or District;
3. Notification of such disbursements shall be provided to the Corps within 10 days after the disbursement;
4. The Corps permit shall require that the permittee shall provide the Corps written notice at least 120 days in advance of any termination or revocation of any financial assurance instrument by the financial institution, and notice at least 30 days in advance of modifications, amendments, and partial releases.

Notwithstanding the above, the Department or District is not obligated to accept financial assurance mechanisms that are not required to satisfy the permit requirements under part IV of chapter 373, F.S.

- D. If the Corps requires an alternative type or an additional amount of financial assurance to meet Corps mitigation requirements outside of the scope of the State permit, the Department or District is not obligated to be a party to any instrument related to that assurance.

## **VI. MITIGATION SITE PROTECTION**

Long-term protection of a mitigation site or preservation to prevent secondary impacts for a State permit, mitigation bank instrument, or as the result of an enforcement action under part IV of chapter 373, F.S., may be provided through the conveyance of a conservation easement or restrictive covenants in accordance with Section 704.06,

F. S., or by transfer of title to the Department or District (hereinafter all referred to as "site protection instrument").

In accordance with 33 C.F.R. § 332.7(a)(1), when such a site protection instrument meets the Corps' requirements for mitigation site protection for the corresponding DA Permit for the same activities, the Corps may agree that the site protection instrument granted to the Department or District provides sufficient site protection, and not require an applicant, sponsor, or permittee to provide an amended, additional, or duplicative mitigation site protection instrument. When the Department or District accepts a site protection instrument in the form of a restrictive covenant or deed

restriction, the Corps may determine that an applicant needs to execute a conservation easement.

- A. When the Department or District agrees to hold or amend a site protection instrument which provides rights to the Corps, the Department and District agree to accept a site protection instrument containing, or that is amended to contain, the following language, unless alternative language is needed on a case-specific basis:

"WHEREAS, the U.S. Army Corps of Engineers Permit No. \_\_\_\_\_ (Corps Permit) authorizes certain activities in the waters of the United States and requires this site protection instrument over the lands identified in Exhibit XX as mitigation for such activities;

"Rights of the U.S. Army Corps of Engineers ("Corps"): The Corps, as a third party beneficiary, shall have the right to enforce the terms and conditions of the site protection instrument, including:

- "1. The right to take action to preserve and protect the environmental value of the Property;
- "2. The right to prevent any activity on the Property that is inconsistent with the purpose of this instrument, and to require the restoration of areas or features of the Property that may be damaged by any inconsistent activity;
- "3. The right to enter upon and inspect the Property in a reasonable manner and at reasonable times to determine if Grantor or its successors and assigns are complying with the covenants and prohibitions contained in this instrument;
- "4. The right to enforce this instrument by injunction or proceed at law or in equity to enforce the provisions of this instrument and the covenants set forth herein, to prevent the occurrence of any of the prohibited activities hereinafter set forth, and the right to require Grantor, or its successors and assigns, to restore such areas or features of the Property that may be damaged by unauthorized activities; and
- "5. The Grantor, including their successors or assigns, shall provide the Corps at least 60 days advance notice in writing before any action is taken to amend, alter, release, or revoke this instrument. The Grantee shall provide reasonable notice and an opportunity to comment or object to the release or amendment to the U.S. Army Corps of Engineers. The Grantee shall consider any comments or objections from the U.S. Army Corps of Engineers when making the final decision to release or amend such a conservation easement."

- B. When the Corps requires additional protection or additional mitigation lands for an

activity that has a corresponding State permit, mitigation bank instrument, or enforcement instrument under part IV of chapter 373, F.S., and the Department or the District is willing to accept the additional or amended site protection instrument, the instrument shall include the following additional provision:

"The Grantor, including their successors or assigns, shall provide the Corps at least 60 days advance notice in writing before any action is taken to amend, alter, release, or revoke this instrument. The Grantee shall provide reasonable notice and an opportunity to comment or object to the release or amendment to the U.S. Army Corps of Engineers. The Corps, as third party beneficiary, must approve any amendment, alteration, release or revocation of this instrument, and must approve any proposed structures, work, or activities on the Property that require approval by the Grantee."

- C. When the Department or District does not agree or is unable to modify the permit, mitigation bank instrument, or enforcement instrument under part IV of chapter 373, F.S., or any existing site protection instrument to include the additional mitigation land needed to meet the Corps's requirements, the Department or District may agree to accept a separate mitigation site protection instrument over the additional land. If the Department or District agrees to accept a separate mitigation site protection instrument over the additional land, the Department or District agree that the instrument shall be accepted with the following additional provision:

"The Grantor, including their successors or assigns, shall provide the Corps at least 60 days advance notice in writing before any action is taken to amend, alter, release, or revoke this instrument. The Grantee shall provide reasonable notice and an opportunity to comment or object to the release or amendment to the U.S. Army Corps of Engineers. The Corps, as third party beneficiary, must approve any amendment, alteration, release or revocation of this instrument, and must approve any proposed structures, work, or activities on the Property that require approval by the Grantee."

- D. In any case where the Department or District agrees to hold or amend a site protection instrument which provides rights to the Corps, as described above, the Corps shall notify the applicable Department or District office within 10 days of any discovery of a violation of the terms and conditions of the site protection instrument, and shall coordinate with the applicable Department or District office prior to requiring restoration of areas or features of the Property that were damaged by unauthorized activities so that any restoration activities receive applicable authorization required under part IV of chapter 373, F.S.
- E. In the event a site protection instrument has already been recorded on behalf of the Department or District for the same activity that will be authorized under a corresponding DA Permit or mitigation bank or in-lieu fee instrument that does not include the "Rights of the Corps" language in VILA., above, the Corps may require the applicant, permittee, or sponsor to request that the Department or District

modify their respective permit, mitigation bank instrument or enforcement instrument with its associated site protection instrument to include that language.

- F. The Department and the District do not agree to accept a site protection instrument on behalf of the Corps when there is no corresponding permit under part IV of chapter 373, F.S., for the activity that is subject to a DA permit.
- G. In all cases, the Corps shall not request an applicant, permittee, or sponsor to record any site protection instrument granted to the Department or District without first coordinating with and obtaining a letter of concurrence from the applicable office of the Department or District; however, final approval of this request may be required from the District Governing Board. Failure to obtain such written concurrence shall result in any such recorded site protection instrument being considered an invalid conveyance of the interest to the Department or District.
- H. In any case when the Corps requires the applicant, permittee, or sponsor to obtain an additional site protection instrument, the Corps agrees to take responsibility for all negotiations with the applicant, permittee, or sponsor associated with processing and preparation of the site protection instrument required by the Corps, including review of the title work. The Corps also shall take responsibility for all steps required to have the site protection instrument recorded, including any subsequent amendments or releases of any site protection instrument previously recorded on behalf of the Department or District, and for sending an original copy of the recorded site protection instrument, and any modifications and releases thereto, to the applicable Department or District office that serves the area in which the site protection instrument is recorded. The Corps also agrees to monitor for compliance and pursue needed enforcement, including litigation, to enforce the terms and conditions of the site protection instrument obtained over any lands that were not required to be protected under the permit, mitigation bank instrument, or enforcement instrument under part IV of chapter 373, F.S.
- I. The Parties agree to coordinate in the event compliance monitoring of the protected lands identifies the need for enforcement.

## **VII. COMPLIANCE AND ENFORCEMENT**

Upon discovery of an unauthorized or non-compliant activity in WOUS, wetlands, or other surface waters, the Party discovering the activity will notify the appropriate Party to this Agreement regarding the unauthorized or non-compliant activity. The Parties may coordinate their enforcement activities when appropriate in order to maximize limited agency resources and encourage compliance. Regardless of any coordination that may occur, each Party will maintain independent enforcement authority and discretion.

## **VIII. INTERAGENCY MEETINGS**

### **A. Permitting Meetings**

Subject to fiscal or travel restrictions, each Party agrees to host interagency permitting meetings on a rotating basis. The time and place of all the meetings will be addressed at the beginning of each calendar year. Because interagency meetings between the Parties and other agencies can serve as a good forum to aid communication, exchange information, conduct pre-application meetings, or to resolve outstanding permitting issues, each Party will endeavor to have a representative attend all interagency meetings.

#### **B. Enforcement Meetings**

Subject to fiscal or travel restrictions, representatives of the Parties' enforcement staff shall endeavor to meet at least annually. If possible, the meeting should take place at Enforcement Workshops hosted by the Department or District, but local meetings in areas of operation are also appropriate and encouraged. The meeting should address issues related to implementation of section VII of this Agreement.

#### **C. Cross Training**

The Parties agree to provide opportunities, when possible, for cross-training. This may take the form of: providing spaces in formally scheduled training courses; providing training sessions at each others' training events; providing personnel and opportunities for cross-training through developmental assignments; sharing interpretations of agency rules and procedures; and performing joint formal and informal training on other subjects of mutual interest.

### **IX. ELECTRONIC COORDINATION**

To the extent practicable, the Parties agree to use electronic media for the transfer of data to facilitate information exchange. The Parties agree to participate in future efforts to enhance electronic communication necessary to achieve their regulatory missions.

### **X. DELEGATED PROGRAMS**

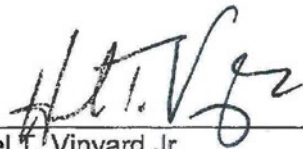
Where the Department or Districts delegate to a local government all or a portion of the permitting or enforcement authority under part IV of chapter 373, F.S., the delegation agreement shall include a provision that the local government shall be subject to all the terms and conditions of this Agreement, although the Corps, with the concurrence of the delegating agency, may allow deviations from these terms and conditions.

### **XI. EFFECTIVE DATE**

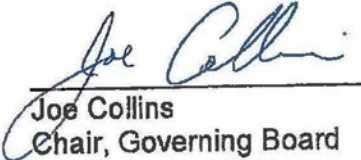
This Agreement shall take effect upon execution by all the Parties. In witness whereof, the Parties hereto have caused this Agreement to be executed by their duly authorized representatives on the latest day and year provided below.

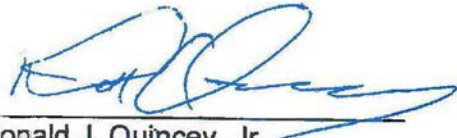
## **XII. TERMINATION**

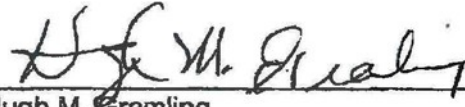
Any Party who wishes to terminate this Agreement with or without cause shall provide 60 days prior written notice to the other Parties. The notice submitted by the Corps shall be signed by the District Engineer of the Jacksonville District. The notice submitted by a District shall be signed by the Chair of the Governing Board. The notice submitted by the Department shall be signed by the Secretary. By mutual agreement of all Parties, the 60 day notice period may be reduced. Within 30 days of a notice of intent to terminate this Agreement, all Parties shall make good faith efforts to preserve the Agreement by attempting to resolve any basis for the termination. This Agreement also may be terminated by future agreements between the Parties that which expressly supersede this Agreement.

  
Herschel T. Vinyard Jr.  
Secretary  
Florida Department of  
Environmental Protection  
4/4/12  
Date

  
Lad Daniels  
Chair, Governing Board  
St. Johns River Water  
Management District  
4/10/12  
Date

  
Joe Collins  
Chair, Governing Board  
South Florida Water  
Management District  
4/12/2012  
Date

  
Donald J. Quincey, Jr.  
Chair, Governing Board  
Suwannee River Water  
Management District  
8-14-12  
Date

  
Hugh M. Gramling  
Vice Chair, Governing Board  
Southwest Florida Water  
Management District  
5/22/12  
Date

  
Alan M. Dodd  
Colonel, U. S. Army  
District Commander  
9-4-12  
Date

  
George Roberts  
Chair, Governing Board  
Northwest Florida Water  
Management District  
4/30/12  
Date



## **APPENDIX F**

### **Bald and Golden Eagle Protection Act**

**16 USC 668-668d**  
**Bald and Golden Eagle Protection Act**

**SUBCHAPTER II—PROTECTION OF BALD AND GOLDEN EAGLES**

Release date: 2004-04-30

- § 668. Bald and golden eagles
- § 668a. Taking and using of the bald and golden eagle for scientific, exhibition, and religious purposes
- § 668b. Enforcement provisions
- § 668c. Definitions
- § 668d. Availability of appropriations for Migratory Bird Treaty Act

**§ 668. Bald and golden eagles**

**(a) Prohibited acts; criminal penalties**

Whoever, within the United States or any place subject to the jurisdiction thereof, without being permitted to do so as provided in this subchapter, shall knowingly, or with wanton disregard for the consequences of his act take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner any bald eagle commonly known as the American eagle or any golden eagle, alive or dead, or any part, nest, or egg thereof of the foregoing eagles, or whoever violates any permit or regulation issued pursuant to this subchapter, shall be fined not more than \$5,000 or imprisoned not more than one year or both: Provided, That in the case of a second or subsequent conviction for a violation of this section committed after October 23, 1972, such person shall be fined not more than \$10,000 or imprisoned not more than two years, or both: Provided further, That the commission of each taking or other act prohibited by this section with respect to a bald or golden eagle shall constitute a separate violation of this section: Provided further, That one-half of any such fine, but not to exceed \$2,500, shall be paid to the person or persons giving information which leads to conviction: Provided further, That nothing herein shall be construed to prohibit possession or transportation of any bald eagle, alive or dead, or any part, nest, or egg thereof, lawfully taken prior to June 8, 1940, and that nothing herein shall be construed to prohibit possession or transportation of any golden eagle, alive or dead, or any part, nest, or egg thereof, lawfully taken prior to the addition to this subchapter of the provisions relating to preservation of the golden eagle.

**(b) Civil penalties**

Whoever, within the United States or any place subject to the jurisdiction thereof, without being permitted to do so as provided in this subchapter, shall take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner, any bald eagle, commonly known as the American eagle, or any golden eagle, alive or dead, or any part, nest, or egg thereof of the foregoing eagles, or whoever violates any permit or regulation issued pursuant to this subchapter, may be assessed a civil penalty by the Secretary of not more than \$5,000 for each such violation. Each violation shall be a separate offense. No penalty shall be assessed unless such person is given notice and opportunity for a hearing with respect to such violation. In determining the amount of the penalty, the gravity of the violation, and the demonstrated good faith of the person charged shall be considered by the Secretary. For good cause shown, the Secretary may remit or mitigate any such penalty. Upon any failure to pay the penalty assessed under this section, the Secretary may request the Attorney General to institute a civil action in a district court of the United States for any district in which such person is found or resides or transacts business to collect the penalty and such court shall have jurisdiction to hear and decide any such action. In hearing any such action, the court must sustain the Secretary's action if supported by substantial evidence.

**(c) Cancellation of grazing agreements**

The head of any Federal agency who has issued a lease, license, permit, or other agreement authorizing the grazing of domestic livestock on Federal lands to any person who is convicted of a violation of this subchapter or of any permit or regulation issued hereunder may immediately cancel each such lease, license, permit, or other agreement. The United States shall not be liable for the payment of any compensation, reimbursement, or damages in connection with the cancellation of any lease, license, permit, or other agreement pursuant to

**16 USC 668-668d**  
**Bald and Golden Eagle Protection Act**

this section.

**§ 668a. Taking and using of the bald and golden eagle for scientific, exhibition, and religious purposes**

Whenever, after investigation, the Secretary of the Interior shall determine that it is compatible with the preservation of the bald eagle or the golden eagle to permit the taking, possession, and transportation of specimens thereof for the scientific or exhibition purposes of public museums, scientific societies, and zoological parks, or for the religious purposes of Indian tribes, or that it is necessary to permit the taking of such eagles for the protection of wildlife or of agricultural or other interests in any particular locality, he may authorize the taking of such eagles pursuant to regulations which he is hereby authorized to prescribe: Provided, That on request of the Governor of any State, the Secretary of the Interior shall authorize the taking of golden eagles for the purpose of seasonally protecting domesticated flocks and herds in such State, in accordance with regulations established under the provisions of this section, in such part or parts of such State and for such periods as the Secretary determines to be necessary to protect such interests: Provided further, That bald eagles may not be taken for any purpose unless, prior to such taking, a permit to do so is procured from the Secretary of the Interior: Provided further, That the Secretary of the Interior, pursuant to such regulations as he may prescribe, may permit the taking, possession, and transportation of golden eagles for the purposes of falconry, except that only golden eagles which would be taken because of depredations on livestock or wildlife may be taken for purposes of falconry: Provided further, That the Secretary of the Interior, pursuant to such regulations as he may prescribe, may permit the taking of golden eagle nests which interfere with resource development or recovery operations.

**§ 668b. Enforcement provisions**

**(a) Arrest; search; issuance and execution of warrants and process**

Any employee of the Department of the Interior authorized by the Secretary of the Interior to enforce the provisions of this subchapter may, without warrant, arrest any person committing in his presence or view a violation of this subchapter or of any permit or regulations issued hereunder and take such person immediately for examination or trial before an officer or court of competent jurisdiction; may execute any warrant or other process issued by an officer or court of competent jurisdiction for the enforcement of the provisions of this subchapter; and may, with or without a warrant, as authorized by law, search any place. The Secretary of the Interior is authorized to enter into cooperative agreements with State fish and wildlife agencies or other appropriate State authorities to facilitate enforcement of this subchapter, and by said agreements to delegate such enforcement authority to State law enforcement personnel as he deems appropriate for effective enforcement of this subchapter. Any judge of any court established under the laws of the United States, and any United States magistrate judge may, within his respective jurisdiction, upon proper oath or affirmation showing probable cause, issue warrants in all such cases.

**(b) Forfeiture**

All bald or golden eagles, or parts, nests, or eggs thereof, taken, possessed, sold, purchased, bartered, offered for sale, purchase, or barter, transported, exported, or imported contrary to the provisions of this subchapter, or of any permit or regulation issued hereunder, and all guns, traps, nets, and other equipment, vessels, vehicles, aircraft, and other means of transportation used to aid in the taking, possessing, selling, purchasing, bartering, offering for sale, purchase, or barter, transporting, exporting, or importing of any bird, or part, nest, or egg thereof, in violation of this subchapter or of any permit or regulation issued hereunder shall be subject to forfeiture to the United States.

**(c) Customs laws applied**

All provisions of law relating to the seizure, forfeiture, and condemnation of a vessel for violation of the customs laws, the disposition of such vessel or the proceeds from the sale thereof, and the remission or mitigation of such forfeitures, shall apply to the seizures and forfeitures incurred, or alleged to have been incurred, under the provisions of this subchapter, insofar as such provisions of law are applicable and not

**16 USC 668-668d**  
**Bald and Golden Eagle Protection Act**

inconsistent with the provisions of this subchapter: Provided, That all powers, rights, and duties conferred or imposed by the customs laws upon any officer or employee of the Treasury Department shall, for the purposes of this subchapter, be exercised or performed by the Secretary of the Interior or by such persons as he may designate.

**§ 668c. Definitions**

As used in this subchapter "whoever" includes also associations, partnerships, and corporations; "take" includes also pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb; "transport" includes also ship, convey, carry, or transport by any means whatever, and deliver or receive or cause to be delivered or received for such shipment, conveyance, carriage, or transportation.

**§ 668d. Availability of appropriations for Migratory Bird Treaty Act**

Moneys now or hereafter available to the Secretary of the Interior for the administration and enforcement of the Migratory Bird Treaty Act of July 3, 1918 [[16 U.S.C. 703](#) et seq.], shall be equally available for the administration and enforcement of this subchapter.

## **APPENDIX G**

### **USFWS Habitat Management Guidelines for the Wood Stork in the Southeast Region**

# HABITAT MANAGEMENT GUIDELINES FOR THE WOOD STORK IN THE SOUTHEAST REGION



B-1





**HABITAT MANAGEMENT GUIDELINES  
FOR THE WOOD STORK IN THE  
SOUTHEAST REGION**

**Prepared by**

**John C. Ogden  
Acting Program Manager  
Wildlife Research  
Everglades National Park**

**for the**

**Southeast Region  
U.S. Fish and Wildlife Service**

**January 1990**

**Cover design by  
Florida Power & Light Company  
Miami, Florida**



# **HABITAT MANAGEMENT GUIDELINES FOR THE WOOD STORK IN THE SOUTHEAST REGION**

## **Introduction**

A number of Federal and state laws and/or regulations prohibit, cumulatively, such acts as harrassing, disturbing, harming, molesting, pursuing, etc., wood storks, or destroying their nests (see Section VII). Although advisory in nature, these guidelines represent a biological interpretation of what would constitute violations of one or more of such prohibited acts. Their purpose is to maintain and/or improve the environmental conditions that are required for the survival and well-being of wood storks in the southeastern United States, and are designed essentially for application in wood stork/human activity conflicts (principally land development and human intrusion into stork use sites). The emphasis is to avoid or minimize detrimental human-related impacts on wood storks. These guidelines were prepared in consultations with state wildlife agencies and wood stork experts in the four southeastern states where the wood stork is listed as Endangered (Alabama, Florida, Georgia, South Carolina).

## **General**

The wood stork is a gregarious species, which nests in colonies (rookeries), and roosts and feeds in flocks, often in association with other species of long-legged water birds. Storks that nest in the southeastern United States appear to represent a distinct population, separate from the nearest breeding population in Mexico. Storks in the southeastern U.S. population have recently (since 1980) nested in colonies scattered throughout Florida, and at several central-southern Georgia and coastal South Carolina sites. Banded and color-marked storks from central and southern Florida colonies have dispersed during non-breeding seasons as far north as southern Georgia, and the coastal counties in South Carolina and southeastern North Carolina, and as far west as central Alabama and northeastern Mississippi. Storks from a colony in south-central Georgia have wintered between southern Georgia and southern Florida. This U.S. nesting population of wood storks was listed as endangered by the U.S. Fish and Wildlife Service on February 28, 1984 (*Federal Register* 49(4):7332-7335).

Wood storks use freshwater and estuarine wetlands as feeding, nesting, and roosting sites. Although storks are not habitat specialists, their needs are exacting enough, and available habitat is limited enough, so that nesting success and the size of regional populations are closely regulated by year-to-year differences in the quality and quantity of suitable habitat. Storks are especially sensitive to environmental conditions at feeding sites; thus, birds may fly relatively long distances either daily or between regions annually, seeking adequate food resources.

All available evidence suggests that regional declines in wood stork numbers have been largely due to the loss or degradation of essential wetland habitat. An understanding of the qualities of good stork habitat should help to focus protection efforts on those sites

that are seasonally important to regional populations of wood storks. Characteristics of feeding, nesting, and roosting habitat, and management guidelines for each, are presented here by habitat type.

#### **I. Feeding habitat.**

A major reason for the wood stork decline has been the loss and degradation of feeding habitat. Storks are especially sensitive to any manipulation of a wetland site that results in either reduced amounts or changes in the timing of food availability.

Storks feed primarily (often almost exclusively) on small fish between 1 and 8 inches in length. Successful foraging sites are those where the water is between 2 and 15 inches deep. Good feeding conditions usually occur where water is relatively calm and uncluttered by dense thickets of aquatic vegetation. Often a dropping water level is necessary to concentrate fish at suitable densities. Conversely, a rise in water, especially when it occurs abruptly, disperses fish and reduces the value of a site as feeding habitat.

The types of wetland sites that provide good feeding conditions for storks include: drying marshes or stock ponds, shallow roadside or agricultural ditches, narrow tidal creeks or shallow tidal pools, and depressions in cypress heads or swamp sloughs. In fact, almost any shallow wetland depression where fish tend to become concentrated, either through local reproduction or the consequences of area drying, may be used by storks.

Nesting wood storks do most of their feeding in wetlands between 5 and 40 miles from the colony, and occasionally at distances as great as 75 miles. Within this colony foraging range and for the 110-150 day life of the colony, and depending on the size of the colony and the nature of the surrounding wetlands, anywhere from 50 to 200 different feeding sites may be used during the breeding season.

Non-breeding storks are free to travel much greater distances and remain in a region only for as long as sufficient food is available. Whether used by breeders or non-breeders, any single feeding site may at one time have small or large numbers of storks (1 to 100+), and be used for one to many days, depending on the quality and quantity of available food. Obviously, feeding sites used by relatively large numbers of storks, and/or frequently used areas, potentially are the more important sites necessary for the maintenance of a regional population of birds.

Differences between years in the seasonal distribution and amount of rainfall usually mean that storks will differ between years in where and when they feed. Successful nesting colonies are those that have a large number of feeding site options, including sites that may be suitable only in years of rainfall extremes. To maintain the wide range of feeding site options requires that many different wetlands, with both relatively short and long annual hydroperiods, be preserved. For example, protecting only the larger wetlands, or those with longer annual hydroperiods, will result in the eventual loss of smaller, seemingly less important wetlands. However, these small scale wetlands are crucial as the only available feeding sites during the wetter periods when the larger habitats are too deeply flooded to be used by storks.

## II. Nesting habitat.

Wood storks nest in colonies, and will return to the same colony site for many years so long as that site and surrounding feeding habitat continue to supply the needs of the birds. Storks require between 110 and 150 days for the annual nesting cycle, from the period of courtship until the nestlings become independent. Nesting activity may begin as early as December or as late as March in southern Florida colonies, and between late February and April in colonies located between central Florida and South Carolina. Thus, full term colonies may be active until June-July in south Florida, and as late as July-August at more northern sites. Colony sites may also be used for roosting by storks during other times of the year.

Almost all recent nesting colonies in the southeastern U.S. have been located either in woody vegetation over standing water, or on islands surrounded by broad expanses of open water. The most dominant vegetation in swamp colonies has been cypress, although storks also nest in swamp hardwoods and willows. Nests in island colonies may be in more diverse vegetation, including mangroves (coastal), exotic species such as Australian pine (*Casuarina*) and Brazilian Pepper (*Schinus*), or in low thickets of cactus (*Opuntia*). Nests are usually located 15-75 feet above ground, but may be much lower, especially on island sites when vegetation is low.

Since at least the early 1970's, many colonies in the southeastern U.S. have been located in swamps where water has been impounded due to the construction of levees or roadways. Storks have also nested in dead and dying trees in flooded phosphate surface mines, or in low, woody vegetation on mounded, dredge islands. The use of these altered wetlands or completely "artificial" sites suggests that in some regions or years storks are unable to locate natural nesting habitat that is adequately flooded during the normal breeding season. The readiness with which storks will utilize water impoundments for nesting also suggests that colony sites could be intentionally created and maintained through long-term site management plans. Almost all impoundment sites used by storks become suitable for nesting only fortuitously, and therefore, these sites often do not remain available to storks for many years.

In addition to the irreversible impacts of drainage and destruction of nesting habitat, the greatest threats to colony sites are from human disturbance and predation. Nesting storks show some variation in the levels of human activity they will tolerate near a colony. In general, nesting storks are more tolerant of low levels of human activity near a colony when nests are high in trees than when they are low, and when nests contain partially or completely feathered young than during the period between nest construction and the early nestling period (adults still brooding). When adult storks are forced to leave their nests, eggs or downy young may die quickly (<20 minutes) when exposed to direct sun or rain.

Colonies located in flooded environments must remain flooded if they are to be successful. Often water is between 3 and 5 feet deep in successful colonies during the nesting season. Storks rarely form colonies, even in traditional nesting sites, when they are dry, and may abandon nests if sites become dry during the nesting period. Flooding in colonies may be most important as a defense against mammalian predators. Studies of stork colonies in Georgia and

Florida have shown high rates of raccoon predation when sites dried during the nesting period. A reasonably high water level in an active colony is also a deterrent against both human and domestic animal intrusions.

Although nesting wood storks usually do most feeding away from the colony site (>5 miles), considerable stork activity does occur close to the colony during two periods in the nesting cycle. Adult storks collect almost all nesting material in and near the colony, usually within 2500 feet. Newly fledged storks, near the end of the nesting cycle, spend from 1-4 weeks during the fledging process flying locally in the colony area, and perched in nearby trees or marshy spots on the ground. These birds return daily to their nests to be fed. It is essential that these fledging birds have little or no disturbance as far out as one-half mile within at least one or two quadrants from the colony. Both the adults, while collecting nesting material, and the inexperienced fledglings, do much low, flapping flight within this radius of the colony. At these times, storks potentially are much more likely to strike nearby towers or utility lines.

Colony sites are not necessarily used annually. Regional populations of storks shift nesting locations between years, in response to year-to-year differences in food resources. Thus, regional populations require a range of options for nesting sites, in order to successfully respond to food availability. Protection of colony sites should continue, therefore, for sites that are not used in a given year.

### **III. Roosting habitat.**

Although wood storks tend to roost at sites that are similar to those used for nesting, they also use a wider range of site types for roosting than for nesting. Non-breeding storks, for example, may frequently change roosting sites in response to changing feeding locations, and in the process, are inclined to accept a broad range of relatively temporary roosting sites. Included in the list of frequently used roosting locations are cypress "heads" or swamps (not necessarily flooded if trees are tall), mangrove islands, expansive willow thickets or small, isolated willow "islands" in broad marshes, and on the ground either on levees or in open marshes.

Daily activity patterns at a roost vary depending on the status of the storks using the site. Non-breeding adults or immature birds may remain in roosts during major portions of some days. When storks are feeding close to a roost, they may remain on the feeding grounds until almost dark before making the short flight. Nesting storks traveling long distances (>40 miles) to feeding sites may roost at or near the latter, and return to the colony the next morning. Storks leaving roosts, especially when going long distances, tend to wait for mid-morning thermals to develop before departing.

### **IV. Management zones and guidelines for feeding sites.**

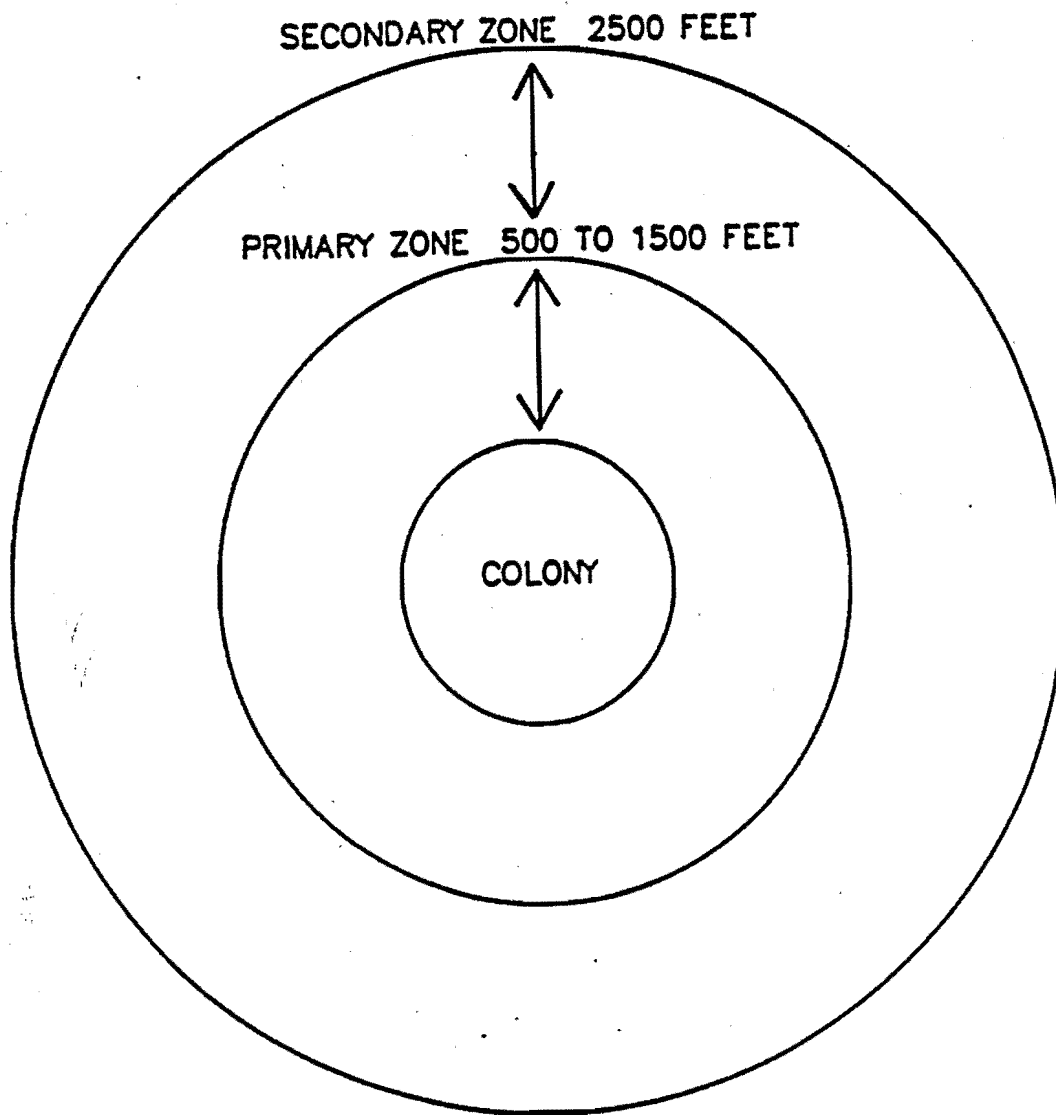
To the maximum extent possible, feeding sites should be protected by adherence to the following protection zones and guidelines:

- A. There should be no human intrusion into feeding sites when storks are present. Depending upon the amount of screening vegetation, human activity should be no closer than between 300 feet (where solid vegetation screens exist) and 750 feet (no vegetation screen).

- B. Feeding sites should not be subjected to water management practices that alter traditional water levels or the seasonally normal drying patterns and rates. Sharp rises in water levels are especially disruptive to feeding storks.
- C. The introduction of contaminants, fertilizers, or herbicides into wetlands that contain stork feeding sites should be avoided, especially those compounds that could adversely alter the diversity and numbers of native fishes, or that could substantially change the characteristics of aquatic vegetation. Increase in the density and height of emergent vegetation can degrade or destroy sites as feeding habitat.
- D. Construction of tall towers (especially with guy wires) within three miles, or high power lines (especially across long stretches of open country) within one mile of major feeding sites should be avoided.

**V. Management zones and guidelines for nesting colonies.**

- A. Primary zone: This is the most critical area, and must be managed according to recommended guidelines to insure that a colony site survives.
  - 1. Size: The primary zone must extend between 1000 and 1500 feet in all directions from the actual colony boundaries when there are no visual or broad aquatic barriers, and never less than 500 feet even when there are strong visual or aquatic barriers. The exact width of the primary zone in each direction from the colony can vary within this range, depending on the amount of visual screen (tall trees) surrounding the colony, the amount of relatively deep, open water between the colony and the nearest human activity, and the nature of the nearest human activity. In general, storks forming new colonies are more tolerant of existing human activity, than they will be of new human activity that begins after the colony has formed.
  - 2. Recommended Restrictions:
    - a. Any of the following activities within the primary zone, at any time of the year, are likely to be detrimental to the colony:
      - (1) Any lumbering or other removal of vegetation, and
      - (2) Any activity that reduces the area, depth, or length of flooding in wetlands under and surrounding the colony, except where periodic (less than annual) water control may be required to maintain the health of the aquatic, woody vegetation, and
      - (3) The construction of any building, roadway, tower, power line, canal, etc.
    - b. The following activities within the primary zone are likely to be detrimental to a colony if they occur when the colony is active:
      - (1) Any unauthorized human entry closer than 300 feet of the colony, and



- (2) Any increase or irregular pattern in human activity anywhere in the primary zone, and
  - (3) Any increase or irregular pattern in activity by animals, including livestock or pets, in the colony, and
  - (4) Any aircraft operation closer than 500 feet of the colony.
- B. Secondary Zone: Restrictions in this zone are needed to minimize disturbances that might impact the primary zone, and to protect essential areas outside of the primary zone. The secondary zone may be used by storks for collecting nesting material, for roosting, loafing, and feeding (especially important to newly fledged young), and may be important as a screen between the colony and areas of relatively intense human activities.
- 1. Size: The secondary zone should range outward from the primary zone 1000-2000 feet, or to a radius of 2500 feet of the outer edge of the colony.
  - 2. Recommended Restrictions:
    - a. Activities in the secondary zone which may be detrimental to nesting wood storks include:
      - (1) Any increase in human activities above the level that existed in the year when the colony first formed, especially when visual screens are lacking, and
      - (2) Any alteration in the area's hydrology that might cause changes in the primary zone, and
      - (3) Any substantial (>20 percent) decrease in the area of wetlands and woods of potential value to storks for roosting and feeding.
    - b. In addition, the probability that low flying storks, or inexperienced, newly-fledged young will strike tall obstructions, requires that high-tension power lines be no closer than one mile (especially across open country or in wetlands) and tall transmission towers no closer than 3 miles from active colonies. Other activities, including busy highways and commercial and residential buildings may be present in limited portions of the secondary zone at the time that a new colony first forms. Although storks may tolerate existing levels of human activities, it is important that these human activities not expand substantially.

## VI. Roosting site guidelines.

The general characteristics and temporary use-patterns of many stork roosting sites limit the number of specific management recommendations that are possible:

- A. Avoid human activities within 500-1000 feet of roost sites during seasons of the year and times of the day when storks may be present. Nocturnal activities in active roosts may be especially disruptive.

- B. Protect the vegetative and hydrological characteristics of the more important roosting sites--those used annually and/or used by flocks of 25 or more storks. Potentially, roosting sites may, some day, become nesting sites.

## VII. Legal Considerations.

### A. Federal Statutes

The U.S. breeding population of the wood stork is protected by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (Act). The population was listed as endangered on February 28, 1984 (49 Federal Register 7332); wood storks breeding in Alabama, Florida, Georgia, and South Carolina are protected by the Act.

Section 9 of the Endangered Species Act of 1973, as amended, states that it is unlawful for any person subject to the jurisdiction of the United States to take (defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.") any listed species anywhere within the United States.

The wood stork is also federally protected by its listing (50 CFR 10.13) under the Migratory Bird Treaty Act (167 U.S.C. 703-711), which prohibits the taking, killing or possession of migratory birds except as permitted.

### B. State Statutes

#### 1. State of Alabama

Section 9-11-232 of Alabama's Fish, Game, and Wildlife regulations curtails the possession, sale, and purchase of wild birds. "Any person, firm, association, or corporation who takes, catches, kills or has in possession at any time, living or dead, any protected wild bird not a game bird or who sells or offers for sale, buys, purchases or offers to buy or purchase any such bird or exchange same for anything of value or who shall sell or expose for sale or buy any part of the plumage, skin, or body of any bird protected by the laws of this state or who shall take or willfully destroy the nests of any wild bird or who shall have such nests or eggs of such birds in his possession, except as otherwise provided by law, shall be guilty of a misdemeanor..."

Section 1 of the Alabama Nongame Species Regulation (Regulation 87-GF-7) includes the wood stork in the list of nongame species covered by paragraph (4). "It shall be unlawful to take, capture, kill, possess, sell, trade for anything of monetary value, or offer to sell or trade for anything of monetary value, the following nongame wildlife species (or any parts or reproductive products of such species) without a scientific collection permit and written permission from the Commissioner, Department of Conservation and Natural Resources...."

#### 2. State of Florida

Rule 39-4.001 of the Florida Wildlife Code prohibits "taking, attempting to take, pursuing, hunting, molesting, capturing, or killing (collectively defined as "taking"), transporting, storing, serving, buying, selling,



## **APPENDIX H**

### **National Bald Eagle Management Guidelines**

# **NATIONAL BALD EAGLE MANAGEMENT GUIDELINES**

**U.S. Fish and Wildlife Service**

**May 2007**

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## INTRODUCTION

The bald eagle (*Haliaeetus leucocephalus*) is protected by the Bald and Golden Eagle Protection Act (Eagle Act) and the Migratory Bird Treaty Act (MBTA). The MBTA and the Eagle Act protect bald eagles from a variety of harmful actions and impacts. The U.S. Fish and Wildlife Service (Service) developed these National Bald Eagle Management Guidelines to advise landowners, land managers, and others who share public and private lands with bald eagles when and under what circumstances the protective provisions of the Eagle Act may apply to their activities. A variety of human activities can potentially interfere with bald eagles, affecting their ability to forage, nest, roost, breed, or raise young. The Guidelines are intended to help people minimize such impacts to bald eagles, particularly where they may constitute “disturbance,” which is prohibited by the Eagle Act.

The Guidelines are intended to:

- (1) Publicize the provisions of the Eagle Act that continue to protect bald eagles, in order to reduce the possibility that people will violate the law,
- (2) Advise landowners, land managers and the general public of the potential for various human activities to disturb bald eagles, and
- (3) Encourage additional nonbinding land management practices that benefit bald eagles (see Additional Recommendations section).

While the Guidelines include general recommendations for land management practices that will benefit bald eagles, the document is intended primarily as a tool for landowners and planners who seek information and recommendations regarding how to avoid disturbing bald eagles. Many States and some tribal entities have developed state-specific management plans, regulations, and/or guidance for landowners and land managers to protect and enhance bald eagle habitat, and we encourage the continued development and use of these planning tools to benefit bald eagles.

Adherence to the Guidelines herein will benefit individuals, agencies, organizations, and companies by helping them avoid violations of the law. However, the Guidelines themselves are not law. Rather, they are recommendations based on several decades of behavioral observations, science, and conservation measures to avoid or minimize adverse impacts to bald eagles.

The U.S. Fish and Wildlife Service strongly encourages adherence to these guidelines to ensure that bald and golden eagle populations will continue to be sustained. The Service realizes there may be impacts to some birds even if all reasonable measures are taken to avoid such impacts. Although it is not possible to absolve individuals and entities from liability under the Eagle Act or the MBTA, the Service exercises enforcement discretion to focus on those individuals, companies, or agencies that take migratory birds without regard for the consequences of their actions and the law, especially when conservation measures, such as these Guidelines, are available, but have not been implemented. The Service will prioritize its enforcement efforts to focus on those individuals or entities who take bald eagles or their parts, eggs, or nests without implementing appropriate measures recommended by the Guidelines.

The Service intends to pursue the development of regulations that would authorize, under limited circumstances, the use of permits if “take” of an eagle is anticipated but unavoidable. Additionally, if the bald eagle is delisted, the Service intends to provide a regulatory mechanism to honor existing (take) authorizations under the Endangered Species Act (ESA).

During the interim period until the Service completes a rulemaking for permits under the Eagle Act, the Service does not intend to refer for prosecution the incidental “take” of any bald eagle under the MBTA or Eagle Act, if such take is in full compliance with the terms and conditions of an incidental take statement issued to the action agency or applicant under the authority of section 7(b)(4) of the ESA or a permit issued under the authority of section 10(a)(1)(B) of the ESA.

The Guidelines are applicable throughout the United States, including Alaska. The primary purpose of these Guidelines is to provide information that will minimize or prevent violations only of *Federal* laws governing bald eagles. In addition to Federal laws, many states and some smaller jurisdictions and tribes have additional laws and regulations protecting bald eagles. In some cases those laws and regulations may be more protective (restrictive) than these Federal guidelines. If you are planning activities that may affect bald eagles, we therefore recommend that you contact both your nearest U.S. Fish and Wildlife Service Field Office (see the contact information on p.16) and your state wildlife agency for assistance.

## LEGAL PROTECTIONS FOR THE BALD EAGLE

### **The Bald and Golden Eagle Protection Act**

The Eagle Act (16 U.S.C. 668-668c), enacted in 1940, and amended several times since then, prohibits anyone, without a permit issued by the Secretary of the Interior, from “taking” bald eagles, including their parts, nests, or eggs. The Act provides criminal and civil penalties for persons who “take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle ... [or any golden eagle], alive or dead, or any part, nest, or egg thereof.” The Act defines “take” as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.” “Disturb” means:

“Disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.”

In addition to immediate impacts, this definition also covers impacts that result from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle=s return, such alterations agitate or bother an eagle to a degree that injures an eagle or substantially interferes with normal breeding, feeding, or sheltering habits and causes, or is likely to cause, a loss of productivity or nest abandonment.

A violation of the Act can result in a criminal fine of \$100,000 (\$200,000 for organizations), imprisonment for one year, or both, for a first offense. Penalties increase substantially for additional offenses, and a second violation of this Act is a felony.

### **The Migratory Bird Treaty Act**

The MBTA (16 U.S.C. 703-712), prohibits the taking of any migratory bird or any part, nest, or egg, except as permitted by regulation. The MBTA was enacted in 1918; a 1972 agreement supplementing one of the bilateral treaties underlying the MBTA had the effect of expanding the scope of the Act to cover bald eagles and other raptors. Implementing regulations define “take” under the MBTA as “pursue, hunt, shoot, wound, kill, trap, capture, possess, or collect.”

Copies of the Eagle Act and the MBTA are available at: <http://permits.fws.gov/ltr/ltr.shtml>.

### **State laws and regulations**

Most states have their own regulations and/or guidelines for bald eagle management. Some states may continue to list the bald eagle as endangered, threatened, or of special concern. If you plan activities that may affect bald eagles, we urge you to familiarize yourself with the regulations and/or guidelines that apply to bald eagles in your state. Your adherence to the Guidelines herein does not ensure that you are in compliance with state laws and regulations because state regulations can be more specific and/or restrictive than these Guidelines.

## **NATURAL HISTORY OF THE BALD EAGLE**

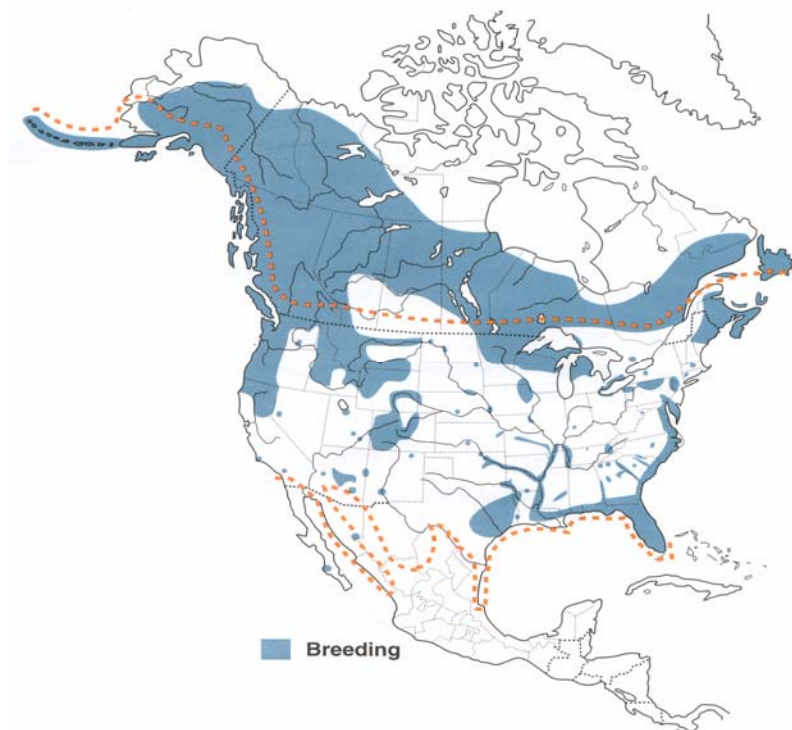
Bald eagles are a North American species that historically occurred throughout the contiguous United States and Alaska. After severely declining in the lower 48 States between the 1870s and the 1970s, bald eagles have rebounded and re-established breeding territories in each of the lower 48 states. The largest North American breeding populations are in Alaska and Canada, but there are also significant bald eagle populations in Florida, the Pacific Northwest, the Greater Yellowstone area, the Great Lakes states, and the Chesapeake Bay region. Bald eagle distribution varies seasonally. Bald eagles that nest in southern latitudes frequently move northward in late spring and early summer, often summering as far north as Canada. Most eagles that breed at northern latitudes migrate southward during winter, or to coastal areas where waters remain unfrozen. Migrants frequently concentrate in large numbers at sites where food is abundant and they often roost together communally. In some cases, concentration areas are used year-round: in summer by southern eagles and in winter by northern eagles.

Juvenile bald eagles have mottled brown and white plumage, gradually acquiring their dark brown body and distinctive white head and tail as they mature. Bald eagles generally attain adult plumage by 5 years of age. Most are capable of breeding at 4 or 5 years of age, but in healthy populations they may not start breeding until much older. Bald eagles may live 15 to 25 years in the wild. Adults weigh 8 to 14 pounds (occasionally reaching 16 pounds in Alaska) and have wingspans of 5 to 8 feet. Those in the northern range are larger than those in the south, and females are larger than males.

### Where do bald eagles nest?

Breeding bald eagles occupy “territories,” areas they will typically defend against intrusion by other eagles. In addition to the active nest, a territory may include one or more alternate nests (nests built or maintained by the eagles but not used for nesting in a given year). The Eagle Act prohibits removal or destruction of both active and alternate bald eagle nests. Bald eagles exhibit high nest site fidelity and nesting territories are often used year after year. Some territories are known to have been used continually for over half a century.

Bald eagles generally nest near coastlines, rivers, large lakes or streams that support an adequate food supply. They often nest in mature or old-growth trees; snags (dead trees); cliffs; rock promontories; rarely on the ground; and with increasing frequency on human-made structures such as power poles and communication towers. In forested areas, bald eagles often select the tallest trees with limbs strong enough to support a nest that can weigh more than 1,000 pounds. Nest sites typically include at least one perch with a clear view of the water where the eagles usually forage. Shoreline trees or snags located in reservoirs provide the visibility and accessibility needed to locate aquatic prey. Eagle nests are constructed with large sticks, and may be lined with moss, grass, plant stalks, lichens, seaweed, or sod. Nests are usually about 4-6 feet in diameter and 3 feet deep, although larger nests exist.



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The range of breeding bald eagles in 2000 (shaded areas). This map shows only the larger concentrations of nests; eagles have continued to expand into additional nesting territories in many states. The dotted line represents the bald eagle's wintering range.

**When do bald eagles nest?**

Nesting activity begins several months before egg-laying. Egg-laying dates vary throughout the U.S., ranging from October in Florida, to late April or even early May in the northern United States. Incubation typically lasts 33-35 days, but can be as long as 40 days. Eaglets make their first unsteady flights about 10 to 12 weeks after hatching, and fledge (leave their nests) within a few days after that first flight. However, young birds usually remain in the vicinity of the nest for several weeks after fledging because they are almost completely dependent on their parents for food until they disperse from the nesting territory approximately 6 weeks later.

The bald eagle breeding season tends to be longer in the southern U.S., and re-nesting following an unsuccessful first nesting attempt is more common there as well. The following table shows the timing of bald eagle breeding seasons in different regions of the country. The table represents the range of time within which the majority of nesting activities occur in each region and does not apply to any specific nesting pair. Because the timing of nesting activities may vary within a given region, you should contact the nearest U.S. Fish and Wildlife Service Field Office (see page 16) and/or your state wildlife conservation agency for more specific information on nesting chronology in your area.

## Chronology of typical reproductive activities of bald eagles in the United States.

| Sept.                                                                                                                                                | Oct. | Nov.                  | Dec.                   | Jan.                  | Feb.                   | March                  | April                 | May                    | June | July | Aug.   |
|------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------------|------------------------|-----------------------|------------------------|------------------------|-----------------------|------------------------|------|------|--------|
| SOUTHEASTERN U.S. (FL, GA, SC, NC, AL, MS, LA, TN, KY, AR, eastern 2 of TX)                                                                          |      |                       |                        |                       |                        |                        |                       |                        |      |      |        |
| Nest Building                                                                                                                                        |      |                       |                        |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      | Egg Laying/Incubation |                        |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       | Hatching/Rearing Young |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       | Fledging Young         |                        |                       |                        |      |      |        |
| CHESAPEAKE BAY REGION (NC, VA, MD, DE, southern 2 of NJ, eastern 2 of PA, panhandle of WV)                                                           |      |                       |                        |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      | Nest Building         |                        |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        | Egg Laying/Incubation |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       | Hatching/Rearing Young |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       |                        |                        |                       | Fledging Young         |      |      |        |
| NORTHERN U.S. (ME, NH, MA, RI, CT, NY, northern 2 of NJ, western 2 of PA, OH, WV exc. panhandle, IN, IL, MI, WI, MN, IA, MO, ND, SD, NB, KS, CO, UT) |      |                       |                        |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       | Nest Building          |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       | Egg Laying/Incubation  |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       |                        | Hatching/Rearing Young |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       |                        |                        |                       | Fledging Young         |      |      |        |
| PACIFIC REGION (WA, OR, CA, ID, MT, WY, NV)                                                                                                          |      |                       |                        |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        | Nest Building         |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       | Egg Laying/Incubation  |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       |                        | Hatching/Rearing Young |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       |                        |                        |                       | Fledging Young         |      |      |        |
| SOUTHWESTERN U.S. (AZ, NM, OK panhandle, western 2 of TX)                                                                                            |      |                       |                        |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      | Nest Building         |                        |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        | Egg Laying/Incubation |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       | Hatching/Rearing Young |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       |                        |                        | Fledging Young        |                        |      |      |        |
| ALASKA                                                                                                                                               |      |                       |                        |                       |                        |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       | Nest Building          |                        |                       |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       |                        |                        | Egg Laying/Incubation |                        |      |      |        |
|                                                                                                                                                      |      |                       |                        |                       |                        |                        |                       | Hatching/Rearing Young |      |      |        |
| Ing Young                                                                                                                                            |      |                       |                        |                       |                        |                        |                       |                        |      |      | Fledg- |
| Sept.                                                                                                                                                | Oct. | Nov.                  | Dec.                   | Jan.                  | Feb.                   | March                  | April                 | May                    | June | July | Aug.   |

**How many chicks do bald eagles raise?**

The number of eagle eggs laid will vary from 1-3, with 1-2 eggs being the most common. Only one eagle egg is laid per day, although not always on successive days. Hatching of young occurs on different days with the result that chicks in the same nest are sometimes of unequal size. The overall national fledging rate is approximately one chick per nest, annually, which results in a healthy expanding population.

**What do bald eagles eat?**

Bald eagles are opportunistic feeders. Fish comprise much of their diet, but they also eat waterfowl, shorebirds/colonial waterbirds, small mammals, turtles, and carrion. Because they are visual hunters, eagles typically locate their prey from a conspicuous perch, or soaring flight, then swoop down and strike. Wintering bald eagles often congregate in large numbers along streams to feed on spawning salmon or other fish species, and often gather in large numbers in areas below reservoirs, especially hydropower dams, where fish are abundant. Wintering eagles also take birds from rafts of ducks at reservoirs and rivers, and congregate on melting ice shelves to scavenge dead fish from the current or the soft melting ice. Bald eagles will also feed on carcasses along roads, in landfills, and at feedlots.

During the breeding season, adults carry prey to the nest to feed the young. Adults feed their chicks by tearing off pieces of food and holding them to the beaks of the eaglets. After fledging, immature eagles are slow to develop hunting skills, and must learn to locate reliable food sources and master feeding techniques. Young eagles will congregate together, often feeding upon easily acquired food such as carrion and fish found in abundance at the mouths of streams and shallow bays and at landfills.

**The impact of human activity on nesting bald eagles**

During the breeding season, bald eagles are sensitive to a variety of human activities. However, not all bald eagle pairs react to human activities in the same way. Some pairs nest successfully just dozens of yards from human activity, while others abandon nest sites in response to activities much farther away. This variability may be related to a number of factors, including visibility, duration, noise levels, extent of the area affected by the activity, prior experiences with humans, and tolerance of the individual nesting pair. The relative sensitivity of bald eagles during various stages of the breeding season is outlined in the following table.

**Nesting Bald Eagle Sensitivity to Human Activities**

| Phase | Activity                                             | Sensitivity to Human Activity                       | Comments                                                                                                                                                                                                                                      |
|-------|------------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I     | Courtship and Nest Building                          | Most sensitive period; likely to respond negatively | Most critical time period. Disturbance is manifested in nest abandonment. Bald eagles in newly established territories are more prone to abandon nest sites.                                                                                  |
| II    | Egg laying                                           | Very sensitive period                               | Human activity of even limited duration may cause nest desertion and abandonment of territory for the breeding season.                                                                                                                        |
| III   | Incubation and early nestling period (up to 4 weeks) | Very sensitive period                               | Adults are less likely to abandon the nest near and after hatching. However, flushed adults leave eggs and young unattended; eggs are susceptible to cooling, loss of moisture, overheating, and predation; young are vulnerable to elements. |
| IV    | Nestling period, 4 to 8 weeks                        | Moderately sensitive period                         | Likelihood of nest abandonment and vulnerability of the nestlings to elements somewhat decreases. However, nestlings may miss feedings, affecting their survival.                                                                             |
| V     | Nestlings 8 weeks through fledging                   | Very sensitive period                               | Gaining flight capability, nestlings 8 weeks and older may flush from the nest prematurely due to disruption and die.                                                                                                                         |

If agitated by human activities, eagles may inadequately construct or repair their nest, may expend energy defending the nest rather than tending to their young, or may abandon the nest altogether. Activities that cause prolonged absences of adults from their nests can jeopardize eggs or young. Depending on weather conditions, eggs may overheat or cool too much and fail to hatch. Unattended eggs and nestlings are subject to predation. Young nestlings are particularly vulnerable because they rely on their parents to provide warmth or shade, without which they may die as a result of hypothermia or heat stress. If food delivery schedules are interrupted, the young may not develop healthy plumage, which can affect their survival. In addition, adults startled while incubating or brooding young may damage eggs or injure their young as they abruptly leave the nest. Older nestlings no longer require constant attention from the adults, but they may be startled by loud or intrusive human activities and prematurely jump from the nest before they are able to fly or care for themselves. Once fledged, juveniles range up to ¼ mile from the nest site, often to a site with minimal human activity. During this period, until about six weeks after departure from the nest, the juveniles still depend on the adults to feed them.

**The impact of human activity on foraging and roosting bald eagles**

Disruption, destruction, or obstruction of roosting and foraging areas can also negatively affect bald eagles. Disruptive activities in or near eagle foraging areas can interfere with feeding, reducing chances of survival. Interference with feeding can also result in reduced productivity (number of young successfully fledged). Migrating and wintering bald eagles often congregate at specific sites for purposes of feeding and sheltering. Bald eagles rely on established roost sites because of their proximity to sufficient food sources. Roost sites are usually in mature trees where the eagles are somewhat sheltered from the wind and weather. Human activities near or within communal roost sites may prevent eagles

from feeding or taking shelter, especially if there are not other undisturbed and productive feeding and roosting sites available. Activities that permanently alter communal roost sites and important foraging areas can altogether eliminate the elements that are essential for feeding and sheltering eagles.

Where a human activity agitates or bothers roosting or foraging bald eagles to the degree that causes injury or substantially interferes with breeding, feeding, or sheltering behavior and causes, or is likely to cause, a loss of productivity or nest abandonment, the conduct of the activity constitutes a violation of the Eagle Act's prohibition against disturbing eagles. The circumstances that might result in such an outcome are difficult to predict without detailed site-specific information. If your activities may disturb roosting or foraging bald eagles, you should contact your local Fish and Wildlife Service Field Office (see page 16) for advice and recommendations for how to avoid such disturbance.

### **RECOMMENDATIONS FOR AVOIDING DISTURBANCE AT NEST SITES**

In developing these Guidelines, we relied on existing state and regional bald eagle guidelines, scientific literature on bald eagle disturbance, and recommendations of state and Federal biologists who monitor the impacts of human activity on eagles. Despite these resources, uncertainties remain regarding the effects of many activities on eagles and how eagles in different situations may or may not respond to certain human activities. The Service recognizes this uncertainty and views the collection of better biological data on the response of eagles to disturbance as a high priority. To the extent that resources allow, the Service will continue to collect data on responses of bald eagles to human activities conducted according to the recommendations within these Guidelines to ensure that adequate protection from disturbance is being afforded, and to identify circumstances where the Guidelines might be modified. These data will be used to make future adjustments to the Guidelines.

To avoid disturbing nesting bald eagles, we recommend (1) keeping a distance between the activity and the nest (distance buffers), (2) maintaining preferably forested (or natural) areas between the activity and around nest trees (landscape buffers), and (3) avoiding certain activities during the breeding season. The buffer areas serve to minimize visual and auditory impacts associated with human activities near nest sites. Ideally, buffers would be large enough to protect existing nest trees and provide for alternative or replacement nest trees.

The size and shape of effective buffers vary depending on the topography and other ecological characteristics surrounding the nest site. In open areas where there are little or no forested or topographical buffers, such as in many western states, distance alone must serve as the buffer. Consequently, in open areas, the distance between the activity and the nest may need to be larger than the distances recommended under Categories A and B of these guidelines (pg. 12) if no landscape buffers are present. The height of the nest above the ground may also ameliorate effects of human activities; eagles at higher nests may be less prone to disturbance.

In addition to the physical features of the landscape and nest site, the appropriate size for the distance buffer may vary according to the historical tolerances of eagles to human activities in particular localities, and may also depend on the location of the nest in relation

to feeding and roosting areas used by the eagles. Increased competition for nest sites may lead bald eagles to nest closer to human activity (and other eagles).

Seasonal restrictions can prevent the potential impacts of many shorter-term, obtrusive activities that do not entail landscape alterations (e.g. fireworks, outdoor concerts). In proximity to the nest, these kinds of activities should be conducted only outside the breeding season. For activities that entail both short-term, obtrusive characteristics and more permanent impacts (e.g., building construction), we recommend a combination of both approaches: retaining a landscape buffer *and* observing seasonal restrictions.

For assistance in determining the appropriate size and configuration of buffers or the timing of activities in the vicinity of a bald eagle nest, we encourage you to contact the nearest U.S. Fish and Wildlife Service Field Office (see page 16).

### Existing Uses

Eagles are unlikely to be disturbed by routine use of roads, homes, and other facilities where such use pre-dates the eagles' successful nesting activity in a given area. Therefore, in most cases *ongoing* existing uses may proceed with the same intensity with little risk of disturbing bald eagles. However, some *intermittent, occasional, or irregular* uses that pre-date eagle nesting in an area may disturb bald eagles. For example: a pair of eagles may begin nesting in an area and subsequently be disturbed by activities associated with an annual outdoor flea market, even though the flea market has been held annually at the same location. In such situations, human activity should be adjusted or relocated to minimize potential impacts on the nesting pair.

## ACTIVITY-SPECIFIC GUIDELINES

The following section provides the Service's management recommendations for avoiding bald eagle disturbance as a result of new or intermittent activities proposed in the vicinity of bald eagle nests. Activities are separated into 8 categories (A – H) based on the nature and magnitude of impacts to bald eagles that usually result from the type of activity. Activities with similar or comparable impacts are grouped together.

In most cases, impacts will vary based on the visibility of the activity from the eagle nest and the degree to which similar activities are already occurring in proximity to the nest site. Visibility is a factor because, in general, eagles are more prone to disturbance when an activity occurs in full view. For this reason, we recommend that people locate activities farther from the nest structure in areas with open vistas, in contrast to areas where the view is shielded by rolling topography, trees, or other screening factors. The recommendations also take into account the existence of similar activities in the area because the continued presence of nesting bald eagles in the vicinity of the existing activities indicates that the eagles in that area can tolerate a greater degree of human activity than we can generally expect from eagles in areas that experience fewer human impacts. To illustrate how these factors affect the likelihood of disturbing eagles, we have incorporated the recommendations for some activities into a table (categories A and B).

First, determine which category your activity falls into (between categories A – H). If the activity you plan to undertake is not specifically addressed in these guidelines, follow the recommendations for the most similar activity represented.

If your activity is under A or B, our recommendations are in table form. The vertical axis shows the degree of visibility of the activity from the nest. The horizontal axis (header row) represents the degree to which similar activities are ongoing in the vicinity of the nest. Locate the row that best describes how visible your activity will be from the eagle nest. Then, choose the column that best describes the degree to which similar activities are ongoing in the vicinity of the eagle nest. The box where the column and row come together contains our management recommendations for how far you should locate your activity from the nest to avoid disturbing the eagles. The numerical distances shown in the tables are the closest the activity should be conducted relative to the nest. In some cases we have included additional recommendations (other than recommended *distance* from the nest) you should follow to help ensure that your activity will not disturb the eagles.

### **Alternate nests**

For activities that entail permanent landscape alterations that may result in bald eagle disturbance, these recommendations apply to both active and alternate bald eagle nests. Disturbance becomes an issue with regard to alternate nests if eagles return for breeding purposes and react to land use changes that occurred while the nest was inactive. The likelihood that an alternate nest will again become active decreases the longer it goes unused. If you plan activities in the vicinity of an alternate bald eagle nest and have information to show that the nest has not been active during the preceding 5 breeding seasons, the recommendations provided in these guidelines for avoiding disturbance around the nest site may no longer be warranted. The nest itself remains protected by other provisions of the Eagle Act, however, and may not be destroyed.

If special circumstances exist that make it unlikely an inactive nest will be reused before 5 years of disuse have passed, and you believe that the probability of reuse is low enough to warrant disregarding the recommendations for avoiding disturbance, you should be prepared to provide all the reasons for your conclusion, including information regarding past use of the nest site. Without sufficient documentation, you should continue to follow these guidelines when conducting activities around the nest site. If we are able to determine that it is unlikely the nest will be reused, we may advise you that the recommendations provided in these guidelines for avoiding disturbance are no longer necessary around that nest site.

This guidance is intended to minimize disturbance, as defined by Federal regulation. In addition to Federal laws, most states and some tribes and smaller jurisdictions have additional laws and regulations protecting bald eagles. In some cases those laws and regulations may be more protective (restrictive) than these Federal guidelines.

### **Temporary Impacts**

For activities that have temporary impacts, such as the use of loud machinery, fireworks displays, or summer boating activities, we recommend seasonal restrictions. These types of activities can generally be carried out outside of the breeding season without causing disturbance. The recommended restrictions for these types of activities can be lifted for alternate nests within a particular territory, including nests that were attended during the current breeding season but not used to raise young, after eggs laid in another nest within the territory have hatched (depending on the distance between the alternate nest and the active nest).

In general, activities should be kept as far away from nest trees as possible; loud and disruptive activities should be conducted when eagles are not nesting; and activity between the nest and the nearest foraging area should be minimized. If the activity you plan to undertake is not specifically addressed in these guidelines, follow the recommendations for the most similar activity addressed, or contact your local U.S. Fish and Wildlife Service Field Office for additional guidance.

If you believe that special circumstances apply to your situation that increase or diminish the likelihood of bald eagle disturbance, or if it is not possible to adhere to the guidelines, you should contact your local Service Field Office for further guidance.

#### **Category A:**

Building construction, 1 or 2 story, with project footprint of ½ acre or less.  
Construction of roads, trails, canals, power lines, and other linear utilities.  
Agriculture and aquaculture – new or expanded operations.  
Alteration of shorelines or wetlands.  
Installation of docks or moorings.  
Water impoundment.

#### **Category B:**

Building construction, 3 or more stories.  
Building construction, 1 or 2 story, with project footprint of more than ½ acre.  
Installation or expansion of marinas with a capacity of 6 or more boats.  
Mining and associated activities.  
Oil and natural gas drilling and refining and associated activities.

|                                                                 | <b><i>If there is no similar activity within 1 mile of the nest</i></b>                                                                                                         | <b><i>If there is similar activity closer than 1 mile from the nest</i></b>                                                                                                    |
|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><i>If the activity will be visible from the nest</i></b>     | 660 feet. Landscape buffers are recommended.                                                                                                                                    | 660 feet, or as close as existing tolerated activity of similar scope. Landscape buffers are recommended.                                                                      |
| <b><i>If the activity will not be visible from the nest</i></b> | Category A:<br>330 feet. Clearing, external construction, and landscaping between 330 feet and 660 feet should be done outside breeding season.<br><br>Category B:<br>660 feet. | 330 feet, or as close as existing tolerated activity of similar scope. Clearing, external construction and landscaping within 660 feet should be done outside breeding season. |

The numerical distances shown in the table are the closest the activity should be conducted relative to the nest.

**Category C. Timber Operations and Forestry Practices**

- Avoid clear cutting or removal of overstory trees within 330 feet of the nest at any time.
- Avoid timber harvesting operations, including road construction and chain saw and yarding operations, during the breeding season within 660 feet of the nest. The distance may be decreased to 330 feet around alternate nests within a particular territory, including nests that were attended during the current breeding season but not used to raise young, after eggs laid in another nest within the territory have hatched.
- Selective thinning and other silviculture management practices designed to conserve or enhance habitat, including prescribed burning close to the nest tree, should be undertaken outside the breeding season. Precautions such as raking leaves and woody debris from around the nest tree should be taken to prevent crown fire or fire climbing the nest tree. If it is determined that a burn during the breeding season would be beneficial, then, to ensure that no take or disturbance will occur, these activities should be conducted only when neither adult eagles nor young are present at the nest tree (i.e., at the beginning of, or end of, the breeding season, either before the particular nest is active or after the young have fledged from that nest). Appropriate Federal and state biologists should be consulted before any prescribed burning is conducted during the breeding season.
- Avoid construction of log transfer facilities and in-water log storage areas within 330 feet of the nest.

**Category D. Off-road vehicle use** (including snowmobiles). No buffer is necessary around nest sites outside the breeding season. During the breeding season, do not operate off-road vehicles within 330 feet of the nest. In open areas, where there is increased visibility and exposure to noise, this distance should be extended to 660 feet.

**Category E. Motorized Watercraft use** (including jet skis/personal watercraft). No buffer is necessary around nest sites outside the breeding season. During the breeding season, within 330 feet of the nest, (1) do not operate jet skis (personal watercraft), and (2) avoid concentrations of noisy vessels (e.g., commercial fishing boats and tour boats), except where eagles have demonstrated tolerance for such activity. Other motorized boat traffic passing within 330 feet of the nest should attempt to minimize trips and avoid stopping in the area where feasible, particularly where eagles are unaccustomed to boat traffic. Buffers for airboats should be larger than 330 feet due to the increased noise they generate, combined with their speed, maneuverability, and visibility.

**Category F. Non-motorized recreation and human entry** (e.g., hiking, camping, fishing, hunting, birdwatching, kayaking, canoeing). No buffer is necessary around nest sites outside the breeding season. If the activity will be visible or highly audible from the nest, maintain a 330-foot buffer during the breeding season, particularly where eagles are unaccustomed to such activity.

**Category G. Helicopters and fixed-wing aircraft.**

Except for authorized biologists trained in survey techniques, avoid operating aircraft within 1,000 feet of the nest during the breeding season, except where eagles have demonstrated tolerance for such activity.

**Category H. Blasting and other loud, intermittent noises.**

Avoid blasting and other activities that produce extremely loud noises within 1/2 mile of active nests, unless greater tolerance to the activity (or similar activity) has been demonstrated by the eagles in the nesting area. This recommendation applies to the use of fireworks classified by the Federal Department of Transportation as Class B explosives, which includes the larger fireworks that are intended for licensed public display.

**RECOMMENDATIONS FOR AVOIDING DISTURBANCE AT FORAGING AREAS AND COMMUNAL ROOST SITES**

1. Minimize potentially disruptive activities and development in the eagles' direct flight path between their nest and roost sites and important foraging areas.
2. Locate long-term and permanent water-dependent facilities, such as boat ramps and marinas, away from important eagle foraging areas.
3. Avoid recreational and commercial boating and fishing near critical eagle foraging areas during peak feeding times (usually early to mid-morning and late afternoon), except where eagles have demonstrated tolerance to such activity.
4. Do not use explosives within ½ mile (or within 1 mile in open areas) of communal roosts when eagles are congregating, without prior coordination with the U.S. Fish and Wildlife Service and your state wildlife agency.
5. Locate aircraft corridors no closer than 1,000 feet vertical or horizontal distance from communal roost sites.

### **ADDITIONAL RECOMMENDATIONS TO BENEFIT BALD EAGLES**

The following are additional management practices that landowners and planners can exercise for added benefit to bald eagles.

1. Protect and preserve potential roost and nest sites by retaining mature trees and old growth stands, particularly within ½ mile from water.
2. Where nests are blown from trees during storms or are otherwise destroyed by the elements, continue to protect the site in the absence of the nest for up to three (3) complete breeding seasons. Many eagles will rebuild the nest and reoccupy the site.
3. To avoid collisions, site wind turbines, communication towers, and high voltage transmission power lines away from nests, foraging areas, and communal roost sites.
4. Employ industry-accepted best management practices to prevent birds from colliding with or being electrocuted by utility lines, towers, and poles. If possible, bury utility lines in important eagle areas.
5. Where bald eagles are likely to nest in human-made structures (e.g., cell phone towers) and such use could impede operation or maintenance of the structures or jeopardize the safety of the eagles, equip the structures with either (1) devices engineered to discourage bald eagles from building nests, or (2) nesting platforms that will safely accommodate bald eagle nests without interfering with structure performance.
6. Immediately cover carcasses of euthanized animals at landfills to protect eagles from being poisoned.
7. Do not intentionally feed bald eagles. Artificially feeding bald eagles can disrupt their essential behavioral patterns and put them at increased risk from power lines, collision with windows and cars, and other mortality factors.
8. Use pesticides, herbicides, fertilizers, and other chemicals only in accordance with Federal and state laws.
9. Monitor and minimize dispersal of contaminants associated with hazardous waste sites (legal or illegal), permitted releases, and runoff from agricultural areas, especially within watersheds where eagles have shown poor reproduction or where bioaccumulating contaminants have been documented. These factors present a risk of contamination to eagles and their food sources.

## CONTACTS

The following U.S. Fish and Wildlife Service Field Offices provide technical assistance on bald eagle management:

|                      |                     |                |                       |                     |                |
|----------------------|---------------------|----------------|-----------------------|---------------------|----------------|
| <u>Alabama</u>       | Daphne              | (251) 441-5181 | <u>New Hampshire</u>  | Concord             | (603) 223-2541 |
| <u>Alaska</u>        | Anchorage           | (907) 271-2888 | <u>New Jersey</u>     | Pleasantville       | (609) 646-9310 |
|                      | Fairbanks           | (907) 456-0203 | <u>New Mexico</u>     | Albuquerque         | (505) 346-2525 |
|                      | Juneau              | (907) 780-1160 | <u>New York</u>       | Cortland            | (607) 753-9334 |
| <u>Arizona</u>       | Phoenix             | (602) 242-0210 |                       | Long Island         | (631) 776-1401 |
| <u>Arkansas</u>      | Conway              | (501) 513-4470 | <u>North Carolina</u> | Raleigh             | (919) 856-4520 |
| <u>California</u>    | Arcata              | (707) 822-7201 |                       | Asheville           | (828) 258-3939 |
|                      | Barstow             | (760) 255-8852 | <u>North Dakota</u>   | Bismarck            | (701) 250-4481 |
|                      | Carlsbad            | (760) 431-9440 | <u>Ohio</u>           | Reynoldsburg        | (614) 469-6923 |
|                      | Red Bluff           | (530) 527-3043 | <u>Oklahoma</u>       | Tulsa               | (918) 581-7458 |
|                      | Sacramento          | (916) 414-6000 | <u>Oregon</u>         | Bend                | (541) 383-7146 |
|                      | Stockton            | (209) 946-6400 |                       | Klamath Falls       | (541) 885-8481 |
|                      | Ventura             | (805) 644-1766 |                       | La Grande           | (541) 962-8584 |
|                      | Yreka               | (530) 842-5763 |                       | Newport             | (541) 867-4558 |
| <u>Colorado</u>      | Lakewood            | (303) 275-2370 |                       | Portland            | (503) 231-6179 |
|                      | Grand Junction      | (970) 243-2778 |                       | Roseburg            | (541) 957-3474 |
| <u>Connecticut</u>   | (See New Hampshire) |                | <u>Pennsylvania</u>   | State College       | (814) 234-4090 |
| <u>Delaware</u>      | (See Maryland)      |                | <u>Rhode Island</u>   | (See New Hampshire) |                |
| <u>Florida</u>       | Panama City         | (850) 769-0552 | <u>South Carolina</u> | Charleston          | (843) 727-4707 |
|                      | Vero Beach          | (772) 562-3909 | <u>South Dakota</u>   | Pierre              | (605) 224-8693 |
|                      | Jacksonville        | (904) 232-2580 | <u>Tennessee</u>      | Cookeville          | (931) 528-6481 |
| <u>Georgia</u>       | Athens              | (706) 613-9493 | <u>Texas</u>          | Clear Lake          | (281) 286-8282 |
|                      | Brunswick           | (912) 265-9336 | <u>Utah</u>           | West Valley City    | (801) 975-3330 |
|                      | Columbus            | (706) 544-6428 | <u>Vermont</u>        | (See New Hampshire) |                |
| <u>Idaho</u>         | Boise               | (208) 378-5243 | <u>Virginia</u>       | Gloucester          | (804) 693-6694 |
|                      | Chubbuck            | (208) 237-6975 | <u>Washington</u>     | Lacey               | (306) 753-9440 |
| <u>Illinois/Iowa</u> | Rock Island         | (309) 757-5800 |                       | Spokane             | (509) 891-6839 |
| <u>Indiana</u>       | Bloomington         | (812) 334-4261 |                       | Wenatchee           | (509) 665-3508 |
| <u>Kansas</u>        | Manhattan           | (785) 539-3474 | <u>West Virginia</u>  | Elkins              | (304) 636-6586 |
| <u>Kentucky</u>      | Frankfort           | (502) 695-0468 | <u>Wisconsin</u>      | New Franken         | (920) 866-1725 |
| <u>Louisiana</u>     | Lafayette           | (337) 291-3100 | <u>Wyoming</u>        | Cheyenne            | (307) 772-2374 |
| <u>Maine</u>         | Old Town            | (207) 827-5938 |                       | Cody                | (307) 578-5939 |
| <u>Maryland</u>      | Annapolis           | (410) 573-4573 |                       |                     |                |
| <u>Massachusetts</u> | (See New Hampshire) |                |                       |                     |                |
| <u>Michigan</u>      | East Lansing        | (517) 351-2555 |                       |                     |                |
| <u>Minnesota</u>     | Bloomington         | (612) 725-3548 |                       |                     |                |
| <u>Mississippi</u>   | Jackson             | (601) 965-4900 |                       |                     |                |
| <u>Missouri</u>      | Columbia            | (573) 234-2132 |                       |                     |                |
| <u>Montana</u>       | Helena              | (405) 449-5225 |                       |                     |                |
| <u>Nebraska</u>      | Grand Island        | (308) 382-6468 |                       |                     |                |
| <u>Nevada</u>        | Las Vegas           | (702) 515-5230 |                       |                     |                |
|                      | Reno                | (775) 861-6300 |                       |                     |                |

|                                                                                                                                                                                                                                                                             |
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| <u>National Office</u><br>U.S. Fish and Wildlife Service<br>Division of Migratory Bird Management<br>4401 North Fairfax Drive, MBSP-4107<br>Arlington, VA 22203-1610<br>(703) 358-1714<br><a href="http://www.fws.gov/migratorybirds">http://www.fws.gov/migratorybirds</a> |
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### State Agencies

To contact a state wildlife agency, visit the Association of Fish & Wildlife Agencies' website at [http://www.fishwildlife.org/where\\_us.html](http://www.fishwildlife.org/where_us.html)

## GLOSSARY

The definitions below apply to these National Bald Eagle Management Guidelines:

**Communal roost sites** – Areas where bald eagles gather and perch overnight – and sometimes during the day in the event of inclement weather. Communal roost sites are usually in large trees (live or dead) that are relatively sheltered from wind and are generally in close proximity to foraging areas. These roosts may also serve a social purpose for pair bond formation and communication among eagles. Many roost sites are used year after year.

**Disturb** – To agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

In addition to immediate impacts, this definition also covers impacts that result from human-caused alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that injures an eagle or substantially interferes with normal breeding, feeding, or sheltering habits and causes, or is likely to cause, a loss of productivity or nest abandonment.

**Fledge** – To leave the nest and begin flying. For bald eagles, this normally occurs at 10-12 weeks of age.

**Fledgling** – A juvenile bald eagle that has taken the first flight from the nest but is not yet independent.

**Foraging area** – An area where eagles feed, typically near open water such as rivers, lakes, reservoirs, and bays where fish and waterfowl are abundant, or in areas with little or no water (i.e., rangelands, barren land, tundra, suburban areas, etc.) where other prey species (e.g., rabbit, rodents) or carrion (such as at landfills) are abundant.

**Landscape buffer** – A natural or human-made landscape feature that screens eagles from human activity (e.g., strip of trees, hill, cliff, berm, sound wall).

**Nest** – A structure built, maintained, or used by bald eagles for the purpose of reproduction. An **active** nest is a nest that is attended (built, maintained or used) by a pair of bald eagles during a given breeding season, whether or not eggs are laid. An **alternate** nest is a nest that is not used for breeding by eagles during a given breeding season.

**Nest abandonment** – Nest abandonment occurs when adult eagles desert or stop attending a nest and do not subsequently return and successfully raise young in that nest for the duration of a breeding season. Nest abandonment can be caused by altering habitat near a nest, even if the alteration occurs prior to the breeding season. Whether the eagles migrate during the non-breeding season, or remain in the area throughout the non-breeding season, nest abandonment can occur at any point between the time the eagles return to the nesting site for the breeding season and the time when all progeny from the breeding season have

dispersed.

**Project footprint** – The area of land (and water) that will be permanently altered for a development project, including access roads.

**Similar scope** – In the vicinity of a bald eagle nest, an existing activity is of similar scope to a new activity where the types of impacts to bald eagles are similar in nature, and the impacts of the existing activity are of the same or greater magnitude than the impacts of the potential new activity. Examples: (1) An existing single-story home 200 feet from a nest is similar in scope to an additional single-story home 200 feet from the nest; (2) An existing multi-story, multi-family dwelling 150 feet from a nest has impacts of a greater magnitude than a potential new single-family home 200 feet from the nest; (3) One existing single-family home 200 feet from the nest has impacts of a lesser magnitude than three single-family homes 200 feet from the nest; (4) an existing single-family home 200 feet from a communal roost has impacts of a lesser magnitude than a single-family home 300 feet from the roost but 40 feet from the eagles' foraging area. The existing activities in examples (1) and (2) are of similar scope, while the existing activities in example (3) and (4) are not.

**Vegetative buffer** – An area surrounding a bald eagle nest that is wholly or largely covered by forest, vegetation, or other natural ecological characteristics, and separates the nest from human activities.

## RELATED LITERATURE

Andrew, J.M. and J.A. Mosher. 1981. Bald eagle nest site selection and nesting habitat in Maryland. *Journal of Wildlife Management* 46:382-390.

Anonymous. 1977. Bald Eagle Habitat Management Guidelines, Forest Service – California Region. U.S Forest Service, San Francisco, CA.

Anthony, R.G. 2001. Low productivity of bald eagles on Prince of Wales Island, southeast Alaska. *Journal of Raptor Research* 35:1-8.

Anthony, R.G., R.W. Frenzel, F.B. Isaacs, and M.G. Garrett. 1994. Probable causes of nesting failures in Oregon's bald eagle population. *Wildlife Society Bulletin* 22:576-582.

Anthony, R.G. and F.B. Isaacs. 1989. Characteristics of bald eagle nest sites in Oregon. *Journal of Wildlife Management* 53:148-158.

Arizona Game and Fish Department. 1999. Bald Eagle Conservation Assessment and Strategy (draft).

Avian Power Line Interaction Committee (APLIC). 1996. Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996. Edison Electric Institute, Raptor Research Foundation, Washington, D.C.

Bangs, E.E., T.N. Bailey and V.D. Berns. Ecology of nesting bald eagles on the Kenai National Wildlife Refuge, Alaska. (USFWS staff)

Becker, J.M. 2002. Response of wintering bald eagles to industrial construction in southeastern Washington. *Wildlife Society Bulletin* 30:875-878.

Brauning, D.W. and J.D. Hassinger. 2000. Pennsylvania Recovery and Management Plan for the Bald Eagle (draft). Pennsylvania Game Commission. Harrisburg, PA.

Brown, B.T., G.S. Mills, C. Powels, W.A. Russell, G.D. Therres and J.J. Pottie. 1999. The influence of weapons-testing noise on bald eagle behavior. *Journal of Raptor Research* 33:227-232.

Brown, B.T. and L.E. Stevens. 1997. Winter bald eagle distribution is inversely correlated with human activity along the Colorado River, Arizona. *Journal of Raptor Research* 31:7-10.

Buehler, D.A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). In *The Birds of North America*, No. 506 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Buehler, D.A., T.J. Mersmann, J.D. Fraser, and J.K.D. Seegar. 1991. Effects of human activity on bald eagle distribution on the northern Chesapeake Bay. *Journal of Wildlife Management* 55:282-290.

Buehler, D.A., T.J. Mersmann, J.D. Fraser, and J.K.D. Seegar. 1991. Nonbreeding bald eagle communal and solitary roosting behavior and roost habitat on the northern Chesapeake Bay. *Journal of Wildlife Management* 55:273-281.

- Chandler, SK., J.D. Fraser, D.A. Buehler and J.K.D. Seegar. 1995. Perch trees and shoreline development as predictors of bald eagle distribution on the Chesapeake Bay. *Journal of Wildlife Management* 59:325-332.
- Cline, K. 1985. Bald Eagles in the Chesapeake: A Management Guide for Landowners. National Wildlife Federation. Washington, D.C.
- Dell, D.D. and P.J. Zwank. 1986. Impact of a high-voltage transmission line on a nesting pair of southern bald eagles in southeast Louisiana. *Journal of Raptor Research* 20(3/4):117-119.
- Dunwiddie, P.W. and R.C. Kuntz. 2001. Long-term trends of bald eagles in winter on the Skagit River, Washington. *Journal of Wildlife Management* 65(2):290-299.
- Fletcher, R.J. et. al. 1999. Effects of recreational trails on wintering diurnal raptors along riparian corridors in a Colorado grassland. *Journal of Raptor Research* 33(3):233-239.
- Fraser, J.D. 1981. The breeding biology and status of the bald eagle on the Chippewa National Forest. PhD. Dissertation, University of Minnesota.
- Fraser, J.D., LD. Frenzel and J.E. Mathisen. 1985. The impact of human activities on breeding bald eagles in north-central Minnesota. *Journal of Wildlife Management* 49(3):585-592.
- Garrett, M.G., J.W. Watson, and R.G. Anthony. 1993. Bald eagle home range and habitat use in the Columbia River Estuary. *Journal of Wildlife Management* 57(1):19-27.
- Gerrard J.M. and G.R. Bortolotti. 1988. The Bald Eagle: Haunts and Habits of a Wilderness Monarch. Smithsonian Institution Press. Washington, D.C.
- Grier, J.W. 1969. Bald eagle behavior and productivity responses to climbing to nests. *Journal of Wildlife Management* 33:961-966.
- Grier, J.W. and J.E. Guinn. 2003. Bald eagle habitats and responses to human disturbance in Minnesota. Report to the Minnesota Department of Natural Resources.
- Grubb, T.G. 1976. Survey and analysis of bald eagle nesting in western Washington. M.S. thesis, Univ. of Washington, Seattle.
- Grubb, T.G. and R.M. King. 1991. Assessing human disturbance of breeding bald eagles with classification tree models. *Journal of Wildlife Management* 55:500-511.
- Grubb, T.G., W.L. Robinson and W.W. Bowerman. 2002. Effects of watercraft on bald eagles nesting in Voyageurs National Park, Minnesota. *Wildlife Society Bulletin* 30:156-161.
- Grubb, T.G. and W.W. Bowerman. 1997. Variations in breeding bald eagle response to jets, light planes and helicopters. *Journal of Raptor Research* 31:213-222.

- Grubb, T.G., W.W. Bowerman, A.J. Bath, J.P. Giesy, D.V.C. Weseloh. 2003. Evaluating Great Lakes bald eagle nesting habitat with Bayesian inference. RMRS-RP-45. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO, 10 pp.
- Hansen, J.A. 1977. Population dynamics and night roost requirements of bald eagles wintering in the Nooksack River Valley, WA. Huxley College of Environmental Studies, Western Washington State College, Bellingham, WA. (Problem Series)
- Hansen, J.A., M.V. Stalmaster and J.R. Newman. 1980. Habitat characteristics, function, and destruction of bald eagle communal roosts in western Washington. Huxley college of Environmental Studies, Western Washington University.
- Hunt, W.G., D.E. Driscoll, E.W. Bianchi, and R.E. Jackman. 1992. Ecology of bald eagles in Arizona. Report to U.S. Bureau of Reclamation, Contract 6-CS-30-04470. BioSystems Analysis Inc., Santa Cruz, California.
- Isaacs, F.B and R.G. Anthony. 1987. Abundance, foraging, and roosting of bald eagles wintering in the Harney Basin, Oregon. Northwest Science 61(2), pp. 114-121.
- Juenemann, B.G. 1973. Habitat evaluations of selected bald eagle nest sites on the Chippewa National Forest. M.S. thesis, University of Minnesota, Minneapolis.
- Keister, G.P., R.G. Anthony and E.J. O'Neill. 1987. Use of communal roosts and foraging area by bald eagles wintering in the Klamath Basin. Journal of Wildlife Management 51(2):415-420.
- Knight, R. and S.K. Knight. 1984. Responses of wintering bald eagles to boating activity. Journal of Wildlife Management 48:999-1004.
- Linscombe, J.T., T.J. Hess, Jr., and V.L. Wright. 1999. Effects of seismic operations on Louisiana's nesting bald eagles. Proceedings of the Southeastern Association of Fish and Wildlife Agencies. 54:235-242.
- Maine (State of) Inland Fisheries and Wildlife Rules. Chapter 8.05 Essential Habitat for Species Listed as Threatened or Endangered.
- Mathisen, J.E. 1968. Effects of human disturbance on nesting bald eagles. Journal of Wildlife Management 32(1): 1-6.
- McGarigal, K., R.G. Anthony and F.B. Isaacs. 1991. Interactions of humans and bald eagles on the Columbia River estuary. Wildlife Monographs 115:1-47.
- McKay, K.J., J.W. Stravers, B.R. Conklin, U. Konig, S. Hawks, C.J. Kohrt, J.S. Lundh and G.V. Swenson. 2001. Potential human impacts on bald eagle reproductive success along the Upper Mississippi River.
- McKewan, L.C. and D.H. Hirth. 1979. Southern bald eagle productivity and nest site selection. Journal of Wildlife Management 43:585-594.

Millsap, B.A. Status of wintering bald eagles in the conterminous 48 States. 1986. Wildlife Society Bulletin 14:433-440.

Millsap, B.A, T. Breen, E. McConnell, T. Steffer, L. Phillips, N. Douglass, and S. Taylor. In Press. Comparative fecundity and survival of bald eagles fledged from suburban and rural natal areas in Florida. Journal of Wildlife Management 68(4).

Montana Bald Eagle Working Group. 1986. Montana Bald Eagle Management Plan. Department of the Interior, Bureau of Land Management. Billings, MT.

Nesbitt, S.A., M.J. Folk and D.A. Wood. 1993. Effectiveness of bald eagle habitat protection guidelines in Florida. Proceedings of the Annual Conference of the Southeast Association of Fish and Wildlife Agencies.

Newman, J.R., W.H. Brennan and L.M. Smith. 1977. Twelve-year changes in nesting patterns of bald eagles on San Juan Island, Washington. The Murrelet 58(2)37-39.

Postapulsky, S. 1974. Raptor reproductive success: some problems with methods, criteria, and terminology. Pages 21-31 in F.N. Hammerstrom, Jr., B.E. Harrell, and R.R. Olendorff, eds. Management of raptors. Raptor Res. Found., Vermillion, S.D.

Rodgers, J.A. and Schwikert, S.T. 2003. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by airboats in Florida. Waterbirds 26(4): 437-443.

Russell, D. 1980. Occurrence and human disturbance sensitivity of wintering bald eagles on the Sauk and Suiattle Rivers, Washington. In R.L. Knight, G.T. Allen, M.V. Stalmaster and C.W. Servheen [eds.]. Proceedings of the Washington Bald Eagle Symposium. Nature Conservancy, Seattle, Washington, pp. 165-174.

Shapiro, A.E., F. Montalbano, and D. Mager. 1982. Implications of construction of a flood control project upon bald eagle nesting activity. Wilson Bulletin 94(1), pp. 55-63.

Skagen, S.K. 1980. Behavioral responses of wintering bald eagles to human activity on the Skagit River, Washington. In R.L. Knight, G.T. Allen, M.V. Stalmaster and C.W. Servheen [eds.]. Proceedings of the Washington Bald Eagle Symposium. Nature Conservancy, Seattle, Washington, pp. 231-241.

Skagen, S.K., R.L. Knight and G.J.H. Orians. 1991. Human disturbance of an avian scavenging guild. Ecological Applications 1:215-225. (Internet)

Stalmaster, M.V. 1976 Winter ecology and effects of human activity on bald eagles in the Nooksack River Valley, Washington. MS Thesis, Western Washington State College, Bellingham.

Stalmaster, M.V. 1980. Management strategies for wintering bald eagles in the Pacific Northwest. Proceedings of the Washington Bald Eagle Symposium, pp 49-67.

Stalmaster, M.V. and J.L. Kaiser. 1998. Effects of recreational activity on wintering bald eagles. Wildlife Monographs 137:1-46.

- Stalmaster, M.V. and J.L. Kaiser. 1997. Flushing responses of wintering bald eagles to military activity. *Journal of Wildlife Management* 61:1307-1313.
- Stalmaster, M.V. and J.R. Newman. 1978. Behavioral responses of wintering bald eagles to human activity. *Journal of Wildlife Management* 42:506-513.
- Steenhof, K. 1978. Management of Wintering Bald Eagles. FWS/OBS-78/79. U.S. Fish and Wildlife Service, Department of the Interior, Washington D.C.
- Steidl, R.J. and R.G. Anthony. 2000. Experimental Effects of Human Activity on Breeding Bald Eagles. *Ecological Applications* 10(1), pp. 258-268.
- Therres, G.D., M.A. Byrd and D.S. Bradshaw. 1993. Effects of development on nesting bald eagles: case studies from Chesapeake Bay. *Transactions of the North American Wildlife and Natural Resources Conference* 58:62-69.
- U.S. Fish and Wildlife Service. 1979. Bald Eagle Management Guidelines: Oregon – Washington. Portland. OR.
- U.S. Fish and Wildlife Service. 1983. Northern States bald eagle recovery plan. Appendices E, F, and G. U.S. Fish and Wildlife Service, Region 6, Denver, CO.
- U.S. Fish and Wildlife Service. 1987. Habitat Management Guidelines for the Bald Eagle in the Southeast Region. U.S. Fish and Wildlife Service, Region 4. Atlanta, GA.
- U.S. Fish and Wildlife Service. 1993. Bald Eagle Basics. Anchorage, AK.
- U.S. Fish and Wildlife Service. 1993. Habitat Management Guidelines for Bald Eagles in Texas. Austin, TX.
- U.S. Fish and Wildlife Service and Virginia Department of Game and Inland Fisheries. 2001. Bald Eagle Protection Guidelines for Virginia. Gloucester and Richmond, VA.
- Watson, J.W. 1993. Responses of nesting bald eagles to helicopter surveys. *Wildlife Society Bulletin* 21:171-178.
- Watson, J.W. 2004. Responses of nesting bald eagles to experimental pedestrian activity. *Journal of Raptor Research* 38:295-305.
- Wood, P.B. 1999. Bald eagle response to boating activity in northcentral Florida. *Journal of Raptor Research* 33:97-101.
- Wood, P.B., T.C. Edwards Jr. and M.W. Collopy. 1989. Characteristics of bald eagle nesting habitat in Florida. *Journal of Wildlife Management* 53(2):441-449.
- Young, L.S. 1980. A quantitative evaluation of human disturbance impacts on breeding eagle ecology of bald eagles in the San Juan Islands, Washington. Washington Department of Game, Olympia.

## **APPENDIX I**

### **Mine Stormwater Management Systems**

## APPENDIX I

### Mine Stormwater Management Systems

#### 1. Applicability

This Appendix is applicable only for mines for which the Department has permitting, compliance, and enforcement responsibilities under the interagency operating agreements adopted under Rule 62-113.100, F.A.C., but is not applicable to borrow pits. See paragraphs 2.0(a)12 and 61 of Volume I for more specific definitions of “borrow pits” and “mines,” respectively.

Applicants are advised that future changes in land use or development of the project area, subsequent to mining operations and reclamation, may necessitate changes to the stormwater management system and associated operation, maintenance, and monitoring requirements.

#### 2. Design Options and Considerations

1. A mine stormwater management system must be designed to accomplish the water quantity and quality objectives specified in Rule 62-330.301(1), F.A.C. These objectives may be addressed through the following two design options: 1) containment of a specified volume and/or 2) compliance with the stormwater treatment and attenuation criteria provided in the Applicant’s Handbook Volume II of the water management district (WMD) where the mine will be located.
2. An industrial wastewater (IW) facility permit, issued in accordance with Chapter 62-620, F.A.C., constitutes authorization to discharge to waters of the state under the National Pollutant Discharge Elimination System (NPDES) Program in accordance with Section 403.0885, F.S. The water quantity and quality objectives of Rule 62-330.301(1), F.A.C., as described in this appendix, with the exception of water elevation (see Part 2.3.b. below) shall be presumed to be met within the physical boundary of an active IW management system that is permitted under Chapter 62-620, F.A.C., prior to commencement of construction on the basis that the IW permit establishes the following:
  1. The total areal extent of the NPDES system.
  2. The designated discharge outfalls and points within the NPDES system.
  3. Specific conditions regarding effluent limitations; standards and prohibitions at outfalls and discharge points; discharge sampling, reporting requirements, and corrective measures.
  4. Best management practices, pollution prevention procedures, and standard operating procedures for wastewater management.
3. Design considerations intended to meet the objectives of Rule 62-330.301(1), F.A.C., are presented below regarding containment, water elevations, stormwater runoff pretreatment, water and soil quality, and karstic subsurface.

##### *a. Containment*

Stormwater runoff that is directly or indirectly conveyed to a mine pit may be managed through containment measures to meet water quantity and quality objectives. An above-grade internal or perimeter berm is an acceptable design method to provide containment.

Containment will be presumed if the mine pit and/or the above-grade berms have sufficient available storage capacity for a given volume and freeboard at all times throughout the life of the mine. The required storage capacity shall be calculated using the larger of two design storm events: 1) the 25-year 24-hour design storm event or 2) the required design storm event specified in the Applicant’s Handbook Volume II of the WMD where the mine will be located. A minimum of three feet of freeboard is

## APPENDIX I

### Mine Stormwater Management Systems

recommended for mine pit lakes having fetch lengths of one mile or less. A wave run-up analysis is necessary to determine the appropriate freeboard for a mine pit lake having a fetch length greater than one mile. The freeboard must be measured from the final stage elevation of the applicable WMD's design storm event using the seasonal high water table as the initial stage elevation of the design storm event. The applicant shall demonstrate recovery of the storage capacity for back-to-back required design storm events if the freeboard will be less than three feet. Alternate reasonable assurance may be provided to demonstrate that overtopping will not occur below the required storage capacity.

In lieu of freeboard, stormwater runoff may be discharged through a permanent structure at an elevation above the final stage elevation of the applicable design storm event using the seasonal high water table as the initial stage elevation of the design storm. Discharge design criteria shall be as specified in the applicable WMD's Applicant's Handbook Volume II. The applicant shall demonstrate that offsite discharges shall not cause adverse water quantity impacts to receiving waters and adjacent lands, adverse flooding to onsite or offsite property, adverse impacts to existing surface water storage and conveyance capabilities, or adverse secondary or cumulative impacts to water resources, by itself or in combination with pre-existing activities.

#### *b. Water Elevations*

Dewatering and subsurface excavation have the potential to adversely affect surface water and groundwater elevations. The applicant shall provide reasonable assurance that such adverse effects will not occur by providing a water elevation drawdown or budget analysis or other engineering methodologies (such as recharge through a trench), to demonstrate that the project activity will not adversely affect wetland hydroperiods or cause adverse flooding and environmental impacts to the property of others as a result of changes to water elevations. To provide this assurance, the Department shall require the permittee to take certain measures, as necessary, such as installing piezometers and staff gauges, and monitoring them on a permitted interval. To the extent that an existing water use permit or consumptive use permit addresses the foregoing, such permit may provide reasonable assurance that the stormwater management system will meet these objectives.

#### *c. Stormwater Runoff Pretreatment*

If a mine pit is owned entirely by one person other than the state, surface water quality standards do not apply within that mine pit lake\*, except with respect to potential discharges to offsite surface waters and groundwater. Except for activities permitted under 62-620, F.A.C., as provided in paragraph 2.2. above, "contact" runoff that may reasonably be expected to contain potentially-hazardous pollutants may require treatment prior to entering the mine pit or other stormwater management systems. Runoff from entrance roads, parking areas, processing areas, petroleum product storage areas, solid waste storage areas, and equipment maintenance or washdown areas may contain potentially-hazardous pollutants. However, areas associated with material processing, such as washing associated with grading and sorting of sand or limestone extracted from the site, are not considered potential sources of pollutants, provided that no chemicals, except Department-approved water conditioners or pH adjusters, are added to the process water used for transporting, washing, or processing the sand or limestone. Such sources of pollution may require separate management systems to prevent direct discharges to the mine pit, other stormwater management systems, offsite property, or any waters of the state. The applicant is also advised to contact the Department's Industrial Wastewater Program regarding the need and requirements for an IW permit.

#### *d. Water and Soil Quality*

## APPENDIX I

### Mine Stormwater Management Systems

Evaluation of the ambient surface water, if present, and groundwater quality is required. Typically, to evaluate the ambient groundwater quality, sampling will be required at 5-foot depth intervals to approximately five feet below the proposed depth of extraction. An alternative sampling interval will be considered, based on available lithologic data and mine depths, when requested by the applicant. Compliance water quality monitoring shall be required, as necessary, on a permitted interval to provide reasonable assurance based on the site-specific conditions and the proposed activities. Representative soil characterization shall be required, as necessary, for areas of the property that may be contaminated with potentially-hazardous substances. Such areas may include existing or historical agricultural areas where potentially-hazardous substances may have been used, fuel storage and fueling areas, and hazardous waste areas within the proposed project area. Existing soil characterization reports and agency determination letters may be submitted in support of an application. Sampling shall be conducted in accordance with the current version of DEP's Standard Operating Procedures (DEP-SOP-001/01), as incorporated by reference in Rule 62-160.800, F.A.C.

#### *e. Karstic Subsurface*

The breaching of confining layers or conduit features in karstic or other highly permeable materials, such as limestone, dolomitic limestone, or dolostone, presents a greater potential for direct discharge of untreated stormwater pollutants into groundwater. The applicant must provide reasonable assurance that groundwater quality standards will not be violated by mining activities that have the potential to penetrate confining layers or flow conduits in karst-sensitive areas. Runoff from entrance roads, parking areas, processing areas, petroleum product storage areas, solid waste storage areas, and equipment maintenance or washdown areas may contain potentially-hazardous pollutants. However, areas associated with material processing, such as washing associated with grading and sorting of sand or limestone extracted from the site, are not considered potential sources of pollutants, provided that no chemicals, except Department-approved water conditioners or pH adjusters, are added to the process water used for transporting, washing, or processing the sand or limestone. Stormwater that is treated by a stormwater management system designed, constructed, and operated in accordance with the applicable Volume II of this handbook, *prior to discharge to the mine excavation*, shall be presumed to not cause or contribute to a water quality violation. The applicant may propose alternative measures demonstrating that stormwater runoff entering the mine pit will not result in offsite exceedances in water quality standards.

*\* Applicants are advised that a mine pit lake that is subject to federal jurisdiction as a water of the United States may require federal authorization, prior to use for stormwater treatment or other wastewater treatment purposes.*

### 3. Pre-Application Contact Information

Applicants are strongly advised to request a pre-application meeting with the Department's Mining & Mitigation Program to discuss sample locations, depths, parameters, and frequencies, prior to performing any sampling or installation of piezometers or monitoring wells. The Mining & Mitigation Program's contact information is as follows:

Department of Environmental Protection  
Bob Martinez Center  
2600 Blair Stone Road, Mail Station 3577  
Tallahassee, Florida 32399-2400

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### **Mine Stormwater Management Systems**

MiningAndMitigation@dep.state.fl.us

Telephone: (850) 245-7554

Alternate telephone: (850) 245-8335 (Division of Water Resource  
Management) Fax Number: (850) 245-8356

Website: <https://floridadep.gov/water/mining-mitigation>

# Chapter 62-340, F.A.C. Data Form Guide

Wetland and Other Surface Water Delineation  
Version: August 2018 ©



From the Staff of  
Wetland Evaluation and Training  
Submerged Lands and Environmental Resources Coordination

# Florida Department of Environmental Protection

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The content of this guide was compiled by members of the Florida Department of Environmental Protection, Submerged Lands and Environmental Resources Coordination, Wetland Evaluation and Training Team. The express purpose of this document is to provide guidance to regulatory staff in order to maintain consistency in the applied field methodologies for wetland delineation pursuant to Chapter 62-340, F.A.C. The information contained in this guide was garnered from various sources pertinent to the field application of wetland delineation methodology outlined in Chapter 62-340, F.A.C. FDEP does

not warrant data provided by other sources for accuracy or for any particular use that may require accurate information. This guide is for information purposes only.

## **Appendix A: subsection 62-340.450(1), (2), (3), F.A.C.**

### **Vegetative Index Plant List**

#### **Botanical Name/ Common Name/ Wetland Status**

*Abildgaardia ovata* flat-spike rush FACW  
*Acacia auriculiformis* ear-leaved acacia FAC  
*Acer negundo* box-elder FACW  
*Acer rubrum* red maple FACW  
*Acer saccharinum* silver maple OBL  
*Acoelorrhaphe wrightii* paurotis palm OBL  
*Acrostichum* spp. leather fern OBL  
*Aeschynomene indica* India joint-vetch FACW  
*Aeschynomene pratensis* meadow joint-vetch OBL  
*Agalinis aphylla* scale-leaf false-foxglove FACW  
*Agalinis linifolia* flax-leaf false-foxglove OBL  
*Agalinis maritima* saltmarsh false-foxglove OBL  
*Agalinis pinetorum* (A. *pulchella*) false-foxglove FACW  
*Agalinis purpurea* large purple false-foxglove FACW  
*Agarista populifolia* hobble-bush FACW  
*Agrostis stolonifera* redtop FACW  
*Aletris* spp. colic-root FAC  
*Alisma subcordatum* subcordate water-plantain OBL  
*Alnus serrulata* hazel alder OBL  
*Alopecurus carolinianus* tufted foxtail FAC  
*Alternanthera maritima* beach alternanthera FACW - Keys only  
*Alternanthera paronychioides* smooth chaff-flower FAC - Keys only  
*Alternanthera philoxeroides* alligator-weed OBL  
*Alternanthera sessilis* sessile alligator-weed OBL  
*Amaranthus australis* southern amaranth OBL  
*Amaranthus cannabinus* tidemarch amaranth OBL  
*Amaranthus floridanus* Florida amaranth OBL  
*Ammannia* spp. toothcup OBL  
*Amorpha fruticosa* indigo-bush FACW  
*Amphicarpum muhlenbergianum* blue maidencane FACW  
*Amsonia rigida* stiff slimpod FACW  
*Amsonia tabernaemontana* eastern slimpod FACW  
*Anagallis pumila* Florida pimpernel FAC  
*Andropogon arctatus* (Campbell) savannah bluestem FAC  
*Andropogon brachystachys* (Campbell) short-spike bluestem FAC  
*Andropogon gerardii* (Campbell) big bluestem FAC  
*Andropogon glomeratus* (Campbell) bushy bluestem FACW  
*Andropogon liebmanii* var. *pungensis* (Campbell) (A. *mohrii*) Mohr's bluestem FACW  
*Andropogon perangustatus* (Campbell) slim bluestem FAC  
*Andropogon virginicus* (Campbell) broom-sedge FAC  
*Annona glabra* pond apple OBL  
*Anthaenania rufa* purple silky-scale FACW  
*Apteria aphylla* nodding nixie FACW  
*Ardisia* spp. marlberry FAC  
*Arenaria godfreyi* Godfrey's stitchwort FACW  
*Arisaema* spp. jack-in-the-pulpit; green-dragon FACW

*Aristida affinis* long-leaf three-awn grass OBL  
*Aristida purpurascens* (s.l.) wand-like three-awn grass FACW  
*Aristida rhizomophora* rhizomatous three-awn grass FAC  
*Aristida spiciformis* three-awn bottlebrush FAC  
*Aristida stricta* pineland three-awn grass FAC  
*Armoracia aquatica* lakecress OBL  
*Arnoglossum diversifolium* variable-leaf indian-plantain FACW  
*Arnoglossum ovatum* egg-leaf indian-plantain FACW  
*Arnoglossum sulcatum* indian-plantain, Georgia OBL  
*Aronia arbutifolia* red chokeberry FACW  
*Arundinaria gigantea* giant cane FACW  
*Arundo donax* giant reed FAC  
*Asclepias connivens* large-flower milkweed FACW  
*Asclepias incarnata* swamp milkweed OBL  
*Asclepias lanceolata* fen-flower milkweed OBL  
*Asclepias longifolia* long-leaf milkweed FACW  
*Asclepias pedicellata* savannah milkweed FACW  
*Asclepias perennis* aquatic milkweed OBL  
*Asclepias rubra* red milkweed OBL  
*Asclepias viridula* southern milkweed FACW  
*Aster carolinianus* climbing aster OBL  
*Aster chapmanii* savannah aster FACW  
*Aster dumosus* bushy aster FAC  
*Aster elliotii* Elliott's aster OBL  
*Aster eryngiifolius* coyote-thistle aster FACW  
*Aster lateriflorus* calico aster FACW  
*Aster spinulosus* bog aster FACW  
*Aster subulatus* saltmarsh aster OBL  
*Aster tenuifolius* saltmarsh aster OBL  
*Aster umbellatus* flat-top white aster FAC  
*Aster vimineus* small white aster FACW  
*Athyrium filix-femina* subarctic lady fern FACW  
*Atriplex patula* halberd-leaf saltbush FACW  
*Avicennia germinans* black mangrove OBL  
*Axonopus* spp. carpet grass FAC  
*Baccharis angustifolia* false-willow OBL  
*Baccharis dioica* broom-bush false-willow FAC  
*Baccharis glomeruliflora* groundsel tree FAC  
*Baccharis halimifolia* eastern false-willow FAC  
*Bacopa* spp. water-hyssop OBL  
*Balduina atropurpurea* purple honeycomb-head FACW  
*Balduina uniflora* one-flower honeycomb-head FACW  
*Bartonia* spp. screwstem FACW  
*Batis maritima* saltwort OBL  
*Betula nigra* river birch OBL  
*Bidens bipinnata* Spanish needles U  
*Bidens pilosa* white beggar-ticks FAC  
*Bidens* spp. beggar-ticks OBL  
*Bigelovia nudata* rayless golden-rod FACW  
*Blechnum serrulatum* swamp fern FACW  
*Boehmeria cylindrica* small-spike false-nettle OBL

***Boltonia* spp.** boltonia FACW  
***Borrichia* spp.** sea oxeye OBL  
***Brachiaria purpurascens*** paragrass FACW  
***Bucida buceras*** gregory wood FAC  
***Bumelia celastrina*** coastal bumelia FAC  
***Bumelia lycioides*** buckthorn bumelia FAC  
***Bumelia reclinata*** bumelia FAC  
***Burmannia* spp.** burmannia OBL  
***Byrsonima lucida*** locust-berry FAC - Keys only  
***Cacalia suaveolens*** sweet-scent indian-plantain FACW  
***Calamovilfa curtissii*** Curtiss' reed grass FACW  
***Callitriche* spp.** water-starwort OBL  
***Calopogon* spp.** grass-pinks FACW  
***Calyccarpum lyonii*** cupseed FACW  
***Campanula americana*** American bellflower FAC  
***Campanula floridana*** bellflower OBL  
***Canna* spp.** canna OBL  
***Canna x generalis*** common canna FAC  
***Caperonia* spp.** caperonia FACW  
***Capparis flexuosa*** caper-tree FACW  
***Cardamine bulbosa*** bitter-cress OBL  
***Cardamine pensylvanica*** spring-cress OBL  
***Carex atlantica*** prickly bog sedge OBL  
***Carex comosa*** bearded sedge OBL  
***Carex crinita*** fringed sedge OBL  
***Carex crus-corvi*** raven-foot sedge OBL  
***Carex decomposita*** cypress-knee sedge OBL  
***Carex elliottii*** Elliott's sedge OBL  
***Carex folliculata*** long sedge OBL  
***Carex gigantea*** large sedge OBL  
***Carex howei*** Howe's sedge OBL  
***Carex hyalinolepis*** sedge, shoreline sedge OBL  
***Carex leptalea*** bristly-stalk sedge OBL  
***Carex louisianica*** Louisiana sedge OBL  
***Carex lupulina*** hop sedge OBL  
***Carex lurida*** shallow sedge OBL  
***Carex* spp.** sedges FACW  
***Carex stipata*** stalk-grain sedge OBL  
***Carex walteriana*** Walter's sedge OBL  
***Carphephorus carnosus*** pineland chaffhead FACW  
***Carphephorus odoratissimus*** vanilla plant FAC  
***Carphephorus paniculatus*** deer-tongue FAC  
***Carphephorus pseudoliatris*** bristle-leaf chaffhead FACW  
***Carpinus caroliniana*** American hornbeam FACW  
***Carya aquatica*** water hickory OBL  
***Casuarina* spp.** casuarina FAC  
***Cayaponia quinqueloba*** five-lobe cayaponia FAC  
***Celtis laevigata*** sugar-berry; hackberry FACW  
***Centella asiatica*** coinwort FACW  
***Cephalanthus occidentalis*** buttonbush OBL  
***Cestrum diurnum*** day jessamine FAC

*Chamaecyparis thyoides* Atlantic white cedar OBL  
*Chaptalia tomentosa* sunbonnet; pineland daisy FACW  
*Chasmanthium latifolium* spanglegrass FAC  
*Chasmanthium sessiliflorum* long-leaf Chasmanthium FAC  
*Chasmanthium* spp. spanglegrass FACW  
*Chiococca* spp. snowberry FAC  
*Chrysobalanus icaco* cocoplum FACW  
*Cicuta* spp. water-hemlock OBL  
*Cirsium lecontei* Leconte's thistle FACW  
*Cirsium muticum* swamp thistle OBL  
*Cirsium nuttallii* Nuttall's thistle FACW  
*Cladium* spp. sawgrass OBL  
*Cleistes divaricata* rosebud OBL  
*Clethra alnifolia* sweet pepper bush FACW  
*Cliftonia monophylla* buckwheat-tree FACW  
*Colocasia esculenta* elephant's ear OBL  
*Colubrina asiatica* Asian snakewood FAC  
*Commelina erecta* sandhill dayflower U  
*Commelina* spp. dayflower FACW  
*Conocarpus erectus* buttonwood FACW  
*Conoclinium coelestinum* mistflower FAC  
*Coreopsis falcata* sickle tickseed FACW  
*Coreopsis floridana* Florida tickseed FACW  
*Coreopsis gladiata* southeastern tickseed FACW  
*Coreopsis integrifolia* ciliate-leaf tickseed FACW  
*Coreopsis leavenworthii* Leavenworth's tickseed FACW  
*Coreopsis linifolia* Texas tickseed FACW  
*Coreopsis nudata* Georgia tickseed OBL  
*Coreopsis tripteris* tall tickseed FAC  
*Cornus amomum* silky dogwood OBL  
*Cornus foemina* swamp dogwood FACW  
*Crataegus aestivalis* mayhaw OBL  
*Crataegus marshallii* parsley haw FACW  
*Crataegus viridis* green haw FACW  
*Crinum americanum* southern swamp-lily OBL  
*Croton elliotii* Elliott's croton FACW  
*Ctenitis submarginalis* brown-hair comb fern FACW  
*Ctenium* spp. toothache grass FACW  
*Cupaniopsis anacardioides* carrotwood FAC  
*Cuphea aspera* common waxweed FACW  
*Cuphea carthagenensis* Columbia waxweed FAC  
*Cyperus alternifolius* alternate-leaf flatsedge OBL  
*Cyperus articulatus* jointed flatsedge OBL  
*Cyperus cuspidatus* coastal-plain flatsedge FAC  
*Cyperus difformis* variable flatsedge OBL  
*Cyperus distinctus* marshland flatsedge OBL  
*Cyperus drummondii* flatsedge OBL  
*Cyperus entrerianus* flatsedge OBL  
*Cyperus erythrorhizos* red-root flatsedge OBL  
*Cyperus esculentus* flatsedge FAC  
*Cyperus filiculmis* sandhill flatsedge U

*Cyperus giganteus* flatsedge FAC  
*Cyperus globulosus* Baldwin's flatsedge FAC  
*Cyperus haspan* sheathed flatsedge OBL  
*Cyperus huarmensis* black knotty-root flatsedge FAC  
*Cyperus lanceolatus* epiphytic flatsedge OBL  
*Cyperus metzii* flatsedge FAC  
*Cyperus ovularis* flatsedge U  
*Cyperus papyrus* papyrus flatsedge OBL  
*Cyperus reflexus* flatsedge U  
*Cyperus refractus* flatsedge U  
*Cyperus retrofractus* flatsedge U  
*Cyperus retrorsus* flatsedge FAC  
*Cyperus rotundus* purple flatsedge FAC  
*Cyperus spp.* flatsedge FACW  
*Cyperus tetragonus* flatsedge U  
*Cypselea humifusa* panal FAC  
*Cyrilla racemiflora* swamp cyrilla FAC  
*Decodon verticillatus* swamp-loosestrife OBL  
*Dichondra caroliniensis* pony-foot FAC  
*Dichromena colorata* starbrush white-top sedge FACW  
*Dichromena floridensis* Everglades white-top sedge FACW  
*Dichromena latifolia* giant white-top sedge OBL  
*Dicliptera brachiata* wild mudwort FACW  
*Digitaria pauciflora* everglades grass FACW  
*Digitaria serotina* dwarf crabgrass FAC  
*Diodia virginiana* button-weed FACW  
*Dionaea muscipula* Venus' flytrap FACW  
*Diospyros virginiana* common persimmon FAC  
*Distichlis spicata* seashore saltgrass OBL  
*Drosera brevifolia* dwarf sundew FACW  
*Drosera capillaris* pink sundew FACW  
*Drosera filiformis* thread-leaf sundew OBL  
*Drosera intermedia* spoon-leaf sundew OBL  
*Drosera tracyi* Gulf coast sundew OBL  
*Drymaria cordata* West Indian chickweed FAC  
*Dryopteris ludoviciana* southern shield-fern FACW  
*Dulichium arundinaceum* three-way sedge OBL  
*Dyschoriste humistrata* swamp dyschoriste FACW  
*Echinochloa* spp. jungle-rice; cockspur grass FACW  
*Echinodorus* spp. burhead OBL  
*Eclipta alba* yerba de Tajo FACW  
*Eleocharis* spp. spikerush OBL  
*Elyonurus tripsacoides* Pan-American balsam-scale FACW  
*Elytraria caroliniensis* Carolina scaly-stem FAC  
*Equisetum hyemale* horsetail FACW  
*Eragrostis* spp. lovegrass FAC  
*Erechtites hieraciifolia* fireweed FAC  
*Erianthus brevibarbis* short-beard plumegrass FACW  
*Erianthus giganteus* sugarcane plumegrass OBL  
*Erianthus strictus* narrow plumegrass OBL  
*Erigeron quercifolius* fleabane FAC

*Erigeron vernus* early whitetop fleabane FACW  
*Eriocaulon* spp. pipewort OBL  
*Eriochloa* spp. cupgrass FACW  
*Erithalis fruticosa* black torchwood FAC  
*Ernodea littoralis* golden-creeper FAC - Keys only  
*Eryngium aquaticum* corn snakeroot OBL  
*Eryngium baldwinii* Baldwin's coyote-thistle FAC  
*Eryngium integrifolium* blue-flower coyote-thistle FACW  
*Eryngium prostratum* creeping coyote-thistle FACW  
*Eryngium yuccifolium* rattlesnake master FACW  
*Erythrodes querceticola* low erythrodes FACW  
*Eulophia alta* wild coco FACW  
*Eupatoriadelphus fistulosus* joe-pye-weed FACW  
*Eupatorium leptophyllum* marsh thoroughwort OBL  
*Eupatorium leucolepis* white-bract thoroughwort FACW  
*Eupatorium mikanioides* semaphore thoroughwort FACW  
*Eupatorium perfoliatum* boneset FACW  
*Eupatorium* spp. thoroughworts FAC  
*Euphorbia humistrata* (*Chamaesyce humistrata*) spreading broomspurge FACW  
*Euphorbia inundata* Florida spurge FACW  
*Euphorbia polyphylla* many-leaved spurge FACW  
*Eustachys glauca* (*Chloris glauca*) saltmarsh fingergrass FACW  
*Eustachys petraea* fingergrass FAC  
*Eustoma exaltatum* prairie-gentian FACW  
*Euthamia* spp. bushy goldenrod FAC  
*Evolvulus convolvuloides* evolvulus FACW  
*Evolvulus sericeus* silky bindweed FACW  
*Ficus aurea* Florida strangler fig FAC  
*Fimbristylis annua* annual fringe-rush FACW  
*Fimbristylis puberula* Vahl's hairy fringe-rush FACW  
*Fimbristylis spathacea* hurricane-grass FAC  
*Fimbristylis* spp. fringe-rush OBL  
*Flaveria bidentis* yellowtop FAC  
*Flaveria floridana* yellowtop FACW  
*Flaveria linearis* yellowtop FACW  
*Flaveria trinervia* yellowtop FAC  
*Forestiera acuminata* swamp privet FACW  
*Forestiera segregata* Florida privet FAC  
*Fothergilla gardenii* dwarf witch-alder FACW  
*Fraxinus americana* white ash U  
*Fraxinus* spp. ash OBL  
*Fuirena* spp. umbrella-sedge OBL  
*Galium tinctorium* stiff marsh bedstraw FACW  
*Gaylussacia dumosa* dwarf huckleberry FAC  
*Gaylussacia frondosa* dangleberry FAC  
*Gaylussacia mosieri* woolly-berry FACW  
*Gentiana* spp. gentian FACW  
*Gleditsia aquatica* water-locust OBL  
*Gleditsia triacanthos* honey-locust FACW  
*Glyceria striata* fowl mannagrass OBL  
*Gordonia lasianthus* loblolly bay FACW

*Gratiola hispida* hispid hyssop FAC  
*Gratiola* spp. hedgehyssop FACW  
*Guapira discolor* blolly FAC - Keys only  
*Habenaria* spp. rein orchid FACW  
*Halesia diptera* silver-bell FACW  
*Harperocallis flava* Harper's beauty FACW  
*Hartwrightia floridana* Florida hartwrightia FACW  
*Hedychium coronarium* ginger FACW  
*Helenium amarum* pasture sneezeweed FAC  
*Helenium* spp. sneezeweed FACW  
*Helianthus agrestis* southeastern sunflower FACW  
*Helianthus angustifolius* swamp sunflower FACW  
*Helianthus carnosus* lakeside sunflower FACW  
*Helianthus floridanus* Florida sunflower FAC  
*Helianthus heterophyllus* wetland sunflower FACW  
*Helianthus simulans* muck sunflower FACW  
*Heliotropium curassavicum* seaside heliotrope FAC  
*Heliotropium polyphyllum* heliotrope FAC  
*Heliotropium procumbens* four-spike heliotrope FACW  
*Hemicarpha* spp. dwarf-bulrush FACW  
*Heteranthera reniformis* kidney-leaf mud-plantain OBL  
*Hibiscus aculeatus* rosemallow FACW  
*Hibiscus coccineus* scarlet rosemallow OBL  
*Hibiscus grandiflorus* swamp rosemallow OBL  
*Hibiscus laevis* halberd-leaf rosemallow OBL  
*Hibiscus moscheutos* swamp rosemallow OBL  
*Hibiscus tiliaceus* sea rosemallow FAC  
*Hydrochloa caroliniensis* watergrass OBL  
*Hydrocleis nymphoides* water-poppy OBL  
*Hydrocotyle ranunculoides* floating pennywort OBL  
*Hydrocotyle* spp. pennywort FACW  
*Hydrolea* spp. false-fiddle-leaf OBL  
*Hygrophila* spp. hygrophila OBL  
*Hymenachne amplexicaulis* trompetilla OBL  
*Hymenocallis* spp. spider-lily OBL  
*Hypericum chapmanii* Chapman's St. John's-wort OBL  
*Hypericum cumulicola* scrub St. John's-wort U  
*Hypericum drummondii* Drummond's St. John's-wort U  
*Hypericum edisonianum* Edison's St. John's-wort OBL  
*Hypericum fasciculatum* marsh St. John's-wort OBL  
*Hypericum gentianoides* pineweed U  
*Hypericum hypericoides* St. Andrew's cross FAC  
*Hypericum lissophloeus* smooth-bark St. John's-wort OBL  
*Hypericum microsepalum* small-sepal St. John's-wort U  
*Hypericum nitidum* Carolina St. John's-wort OBL  
*Hypericum prolificum* shrubby St. John's-wort U  
*Hypericum punctatum* dotted St. John's-wort U  
*Hypericum reductum* Atlantic St. John's-wort U  
*Hypericum* spp. St. John's-wort FACW  
*Hypericum tetrapetalum* four-petal St. John's-wort FAC  
*Hypolepis repens* bead fern FACW

*Hypoxis* spp. yellow stargrasses FACW  
*Hyptis alata* musky mint FACW  
*Ilex amelanchier* sarvis holly OBL  
*Ilex cassine* dahoon holly OBL  
*Ilex coriacea* bay-gall holly FACW  
*Ilex decidua* deciduous holly FACW  
*Ilex myrtifolia* myrtle holly OBL  
*Ilex opaca* var. *opaca* American holly FAC  
*Ilex verticillata* winterberry OBL  
*Ilex vomitoria* yaupon holly FAC  
*Illicium floridanum* Florida anise OBL  
*Illicium parviflorum* star anise FACW  
*Impatiens capensis* spotted touch-me-not OBL  
*Iris* spp. iris OBL  
*Iris verna* dwarf iris U  
*Isoetes* spp. quillwort OBL  
*Itea virginica* virginia willow OBL  
*Iva frutescens* marsh elder OBL  
*Iva microcephala* little marsh elder FACW  
*Jacquinia keyensis* joewood FAC  
*Juncus marginatus* rush FACW  
*Juncus* spp. rush OBL  
*Juncus tenuis* rush FAC  
*Justicia brandegeana* shrimp plant U  
*Justicia* spp. water-willow OBL  
*Kalmia latifolia* mountain laurel FACW  
*Kosteletzkya pentasperma* coastal mallow FAC  
*Kosteletzkya virginica* seashore mallow OBL  
*Lachnanthes caroliniana* redroot FAC  
*Lachnocaulon anceps* white-head bogbutton FACW  
*Lachnocaulon beyrichianum* southern bogbutton FACW  
*Lachnocaulon digynum* pineland bogbutton OBL  
*Lachnocaulon engleri* Engler's bogbutton OBL  
*Lachnocaulon minus* Small's bogbutton OBL  
*Laguncularia racemosa* white mangrove OBL  
*Laportea canadensis* Canada wood-nettle FACW  
*Leersia* spp. cutgrass OBL  
*Leitneria floridana* corkwood OBL  
*Leptochloa* spp. sprangle-top FACW  
*Leptochloa virgata* tropic sprangle-top FAC  
*Leucothoe* spp. dog-hobble FACW  
*Liatris garberi* Garber's gayfeather FACW  
*Liatris gracilis* blazing star FAC  
*Liatris spicata* spiked gayfeather FAC  
*Lilaeopsis* spp. lilaeopsis OBL  
*Lilium catesbaei* southern red lily FAC  
*Lilium iridollae* panhandle lily OBL  
*Limnobiium spongia* frogbit OBL  
*Limnophila* spp. marshweed OBL  
*Limonium carolinianum* sea-lavender OBL  
*Lindera benzoin* northern spicebush FACW

*Lindera melissifolia* southern spicebush OBL  
*Lindernia crustacea* Malayan false-pimpernel FAC  
*Lindernia* spp. false-pimpernel FACW  
*Linum carteri* Carter's flax FACW  
*Linum floridanum* Florida yellow flax FAC  
*Linum medium* stiff yellow flax FAC  
*Linum striatum* ridged yellow flax FACW  
*Linum westii* West's flax OBL  
*Liparis elata* (L. *nervosa*) tall liparis OBL  
*Lipocarpha* spp. lipocarpha FACW  
*Liquidambar styraciflua* sweetgum FACW  
*Liriodendron tulipifera* tulip tree FACW  
*Listera* spp. twayblade FACW  
*Litsea aestivalis* pondspice OBL  
*Lobelia cardinalis* cardinal flower OBL  
*Lobelia floridana* Florida lobelia OBL  
*Lobelia* spp. lobelia FACW  
*Lophiola americana* golden-crest FACW  
*Ludwigia hirtella* hairy seedbox FACW  
*Ludwigia maritima* seaside seedbox FACW  
*Ludwigia* spp. ludwigia; water-primrose OBL  
*Ludwigia suffruticosa* headed seedbox FACW  
*Ludwigia virgata* savanna seedbox FACW  
*Lycium carolinianum* Christmas berry OBL  
*Lycopodium* spp. clubmoss FACW  
*Lycopus* spp. bugleweed OBL  
*Lyonia ligustrina* maleberry FAC  
*Lyonia lucida* fetter-bush FACW  
*Lyonia mariana* fetter-bush FACW  
*Lysimachia* spp. loosestrife OBL  
*Lythrum* spp. marsh loosestrife OBL  
*Macbridea* spp. birds-in-a-nest FACW  
*Macranthera flammea* flameflower OBL  
*Magnolia virginiana* var. *australis* sweetbay magnolia OBL  
*Malaxis spicata* Florida adder's-mouth OBL  
*Manilkara bahamensis* wild dilly FAC - Keys only  
*Manisuris cylindrica* pitted jointgrass FAC  
*Manisuris* spp. jointgrass FACW  
*Marshallia graminifolia* grass-leaf barbara's-buttons FACW  
*Marshallia tenuifolia* slim-leaf barbara's-buttons FACW  
*Maxillaria crassifolia* hidden orchid OBL  
*Maytenus phyllanthoides* Florida mayten FAC  
*Mecardonia* spp. mecardonia FACW  
*Melaleuca quinquenervia* punk tree FAC  
*Melanthera nivea* squarestem FACW  
*Melanthium virginicum* Virginia bunchflower OBL  
*Melochia corchorifolia* chocolate-weed FAC  
*Metopium toxiferum* poison wood FAC  
*Micranthemum* spp. baby tears OBL  
*Micromeria brownei* (*Satureja brownei*) Brown's savory OBL  
*Mimosa pigra* black mimosa FAC

*Mimulus alatus* monkey-flower OBL  
*Mitreola* spp. hornpod FACW  
*Monanthochloe littoralis* keygrass OBL  
*Morinda royoc* Keys rhubarb FACW - Keys only  
*Morus rubra* red mulberry FAC  
*Muhlenbergia capillaris* muhly grass OBL  
*Muhlenbergia expansa* cutover muhly FAC  
*Muhlenbergia schreberi* nimblewill FACW  
*Murdannia* spp. dewflower FAC  
*Myosurus minimus* tiny mouse-tail FAC  
*Myrica cerifera* southern bayberry FAC  
*Myrica heterophylla* evergreen bayberry FACW  
*Myrica inodora* odorless bayberry FACW  
*Myrsine guianensis* guiana myrsine FAC  
*Nasturtium* spp. water-cress OBL  
*Nelumbo* spp. water-lotus OBL  
*Nemastylis floridana* fall-flowering pleatleaf FACW  
*Nemophila aphylla* small-flower baby-blue-eyes FACW  
*Nephrolepis* spp. sword ferns FAC  
*Neyraudia reynaudiana* silk reed FAC  
*Nuphar luteum* yellow cow-lily OBL  
*Nymphaea* spp. water-lily OBL  
*Nymphoides* spp. floating-hearts OBL  
*Nyssa aquatica* water tupelo OBL  
*Nyssa ogeche* ogeechee tupelo OBL  
*Nyssa sylvatica* var. *biflora* swamp tupelo OBL  
*Oldenlandia* spp. water bluets FACW  
*Onoclea sensibilis* sensitive fern FACW  
*Oplismenus setarius* woods grass FAC  
*Orontium aquaticum* golden club OBL  
*Oryza sativa* cultivated rice FAC  
*Osmunda cinnamomea* cinnamon fern FACW  
*Osmunda regalis* royal fern OBL  
*Oxypolis* spp. water drop-wort OBL  
*Panicum abscissum* (Hall) cut-throat grass FACW  
*Panicum anceps* beaked panicum FAC  
*Panicum commutatum* panicum FAC  
*Panicum dichotomiflorum* fall panicum FACW  
*Panicum dichotomum* panicum FACW  
*Panicum ensifolium* panic grass OBL  
*Panicum erectifolium* erect-leaf witchgrass OBL  
*Panicum gymnocarpon* savannah panicum OBL  
*Panicum hemitomon* maiden-cane OBL  
*Panicum hians* gaping panicum FAC  
*Panicum longifolium* tall thin panicum OBL  
*Panicum pinetorum* panicum FACW  
*Panicum repens* torpedo grass FACW  
*Panicum rigidulum* red-top panicum FACW  
*Panicum scabriusculum* woolly panicum OBL  
*Panicum scoparium* panicum FACW  
*Panicum spretum* panicum FACW

*Panicum strigosum* panicum FAC  
*Panicum tenerum* bluejoint panicum OBL  
*Panicum tenue* panicum FAC  
*Panicum verrucosum* warty panicum FACW  
*Panicum virgatum* switchgrass FACW  
*Parietaria* spp. pellitory FAC  
*Parnassia* spp. grass-of-Parnassus OBL  
*Paspalidium geminatum* water panicum OBL  
*Paspalum acuminatum* brook paspalum FACW  
*Paspalum boscianum* bull paspalum FACW  
*Paspalum conjugatum* sour paspalum FAC  
*Paspalum dilatatum* dallisgrass FAC  
*Paspalum dissectum* mudbank paspalum OBL  
*Paspalum distichum* joint paspalum OBL  
*Paspalum fimbriatum* Panama paspalum FAC  
*Paspalum floridanum* Florida paspalum FACW  
*Paspalum laeve* field paspalum FACW  
*Paspalum monostachyum* gulf paspalum OBL  
*Paspalum plicatulum* brown-seed paspalum FAC  
*Paspalum praecox* early paspalum OBL  
*Paspalum pubiflorum* hairy-seed paspalum FACW  
*Paspalum repens* water paspalum OBL  
*Paspalum setaceum* thin paspalum FAC  
*Paspalum urvillei* vasey grass FAC  
*Pavonia spicata* mangrove mallow FACW  
*Peltandra* spp. arum; spoon flower OBL  
*Pennisetum purpureum* elephant ear grass FAC  
*Penthorum sedoides* ditch stonecrop OBL  
*Pentodon pentandrus* Hall's pentodon OBL  
*Persea palustris* swamp bay OBL  
*Phalaris* spp. canary grass FAC  
*Philoxerus vermicularis* silverhead FACW  
*Phragmites australis* common reed OBL  
*Phyla* spp. frog-fruit FAC  
*Phyllanthus caroliniensis* Carolina leaf-flower FACW  
*Phyllanthus liebmannianus* Florida leaf-flower FACW  
*Phyllanthus urinaria* water leaf-flower FAC  
*Physostegia godfreyi* Godfrey's dragon-head OBL  
*Physostegia leptophylla* slender-leaf dragon-head OBL  
*Physostegia purpurea* purple dragon-head FACW  
*Physostegia virginiana* false dragon-head FACW  
*Pieris phillyreifolia* climbing fetter-bush FACW  
*Pilea* spp. clearweed FACW  
*Pinckneya bracteata* (*P. pubens*) fever-tree OBL  
*Pinguicula* spp. butterwort OBL  
*Pinus glabra* spruce pine FACW  
*Pinus serotina* pond pine FACW  
*Piriqueta caroliniana* piriqueta FAC  
*Pisonia rotundata* pisonia FAC - Keys only  
*Pithecellobium keyense* blackbead FAC - Keys only  
*Pithecellobium unguis-cati* catclaw FAC - Keys only

*Planera aquatica* planer tree OBL  
*Platanthera* spp. fringed orchid OBL  
*Platanus occidentalis* sycamore FACW  
*Pleea tenuifolia* rush-featherling OBL  
*Pluchea* spp. camphor-weed FACW  
*Pogonia ophioglossoides* rose pogonia OBL  
*Polygala cymosa* tall milkwort OBL  
*Polygala leptostachys* sandhill milkwort U  
*Polygala lewtonii* scrub milkwort U  
*Polygala polygama* racemed milkwort U  
*Polygala* spp. milkwort FACW  
*Polygala verticillata* whorled milkwort U  
*Polygonum argyrocoleon* silversheath smartweed U  
*Polygonum* spp. smartweed OBL  
*Polygonum virginianum* jumpseed FACW  
*Polypogon* spp. rabbit-foot grass FAC  
*Polypremum procumbens* rustweed FAC  
*Pontederia cordata* pickerelweed OBL  
*Ponthieva racemosa* shadow-witch FACW  
*Populus deltoides* eastern cottonwood FACW  
*Populus heterophylla* swamp cottonwood OBL  
*Proserpinaca* spp. mermaid-weed OBL  
*Psidium cattleianum* strawberry guava FAC  
*Psilocarya* spp. baldrush OBL  
*Psychotria* spp. wild coffee FAC  
*Pteris tripartita* giant brake FACW  
*Ptilimnium capillaceum* mock bishop-weed FACW  
*Pycnanthemum nudum* coastal-plain mountain-mint FACW  
*Quercus laurifolia* laurel oak FACW  
*Quercus lyrata* overcup oak OBL  
*Quercus michauxii* swamp chestnut oak FACW  
*Quercus nigra* water oak FACW  
*Quercus pagoda* cherry-bark oak FACW  
*Quercus phellos* willow oak FACW  
*Randia aculeata* box briar FAC - Keys only  
*Ranunculus* spp. butter-cup FACW  
*Reimarochloa oligostachya* Florida reimar grass FACW  
*Reynosia septentrionalis* darling plum FAC - Keys only  
*Rhapidophyllum hystrix* needle palm FACW  
*Rhexia parviflora* white meadow-beauty OBL  
*Rhexia salicifolia* panhandle meadow-beauty OBL  
*Rhexia* spp. meadow-beauty FACW  
*Rhizophora mangle* red mangrove OBL  
*Rhododendron viscosum* swamp azalea FACW  
*Rhodomertus tomentosus* downy rose-myrtle FAC  
*Rhynchospora cephalantha* clustered beakrush OBL  
*Rhynchospora chapmanii* Chapman's beakrush OBL  
*Rhynchospora corniculata* short-bristle beakrush OBL  
*Rhynchospora decurrens* swamp-forest beakrush OBL  
*Rhynchospora divergens* spreading beakrush OBL  
*Rhynchospora grayi* Gray's beakrush U

*Rhynchospora harperi* Harper's beakrush OBL  
*Rhynchospora intermedia* pinebarren beakrush U  
*Rhynchospora inundata* horned beakrush OBL  
*Rhynchospora macra* large beakrush OBL  
*Rhynchospora megalocarpa* giant-fruited beakrush U  
*Rhynchospora microcarpa* southern beakrush OBL  
*Rhynchospora miliacea* millet beakrush OBL  
*Rhynchospora mixta* mingled beakrush OBL  
*Rhynchospora oligantha* few-flower beakrush OBL  
*Rhynchospora* spp. beakrush FACW  
*Rhynchospora stenophylla* Chapman's beakrush OBL  
*Rhynchospora tracyi* Tracy's beakrush OBL  
*Rorippa* spp. yellow-cress OBL  
*Rosa palustris* swamp rose OBL  
*Rotala ramosior* toothcup OBL  
*Roystonea* spp. royal palm FACW  
*Rubus* spp. blackberries FAC  
*Rudbeckia fulgida* orange coneflower FACW  
*Rudbeckia graminifolia* grass-leaf coneflower FACW  
*Rudbeckia laciniata* cut-leaf coneflower FACW  
*Rudbeckia mohrii* Mohr's coneflower OBL  
*Rudbeckia nitida* shiny coneflower FACW  
*Ruellia brittoniana* Britton's wild-petunia FAC  
*Ruellia caroliniensis* wild-petunia FAC  
*Ruellia noctiflora* night-flowering wild-petunia FACW  
*Rumex* spp. dock FACW  
*Sabal minor* dwarf palmetto FACW  
*Sabal palmetto* cabbage palm FAC  
*Sabatia bartramii* Bartram's rose-gentian OBL  
*Sabatia calycina* coast rose-gentian OBL  
*Sabatia dodecandra* large rose-gentian OBL  
*Sabatia* spp. rose-gentian FACW  
*Sacciolepis indica* glenwood grass FAC  
*Sacciolepis striata* American cupscale OBL  
*Sachsia polycephala* sachsia FACW  
*Sagittaria* spp. arrowhead OBL  
*Salicornia* spp. glasswort OBL  
*Salix* spp. willow OBL  
*Sambucus canadensis* elderberry FAC  
*Samolus* spp. water pimpernel OBL  
*Sapium sebiferum* Chinese tallow-tree FAC  
*Sarracenia minor* hooded pitcher-plant FACW  
*Sarracenia* spp. pitcher-plant OBL  
*Saururus cernuus* lizard's tail OBL  
*Schinus terebinthifolius* Brazilian pepper-tree FAC  
*Schizachyrium* spp. bluestem FAC  
*Schoenolirion croceum* sunny bells FACW  
*Schoenolirion elliottii* sunny bells FACW  
*Schoenus nigricans* black-sedge FACW  
*Scirpus* spp. bulrush OBL  
*Scleria* spp. nutrush FACW

*Sclerolepis uniflora* one-flower hardscale FACW  
*Scoparia dulcis* sweet broom FAC  
*Scutellaria floridana* skullcap FAC  
*Scutellaria integrifolia* rough skullcap FAC  
*Scutellaria lateriflora* blue skullcap OBL  
*Scutellaria racemosa* skullcap OBL  
*Sebastiania fruticosa* gulf sebastian-bush FAC  
*Selaginella apoda* meadow spike-moss FACW  
*Senecio aureus* golden ragwort OBL  
*Senecio glabellus* butterweed OBL  
*Sesbania* spp. rattle-bush FAC  
*Sesuvium* spp. sea-purslane FACW  
*Setaria geniculata* bristle grass FAC  
*Setaria magna* foxtail OBL  
*Seymeria cassioides* black senna FAC  
*Sisyrinchium atlanticum* eastern blue-eye-grass FACW  
*Sisyrinchium capillare* blue-eye-grass FACW  
*Sisyrinchium mucronatum* Michaux's blue-eye-grass FACW  
*Sium suave* water-parsnip OBL  
*Solanum bahamense* canker-berry FACW  
*Solanum erianthum* shrub nightshade FACW  
*Solidago elliotii* Elliott's goldenrod OBL  
*Solidago fistulosa* marsh goldenrod FACW  
*Solidago leavenworthii* Leavenworth's goldenrod FACW  
*Solidago patula* rough-leaf goldenrod OBL  
*Solidago rugosa* wrinkled goldenrod FAC  
*Solidago sempervirens* seaside goldenrod FACW  
*Solidago stricta* willow-leaf goldenrod FACW  
*Sophora tomentosa* coast sophora FACW  
*Sparganium americanum* burreed OBL  
*Spartina alterniflora* saltmarsh cordgrass OBL  
*Spartina bakeri* sand cordgrass FACW  
*Spartina cynosuroides* big cordgrass OBL  
*Spartina patens* saltmeadow cordgrass FACW  
*Spartina spartinae* gulf cordgrass OBL  
*Spergularia marina* saltmarsh sandspurry OBL  
*Spermacoce glabra* smooth button-plant FACW  
*Sphagnum* spp. sphagnum moss OBL  
*Sphenoclea zeylanica* chicken-spike FACW  
*Sphenopholis pensylvanica* swamp wedgescale OBL  
*Sphenostigma coelestinum* Bartram's ixia FACW  
*Spigelia loganioides* pink-root FACW  
*Spilanthes americana* creeping spotflower FACW  
*Spiranthes* spp. ladies'-tresses FACW  
*Sporobolus floridanus* Florida dropseed FACW  
*Sporobolus virginicus* seashore dropseed OBL  
*Stachys lythroides* hedgenettle OBL  
*Staphylea trifolia* American bladdernut FACW  
*Stenandrium floridanum* stenandrium FACW  
*Stenanthium gramineum* eastern feather-bells FACW  
*Stillingia aquatica* corkwood OBL

*Stillingia sylvatica* var. **tenuis** marsh queen's-delight FAC  
*Stipa avenacioides* Florida needle grass FACW  
*Stokesia laevis* stokesia FACW  
*Strumpfia maritima* strumpfia FACW - Keys only  
*Styrax americana* snowbell; storax OBL  
*Suaeda* spp. sea-blite OBL  
*Suriana maritima* bay-cedar FAC  
*Syngonanthus flavidulus* bantam-buttons FACW  
*Syzygium* spp. Java plum FAC  
*Taxodium ascendens* pond cypress OBL  
*Taxodium distichum* bald cypress OBL  
*Teucrium canadense* American germander FACW  
*Thalia geniculata* thalia; fire flag OBL  
*Thalictrum* spp. meadow-rue FACW  
*Thelypteris* spp. shield fern FACW  
*Thespesia populnea* seaside mahoe FAC  
*Thrinax radiata* Florida thatch palm FAC - Keys only  
*Tilia americana* American basswood FACW  
*Tofieldia racemosa* coastal false-asphodel OBL  
*Toxicodendron vernix* poison sumac FACW  
*Trachelospermum difforme* climbing-dogbane FACW  
*Tradescantia fluminensis* trailing spiderwort FAC  
*Trema* spp. trema FAC  
*Trepocarpus aethusae* aethusa-like trepocarpus FACW  
*Triadenum* spp. marsh St. John's-wort OBL  
*Trianthema portulacastrum* horse-purslane FACW  
*Tridens ambiguus* savannah tridens FACW  
*Tridens strictus* long-spike tridens FACW  
*Triglochin striata* arrow-grass OBL  
*Triphora* spp. nodding pogonias FACW  
*Tripsacum dactyloides* eastern gama grass FAC  
*Typha* spp. cattail OBL  
*Ulmus rubra* slippery elm U  
*Ulmus* spp. elm FACW  
*Urechites lutea* wild allamanda FACW  
*Utricularia* spp. bladderwort OBL  
*Uvularia floridana* Florida bellwort FACW  
*Vaccinium corymbosum* highbush blueberry FACW  
*Vaccinium elliotii* Elliott's blueberry FAC  
*Verbena scabra* sandpaper vervain FACW  
*Verbesina chapmanii* Chapman's crownbeard FACW  
*Verbesina heterophylla* diverse-leaf crownbeard FACW  
*Verbesina virginica* white crownbeard FAC  
*Vernonia angustifolia* narrow-leaf ironweed U  
*Vernonia* spp. ironweed FACW  
*Veronica anagallis-aquatica* water speedwell OBL  
*Veronicastrum virginicum* culver's-root FACW  
*Viburnum dentatum* arrow-wood FACW  
*Viburnum nudum* possum-haw viburnum FACW  
*Viburnum obovatum* walter viburnum FACW  
*Vicia acutifolia* four-leaf vetch FACW

*Vicia floridana* Florida vetch FACW  
*Vicia ocalensis* Ocala vetch OBL  
*Viola affinis* Leconte's violet FACW  
*Viola esculenta* edible violet FACW  
*Viola lanceolata* lance-leaf violet OBL  
*Viola primulifolia* primrose-leaf violet FACW  
*Websteria confervoides* water-meal OBL  
*Wedelia trilobata* creeping ox-eye FAC  
*Woodwardia areolata* chainfern OBL  
*Woodwardia virginica* chainfern FACW  
*Xanthorhiza simplicissima* shrubby yellow-root FACW  
*Xanthosoma sagittifolium* elephant ear FACW  
*Xyris caroliniana* Carolina yellow-eyed grass FACW  
*Xyris jupicai* tropical yellow-eyed grass FACW  
*Xyris* spp. yellow-eyed grass OBL  
*Yeatesia viridiflora* green-flower yeatesia FACW  
*Zephyranthes atamasco* atamasco lily FACW  
*Zigadenus densus* crow poison FACW  
*Zigadenus glaberrimus* atlantic deathcamas FACW  
*Zizania aquatica* wildrice OBL  
*Zizaniopsis miliacea* southern wildrice OBL

**Any plant not specifically listed is considered an upland plant except vines, aquatic plants, and any plant species not introduced into the State of Florida as of the effective date of Chapter 62-340, F.A.C. (Effective Date July 1, 1994)**

**Chapter 62-340, F.A.C.**  
**Delineation of the Landward Extent of Wetlands and Surface Waters**

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**62-340.100 Intent.**

(1) This rule's intent is to provide a unified statewide methodology for the delineation of the extent of wetlands and surface waters to satisfy the mandate of Section 373.421, F.S. This delineation methodology is intended to approximate the combined landward extent of wetlands as determined by a water management district and the Department immediately before the effective date of this rule. Before implementing the specific provisions of this methodology, the regulating agency shall attempt to identify wetlands according to the definition for wetlands in subsection 373.019(27), F.S., and subsection 62-340.200(19), F.A.C., below. The landward extent of wetlands shall be determined by the dominance of plant species, soils and other hydrologic evidence indicative of regular and periodic inundation or saturation. In all cases, attempts shall be made to locate the landward extent of wetlands visually by on site inspection, or aerial photointerpretation in combination with ground truthing, without quantitative sampling. If this cannot be accomplished, the quantitative methods in paragraph 62-301.400(1)(c), F.A.C., shall be used unless the applicant or petitioner and regulating agency agree, in writing, on an alternative method for quantitatively analyzing the vegetation on site. The methodology shall not be used to delineate areas which are not wetlands as defined in subsection 62-340.200(19), F.A.C., nor to delineate as wetlands or surface waters areas exempted from delineation by statute or agency rule.

2) The Department shall be responsible for ensuring statewide coordination and consistency in the delineation of surface waters and wetlands pursuant to this rule, by providing training and guidance to the Department, Districts, and local governments in implementing the methodology.

*Specific Authority 373.421 FS. Law Implemented 373.421, 373.4211 FS. History—New 7-1-94, Formerly 17-340.100.*

**62-340.200 Definitions.**

When used in this chapter, the following terms shall mean:

- (1) **“Aquatic plant”** means a plant, including the roots, which typically floats on water or requires water for its entire structural support, or which will desiccate outside of water.
- (2) **“Canopy”** means the plant stratum composed of all woody plants and palms with a trunk four inches or greater in diameter at breast height, except vines.
- (3) **“Diameter at Breast Height (DBH)”** means the diameter of a plant's trunk or main stem at a height of 4.5 feet above the ground.
- (4) **“Facultative plants”** means those plant species listed in subsection 62-340.450(3), F.A.C., of this chapter. For the purposes of this rule, facultative plants are not indicators of either wetland or upland conditions.
- (5) **“Facultative Wet plants”** means those plant species listed in subsection 62-340.450(2), F.A.C., of this chapter.

- (6) **“Ground Cover”** means the plant stratum composed of all plants not found in the canopy or subcanopy, except vines and aquatic plants.
- (7) **“Ground truthing”** means verification on the ground of conditions on a site.
- (8) **“Hydric Soils”** means soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part of the soil profile.
- (9) **“Hydric Soil Indicators”** means those indicators of hydric soil conditions as identified in *Soil and Water Relationships of Florida's Ecological Communities* (Florida Soil Conservation ed. Staff 1992).
- (10) **“Inundation”** means a condition in which water from any source regularly and periodically covers a land surface.
- (11) **“Obligate plants”** means those plant species listed in subsection 62-340.450(1), F.A.C., of this chapter.
- (12) **“Regulating agency”** means the Department of Environmental Protection, the water management districts, state or regional agencies, local governments, and any other governmental entities.
- (13) **“Riverwash”** means areas of unstabilized sandy, silty, clayey, or gravelly sediments. These areas are flooded, washed, and reworked by rivers or streams so frequently that they may support little or no vegetation.
- (14) **“Saturation”** means a water table six inches or less from the soil surface for soils with a permeability equal to or greater than six inches per hour in all layers within the upper 12 inches, or a water table 12 inches or less from the soil surface for soils with a permeability less than six inches per hour in any layer within the upper 12 inches.
- (15) **“Seasonal High Water”** means the elevation to which the ground and surface water can be expected to rise due to a normal wet season.
- (16) **“Subcanopy”** means the plant stratum composed of all woody plants and palms, exclusive of the canopy, with a trunk or main stem with a DBH between one and four inches, except vines.
- (17) **“Upland plants”** means those plant species, not listed as Obligate, Facultative Wet, or Facultative by this rule, excluding vines, aquatic plants, and any plant species not introduced into the State of Florida as of the effective date of this rule.
- (18) **“U.S.D.A.-S.C.S.”** means the United States Department of Agriculture, Soil Conservation Service.
- (19) **“Wetlands,”** as defined in subsection 373.019(27), F.S., means those areas that are inundated or saturated by surface water or ground water at a frequency and a duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. Soils present in wetlands generally are classified as hydric or alluvial, or possess characteristics that are associated with reducing soil conditions. The prevalent vegetation in wetlands generally consists of facultative or obligate hydrophytic macrophytes that are typically adapted to areas having soil conditions described above. These species, due to morphological, physiological, or reproductive adaptations, have the ability to grow, reproduce or persist in aquatic environments or anaerobic soil conditions. Florida wetlands generally include swamps, marshes, bayheads, bogs, cypress domes and strands, sloughs, wet prairies, riverine swamps and marshes, hydric seepage slopes, tidal marshes, mangrove swamps and other similar areas. Florida wetlands generally do not include longleaf or slash pine flatwoods with an understory dominated by saw palmetto.

*Specific Authority 373.421 FS. Law Implemented 373.421, 373.4211 FS. History—New 7-1-94, Formerly 17-340.200.*

### **62-340.300 Delineation of Wetlands.**

The landward extent (i.e., the boundary) of wetlands as defined in subsection 62-340.200(19), F.A.C., shall be determined by applying reasonable scientific judgment to evaluate the dominance of plant species, soils, and other hydrologic evidence of regular and periodic inundation and saturation as set forth below. In applying reasonable scientific judgment, all reliable information shall be evaluated in

determining whether the area is a wetland as defined in subsection 62-340.200(19), F.A.C.

(1) Before using the wetland delineation methodology described below, the regulating agency shall attempt to identify and delineate the landward extent of wetlands by direct application of the definition of wetlands in subsection 62-340.200(19), F.A.C., with particular attention to the vegetative communities which the definition lists as wetlands and non-wetlands. If the boundary cannot be located easily by use of the definition in subsection 62-340.200(19), F.A.C., the provisions of this rule shall be used to locate the landward extent of a wetland. In applying the provisions of this rule, the regulating agency shall attempt to locate the landward extent of wetlands visually by on site inspection, or aerial photointerpretation in combination with ground truthing.

(2) The landward extent of a wetland as defined in subsection 62-340.200(19), F.A.C., shall include any of the following areas:

(a) Those areas where the areal extent of obligate plants in the appropriate vegetative stratum is greater than the areal extent of all upland plants in that stratum, as identified using the method in Rule 62-340.400, F.A.C., and either:

1. The substrate is composed of hydric soils or riverwash, as identified using standard U.S.D.A.-S.C.S. practices for Florida, including the approved hydric soil indicators, except where the hydric soil is disturbed by a nonhydrological mechanical mixing of the upper soil profile and the regulating agency establishes through data or evidence that hydric soil indicators would be present but for the disturbance;

2. The substrate is nonsoil, rock outcrop-soil complex, or the substrate is located within an artificially created wetland area; or

3. One or more of the hydrologic indicators listed in Rule 62-340.500, F.A.C., are present and reasonable scientific judgment indicates that inundation or saturation is present sufficient to meet the wetland definition of subsection 62-340.200(19), F.A.C.

(b) Those areas where the areal extent of obligate or facultative wet plants, or combinations thereof, in the appropriate stratum is equal to or greater than 80% of all the plants in that stratum, excluding facultative plants, and either:

1. The substrate is composed of hydric soils or riverwash, as identified using standard U.S.D.A.-S.C.S. practices for Florida, including the approved hydric soil indicators, except where the hydric soil is disturbed by a nonhydrologic mechanical mixing of the upper soil profile and the regulating agency establishes through data or evidence that hydric soil indicators would be present but for the disturbance;

2. The substrate is nonsoil, rock outcrop-soil complex, or the substrate is located within an artificially created wetland area; or

3. One or more of the hydrologic indicators listed in Rule 62-340.500, F.A.C., are present and reasonable scientific judgment indicates that inundation or saturation is present sufficient to meet the wetland definition of subsection 62-340.200(19), F.A.C.

(c) Those areas, other than pine flatwoods and improved pastures, with undrained hydric soils which meet, in situ, at least one of the criteria listed below. A hydric soil is considered undrained unless reasonable scientific judgment indicates permanent artificial alterations to the on site hydrology have resulted in conditions which would not support the formation of hydric soils.

1. Soils classified according to United States Department of Agriculture's *Keys to Soil Taxonomy* (4th ed. 1990) as Umbraqualfs, Sulfaquents, Hydraquents, Humaquepts, Histosols (except Folists), Argiaquolls, or Umbraquolls.

2. Saline sands (salt flats-tidal flats).

3. Soil within a hydric mapping unit designated by the U.S.D.A.-S.C.S. as frequently flooded or depressional, when the hydric nature of the soil has been field verified using the U.S.D.A.-S.C.S. approved hydric soil indicators for Florida. If a permit applicant, or a person petitioning for a formal determination pursuant to subsection 373.421(2), F.S., disputes the boundary of a frequently flooded or depressional mapping unit, the applicant or petitioner may request that the regulating agency, in cooperation with the U.S.D.A.-S.C.S., confirm the boundary. For the purposes of subsection 120.60(2), F.S., a request for a boundary confirmation pursuant to this subparagraph shall have the same effect as a timely request for additional information by the regulating agency. The regulating agency's receipt of

the final response provided by the U.S.D.A.-S.C.S. to the request for boundary confirmation shall have the same effect as a receipt of timely requested additional information.

4. For the purposes of this paragraph only, “pine flatwoods” means a plant community type in Florida occurring on flat terrain with soils which may experience a seasonal high water table near the surface. The canopy species consist of a monotypic or mixed forest of long leaf pine or slash pine. The subcanopy is typically sparse or absent. The ground cover is dominated by saw palmetto with areas of wire grass, gallberry, and other shrubs, grasses, and forbs, which are not obligate or facultative wet species. Pine flatwoods do not include those wetland communities as listed in the wetland definition contained in subsection 62-340.200(19), F.A.C., which may occur in the broader landscape setting of pine flatwoods and which may contain slash pine. Also for the purposes of this paragraph only, “improved pasture” means areas where the dominant native plant community has been replaced with planted or natural recruitment of herbaceous species which are not obligate or facultative wet species and which have been actively maintained for livestock through mechanical means or grazing.

(d) Those areas where one or more of the hydrologic indicators listed in Rule 62-340.500, F.A.C., are present, and which have hydric soils, as identified using the U.S.D.A.-S.C.S. approved hydric soil indicators for Florida, and reasonable scientific judgment indicates that inundation or saturation is present sufficient to meet the wetland definition of subsection 62-340.200(19), F.A.C. These areas shall not extend beyond the seasonal high water elevation.

(3)(a) If the vegetation or soils of an upland or wetland area have been altered by natural or man-induced factors such that the boundary between wetlands and uplands cannot be delineated reliably by use of the methodology in subsection 62-340.300(2), F.A.C., as determined by the regulating agency, and the area has hydric soils or riverwash, as identified using standard U.S.D.A.-S.C.S. practices for Florida, including the approved hydric soil indicators, except where the hydric soil is disturbed by a non hydrologic mechanical mixing of the upper soil profile and the regulating agency establishes through data or evidence that hydric soil indicators would be present but for the disturbance, then the most reliable available information shall be used with reasonable scientific judgment to determine where the methodology in subsection 62-340.300(2), F.A.C., would have delineated the boundary between wetlands and uplands. Reliable available information may include, but is not limited to, aerial photographs, remaining vegetation, authoritative site-specific documents, or topographical consistencies.

(b) This subsection shall not apply to any area where regional or site-specific permitted activity, or activities which did not require a permit, under Sections 253.123 and 253.124, F.S. (1957), as subsequently amended, the provisions of Chapter 403, F.S. (1983), relating to dredging and filling activities, Chapter 84-79, Laws of Florida, and Part IV of Chapter 373, F.S., have altered the hydrology of the area to the extent that reasonable scientific judgment, or application of the provisions of Section 62-340.550, F.A.C., indicate that under normal circumstances the area no longer inundates or saturates at a frequency and duration sufficient to meet the wetland definition in subsection 62-340.200(19), F.A.C.

(c) This subsection shall not be construed to limit the type of evidence which may be used to delineate the landward extent of a wetland under this chapter when an activity violating the regulatory requirements of Sections 253.123 and 253.124, F.S. (1957), as subsequently amended, the provisions of Chapter 403, F.S. (1983), relating to dredging and filling activities, Chapter 84-79, Laws of Florida, and Part IV of Chapter 373, F.S., has disturbed the vegetation or soils of an area.

(4) The regulating agency shall maintain sufficient soil scientists on staff to provide evaluation or consultation regarding soil determinations in applying the methodologies set forth in subsection 62-340.300(2) or (3), F.A.C. Services provided by the U.S.D.A.-S.C.S., or other competent soil scientists, under contract or agreement with the regulating agency, may be used in lieu of, or to augment, agency staff.

*Specific Authority 373.421 FS. Law Implemented 373.421, 373.4211 FS. History—New 7-1-94, Formerly 17-340.300.*

#### **62-340.400 Selection of Appropriate Vegetative Stratum.**

Dominance of plant species, as described in paragraphs 62-340.300(2)(a) and 62-340.300(2)(b), F.A.C., shall be determined in a plant stratum (canopy, subcanopy, or ground cover). The top stratum shall be used to determine dominance unless the top stratum, exclusive of facultative plants, constitutes less than 10 percent areal extent, or unless reasonable scientific judgment establishes that the indicator status of the top stratum is not indicative of the hydrologic conditions on site. In such cases, the stratum most indicative of on site hydrologic conditions, considering the seasonal variability in the amount and distribution of rainfall, shall be used. The evidence concerning the presence or absence of regular and periodic inundation or saturation shall be based on in situ data. All facts and factors relating to the presence or absence of regular and periodic inundation or saturation shall be weighed in deciding whether the evidence supports shifting to a lower stratum. The presence of obligate, facultative wet, or upland plants in a lower stratum does not by itself constitute sufficient evidence to shift strata, but can be considered along with other physical data in establishing the weight of evidence necessary to shift to a lower stratum. The burden of proof shall be with the party asserting that a stratum other than the top stratum should be used to determine dominance. Facultative plants shall not be considered for purposes of determining appropriate strata or dominance.

*Specific Authority 373.421 FS. Law Implemented 373.421, 373.4211 FS. History—New 7-1-94, Formerly 17-340.400.*

#### **62-340.450 Vegetative Index.**

- (1) Obligate Species (See Appendix A)
- (2) Facultative Wet Species (See Appendix A)
- (3) Facultative Species (See Appendix A)

(4) Nomenclature. Use of plants in this rule is based solely on the scientific names. Common names are included in the above lists for information purposes only. The following references shall be used by the regulating agency to resolve any uncertainty about the nomenclature or taxonomy of any plant listed by a given scientific name in this section: R. Godfrey, *Trees, Shrubs and Woody Vines of Northern Florida and Adjacent Georgia & Alabama* (Univ. Ga. Press, Athens 1988) and D. Lellinger, *Ferns & Fern-Allies of the United States & Canada* (Smithsonian Institution Press, Washington D.C. 1985) for all species covered by these references. For all other listed scientific names the following references will be followed unless the species list in this section designates a different authority next to an individual species name: R. Godfrey & J. Wooten, *Aquatic and Wetland Plants of Southeastern United States: Monocotyledons* (Univ. Ga. Press, Athens 1979); R. Godfrey & J. Wooten, *Aquatic and Wetland Plants of Southeastern United States: Dicotyledons* (Univ. Ga. Press, Athens 1979); D. & H. Correll, *Flora of the Bahama Archipelago* (A.R. Gantner, Germany 1982). When the species list in this section designates a different authority next to an individual species name, the regulating agency shall resolve any ambiguity in nomenclature by using the name identified in D. Hall, *The Grasses of Florida* (Doctoral Dissertation, Univ. of Fla., Gainesville 1978); or C. Campbell, *Systematics of the Andropogon Virginicus Complex* (GRAMINEAE), 64 *Journal of the Arnold Arboretum* 171-254 (1983).

*Specific Authority 373.421 FS. Law Implemented 373.421, 373.4211 FS. History—New 7-1-94, Formerly 17-340.450.*

#### **62-340.500 Hydrologic Indicators.**

The indicators below may be used as evidence of inundation or saturation when used as provided in Rule 62-340.300, F.A.C. Several of the indicators reflect a specific water elevation. These specific water elevation indicators are intended to be evaluated with meteorological information, surrounding topography and reliable hydrologic data or analyses when provided, to ensure that such indicators reflect inundation or saturation of a frequency and duration sufficient to meet the wetland definition in subsection 62-340.200(19), F.A.C., and not rare or aberrant events. These specific water elevation indicators are not intended to be extended from the site of the indicator into surrounding areas when reasonable scientific judgment indicates that the surrounding areas are not wetlands as defined in

subsection 62-340.200(19), F.A.C.

- (1) **Algal mats.** The presence or remains of nonvascular plant material which develops during periods of inundation and persists after the surface water has receded.
- (2) **Aquatic mosses or liverworts on trees or substrates.** The presence of those species of mosses or liverworts tolerant of or dependent on surface water inundation.
- (3) **Aquatic plants.** Defined in subsection 62-340.200(1), F.A.C.
- (4) **Aufwuchs.** The presence or remains of the assemblage of sessile, attached or free-living, nonvascular plants and invertebrate animals (including protozoans) which develop a community on inundated surfaces.
- (5) **Drift lines and rafted debris.** Vegetation, litter, and other natural or manmade material deposited in discrete lines or locations on the ground or against fixed objects, or entangled above the ground within or on fixed objects in a form and manner which indicates that the material was waterborne. This indicator should be used with caution to ensure that the drift lines or rafted debris represent usual and recurring events typical of inundation or saturation at a frequency and duration sufficient to meet the wetland definition of subsection 62-340.200(19), F.A.C.
- (6) **Elevated lichen lines.** A distinct line, typically on trees, formed by the water-induced limitation on the growth of lichens.
- (7) **Evidence of aquatic fauna.** The presence or indications of the presence of animals which spend all or portions of their life cycle in water. Only those life stages which depend on being in or on water for daily survival are included in this indicator.
- (8) **Hydrologic data.** Reports, measurements, or direct observation of inundation or saturation which support the presence of water to an extent consistent with the provisions of the definition of wetlands and the criteria within this rule, including evidence of a seasonal high water table at or above the surface according to methodologies set forth in *Soil and Water Relationships of Florida's Ecological Communities* (Florida Soil Conservation Staff 1992).
- (9) **Morphological plant adaptations.** Specialized structures or tissues produced by certain plants in response to inundation or saturation which normally are not observed when the plant has not been subject to conditions of inundation or saturation.
- (10) **Secondary flow channels.** Discrete and obvious natural pathways of water flow landward of the primary bank of a stream watercourse and typically parallel to the main channel.
- (11) **Sediment deposition.** Mineral or organic matter deposited in or shifted to positions indicating water transport.
- (12) **Vegetated tussocks or hummocks.** Areas where vegetation is elevated above the natural grade on a mound built up of plant debris, roots, and soils so that the growing vegetation is not subject to the prolonged effects of soil anoxia.
- (13) **Water marks.** A distinct line created on fixed objects, including vegetation, by a sustained water elevation.

*Specific Authority 373.421 FS. Law Implemented 373.421, 373.4211 FS. History—New 7-1-94, Formerly 17-340.500.*

#### **62-340.550 Wetland Hydrology.**

A wetland delineation using the methodology described above, can be refuted by either reliable hydrologic records or site specific hydrologic data which indicate that neither inundation for at least seven consecutive days, nor saturation for at least twenty consecutive days, occurs during conditions which represent long-term hydrologic conditions. Hydrologic records or site specific hydrologic data must be of such a duration, frequency, and accuracy to demonstrate that the records or data are representative of the long-term hydrologic conditions, including the variability in quantity and seasonality of rainfall. When sufficient amounts of either reliable hydrologic records or site specific hydrologic data are not available to prove that the wetland area of concern does not inundate or saturate as described above, a site-specific field-verified analytic or numerical model may be used to demonstrate that the wetland area no longer inundates or saturates regularly or periodically under typical

long-term hydrologic conditions. Before initiating the use of a model to evaluate if a wetland delineation should be refuted based on hydrologic conditions, the applicant or petitioner shall first meet with the appropriate regulating agency and reach an agreement on the terms of study, including data collection, the specific model, model development and calibration, and model verification. If the data, analyses, or models are deemed inadequate based on the hydrologic conditions being addressed, the regulating agency shall provide a case-by-case review of the applicability of any data, analyses, or models and shall provide specific reasons, based on generally accepted scientific and engineering practices, why they are inadequate.

*Specific Authority 373.421 FS. Law Implemented 373.421, 373.4211 FS. History—New 7-1-94, Formerly 17-340.550.*

#### **62-340.600 Surface Waters.**

(1) For the purposes of Section 373.421, F.S., surface waters are waters on the surface of the earth, contained in bounds created naturally or artificially, including, the Atlantic Ocean, the Gulf of Mexico, bays, bayous, sounds, estuaries, lagoons, lakes, ponds, impoundments, rivers, streams, springs, creeks, branches, sloughs, tributaries, and other watercourses. However, state water quality standards apply only to those waters defined in subsection 403.031(13), F.S.

(2) The landward extent of a surface water in the State for the purposes of implementing Section 373.414, F.S., shall be the more landward of the following:

(a) Wetlands as located by Rule 62-340.300, F.A.C., of this chapter;

(b) The mean high water line elevation for tidal water bodies;

(c) The ordinary high water line for non-tidal natural water bodies;

(d) The top of the bank for artificial lakes, borrow pits, canals, ditches and other artificial water bodies with side slopes of 1 foot vertical to 4 feet horizontal or steeper, excluding spoil banks when the canals and ditches have resulted from excavation into the ground; or

(e) The seasonal high water line for artificial lakes, borrow pits, canals, ditches, and other artificial water bodies with side slopes flatter than 1 foot vertical to 4 feet horizontal along with any artificial water body created by diking or impoundment above the ground.

(3) Determinations made pursuant to paragraphs (2)(b) and (2)(c) shall be for regulatory purposes and are not intended to be a delineation of the boundaries of lands for the purposes of title.

*Specific Authority 373.421 FS. Law Implemented 373.421, 373.4211, 403.031(13) FS. History—New 7-1-94, Formerly 17-340.600.*

#### **62-340.700 Exemptions for Treatment or Disposal Systems.**

(1) Alteration and maintenance of the following shall be exempt from the rules adopted by the department and the water management districts to implement subsections 373.414(1) through 373.414(6), 373.414(8) and 373.414(10), F.S.; and subsection 373.414(7), F.S., regarding any authority to apply state water quality standards within any works, impoundments, reservoirs, and other watercourses described in this subsection and any authority granted pursuant to Section 373.414, F.S. (1991):

(a) Works, impoundments, reservoirs, and other watercourses constructed and operated solely for wastewater treatment or disposal in accordance with a valid permit reviewed or issued under Rules 62-28.700, 62-302.520, F.A.C., Chapters 62-17, 62-600, 62-610, 62-640, 62-650, 62-660, 62-670, 62-671, 62-673, or 62-701, F.A.C., or Section 403.0885, F.S., or rules implementing Section 403.0885, F.S., except for treatment wetlands or receiving wetlands permitted to receive wastewater pursuant to Chapter 62-611, F.A.C., or Section 403.0885, F.S., or its implementing rules;

(b) Works, impoundments, reservoirs, and other watercourses constructed solely for wastewater treatment or disposal before a construction permit was required under Chapter 403, F.S., and operated solely for wastewater treatment or disposal in accordance with a valid permit reviewed or issued under Rules 62-28.700, 62-302.520, F.A.C., Chapters 62-17, 62-600, 62-610, 62-640, 62-650, 62-660, 62-670, 62-671, 62-673, or 62-701, F.A.C., or Section 403.0885, F.S., or rules implementing Section 403.0885,

F.S., except for treatment wetlands or receiving wetlands permitted to receive wastewater pursuant to Chapter 62-611, F.A.C., or Section 403.0885, F.S., or its implementing rules;

(c) Works, impoundments, reservoirs, and other watercourses of less than 0.5 acres in combined area on a project-wide basis, constructed and operated solely for stormwater treatment in accordance with a noticed exemption under Chapter 62-25, F.A.C., or a valid permit issued under Chapters 62-25 (excluding Rule 62-25.042), 62-330, 40B-4, 40C-4, 40C-42 (excluding Rule 40C-42.0265), 40C-44, 40D-4, 40D-40, 40D-45, or 40E-4, F.A.C., except those permitted as wetland stormwater treatment systems; or

(d) Works, impoundments, reservoirs, and other watercourses of less than 0.5 acres in combined area on a project-wide basis, constructed and operated solely for stormwater treatment before a permit was required under Chapters 62-25, 40B-4, 40C-4, 40C-42, 40C-44, 40D-4, 40D-40, 40D-45, or 40E-4, F.A.C.

(2) Alteration and maintenance of the following shall be exempt from the rules adopted by the department and the water management districts to implement subsections 373.414(1), 373.414(2)(a), 373.414(8), and 373.414(10), F.S.; and subsections 373.414(3) through 373.414(6), F.S.; and subsection 373.414(7), F.S., regarding any authority to apply state water quality standards within any works, impoundments, reservoirs, and other watercourses described in this subsection and any authority granted pursuant to Section 373.414, F.S. (1991), except for authority to protect threatened and endangered species in isolated wetlands:

(a) Works, impoundments, reservoirs, and other watercourses of 0.5 acre or greater in combined area on a project-wide basis, constructed and operated solely for stormwater treatment in accordance with a noticed exemption under Chapter 62-25, F.A.C., or a valid permit issued under Chapters 62-25 (excluding Rule 62-25.042), 62-330, 40B-4, 40C-4, 40C-42 (excluding Rule 40C-42.0265), 40C-44, 40D-4, 40D-40, 40D-45, 40E-4, except those permitted as wetland stormwater treatment systems; or

(b) Works, impoundments, reservoirs, and other watercourses of 0.5 acres or greater in combined area on a project-wide basis, constructed and operated solely for stormwater treatment before a permit was required under Chapters 62-25, 40B-4, 40C-4, 40C-42, 40C-44, 40D-4, 40D-40, 40D-45, or 40E-4, F.A.C.

(3) The exemptions in subsections 62-340.700(1) and (2) shall not apply to works, impoundments, reservoirs or other watercourses that

(a) Are currently wetlands which existed before construction of the stormwater treatment system and were incorporated in it;

(b) Are proposed to be altered through expansion into wetlands or other surface waters; or

(c) Are wetlands created, enhanced, or restored as mitigation for wetland or surface water impacts under a permit issued by the Department or a water management district.

(4) Alterations and maintenance of works, impoundments, reservoirs, and other watercourses exempt under this subsection shall not be considered in determining whether any wetland permitting threshold is met or exceeded under part IV of Chapter 373, F.S.

(5) Works, impoundments, reservoirs, and other watercourses exempt under this subsection, other than isolated wetlands in systems described in subsection 62-340.700(2), F.A.C., above, shall not be delineated under Section 373.421, F.S.

(6) This exemption shall not affect the application of state water quality standards, including those applicable to Outstanding Florida Waters, at the point of discharge to waters as defined in subsection 403.031(13), F.S.

(7) As used in this subsection, “solely for” means the reason for which a work, impoundment, reservoir, or other watercourse is constructed and operated; and such construction and operation would not have occurred but for the purposes identified in subsection 62-340.700(1) or 62-340.700(2), F.A.C. Furthermore, the phrase does not refer to a work, impoundment, reservoir, or other watercourse constructed or operated for multiple purposes. Incidental uses, such as occasional recreational uses, will not render the exemption inapplicable, so long as the incidental uses are not part of the original planned purpose of the work, impoundment, reservoir, or other watercourse. However, for those works,

impoundments, reservoirs, or other watercourses described in paragraphs 62-340.700(1)(c) and 62-340.700(2)(a), F.A.C., use of the system for flood attenuation, whether originally planned or unplanned, shall be considered an incidental use, so long as the works, impoundments, reservoirs, and other watercourses are no more than 2 acres larger than the minimum area required to comply with the stormwater treatment requirements of the district or department. For the purposes of this subsection, reuse from a work, impoundment, reservoir, or other watercourse is part of treatment or disposal. *Specific Authority 373.414(9) FS. Law Implemented 373.414(9) FS. History—New 7-1-94, Formerly 17-340.700.*

**62-340.750 Exemption for Surface Waters or Wetlands Created by Mosquito Control Activities.**

Construction, alteration, operation, maintenance, removal, and abandonment of stormwater management systems, dams, impoundments, reservoirs, appurtenant works, or works, in, on or over lands that have become surface waters or wetlands solely because of mosquito control activities undertaken as part of a governmental mosquito control program, and which lands were neither surface waters nor wetlands before such activities, shall be exempt from the rules adopted by the department and water management districts to implement subsections 373.414(1) through 373.414(6), 373.414(8), and 373.414(10), F.S.; and subsection 373.414(7), F.S., regarding any authority granted pursuant to Section 373.414, F.S. (1991). Activities exempted under this section shall not be considered in determining whether any wetland permitting threshold is met or exceeded under part IV of Chapter 373, F.S. This exemption shall not affect the regulation of impacts on other surface waters or wetlands, or the application of state water quality standards to waters as defined in subsection 403.031(13), F.S., including standards applicable to Outstanding Florida Waters.

*Specific Authority 373.414(9) FS. Law Implemented 373.414(9) FS. History—New 7-1-94, Formerly 17-340.750.*

See *The Florida Wetlands Delineation Manual* for further clarification.

## **Data Form Guide Notes:**

### **Tips from NRCS Field Indicators of Hydric Soils in the United States Version 8.1, 2017:**

- As long as the soil meets the definition of a hydric soil, the lack of an indicator does not preclude the soil from being hydric.
- Concentrate sampling efforts near the wetland edge and, if these soils are hydric, assume that soils in the wetter, interior portions also are hydric. The indicators were developed mostly to identify the boundary of hydric soil areas and generally work best on the margins. Not all of the obviously wetter hydric soils will be identified by the indicators.

## **SOIL AND WATER RELATIONSHIPS OF FLORIDA'S ECOLOGICAL COMMUNITIES**

July, 1992 Adapted

### **Field Identification of Hydric Soils**

#### **Hydric Soil Indicator Concept**

The Hydric Soil Indicator concept is based on the premise that hydric soils develop and exhibit characteristic morphologies that result from repeated periods of saturation and/or inundation for more than a few days. Saturation or inundation when combined with anaerobic microbiological activity in the soil causes a depletion of oxygen. This anaerobiosis promotes biogeochemical processes such as the accumulation of organic matter and the reduction, translocation, and/or accumulation of iron and other reducible elements. These processes result in characteristic morphologies which persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils.

Hydric soil indicators are formed predominantly by the accumulation or loss of iron, manganese, sulfur, or carbon compounds. The presence of hydrogen sulfide gas (rotten egg odor) is a strong indicator of a hydric soil, but this indicator is found in only the wettest sites containing sulfur.

#### **Hydric Soil Indicator Identification Procedure**

To document a hydric soil, dig a hole and describe the soil profile to a depth of approximately 50 cm (20 inches). Using the completed soil description specify which of the Hydric Soil Indicators have been matched. Deeper examination of soil may be required where Hydric Soil Indicators are not easily seen within 50 cm (20 in.) of the surface. It is always recommended that soils be excavated and described as deep as necessary to make reliable interpretations. Examination to less than 50 cm (20 in.) may suffice in soils with surface horizons of organic material or mucky mineral material because these shallow organic accumulations only occur in hydric soils. Depths used in are measured from the muck or mineral soil surface unless otherwise indicated. All colors refer to moist Munsell colors.

### **Estimating Seasonal High Saturation**

#### **Introduction**

Seasonal High Water Table (SHWT) is the shallowest depth to free water that stands in an unlined borehole or where the soil moisture tension is zero for a significant period (more than a few weeks). The depth to the estimated SHWT is the used soil interpretation in Florida. This method of estimating SHWT applies only to areas lacking hydrologic modifications. Hydrologic modifications such as ditches and dikes can make the soil either wetter or drier.

By observing soil features, SHWT predictions can be made for hydric soils as well as other soils.

#### **Field Identification of SHWT**

The procedure for field Identification of SHWT is based on the assumption that, when soils are wet enough, for a long enough duration to develop SHWT, they should exhibit certain visible properties

that are to be used to determine on-site SHWT. All SHWT determinations should be based on field observations of moist soils.

### **Procedure**

SHWT is determined by examining soils with a hydric soil indicator in a freshly dug pit for the SHWT indicators listed below. Presence of the shallowest of the SHWT indicators listed below indicates the depth to SHWT.

1. Soils with the following hydric soil indicators have SHWT at or above the surface:  
A1 (Histosol or Histel), A2 (Histic Epipedon), A3 (Black Histic), A4 (Hydrogen Sulfide), A7 (5 cm Mucky Mineral), A8 (Muck Presence) or A9 (1 cm Muck), S4 (Sandy Gleyed Matrix), and F2 (Loamy Gleyed Matrix).
2. Soils with the following hydric soil indicators have SHWT within 6 inches of the surface:  
A5 (Stratified Layers), A6 (Organic Bodies), A11 (Depleted Below Dark Surface), A12 (Thick Dark Surface), S5 (Sandy Redox), S6 (Stripped Matrix), S7 (Dark Surface), S8 (Polyvalue Below Surface), S9 (Thin Dark Surface), F10 (Marl), and F13 (Umbric Surface).  
Depth to SHWT is the depth at which all requirements of a particular indicator are met. For example, if S6 (Stripped Matrix) starts at 4 inches, depth to SHWT is 4 inches or if S7 (Dark Surface) starts at the soil surface, depth to SHWT is the soil surface.
3. Soils with the following hydric soil indicators have SHWT within 12 inches of the surface:  
F3 (Depleted Matrix), F6 (Redox Dark Surface), and F7 (Depleted Dark Surface). Depth to SHWT is the depth at which all requirements of a particular indicator are met.  
For example, if F3 (Depleted Matrix) starts at 8 inches, depth to SHWT is 8 inches.
4. Soils with the following hydric soil indicators lack significant saturation but are inundated for long or very long duration:  
F8 (Redox Depressions) and F12 (Iron/Manganese Masses).

---

### **Data Form Guide Note:**

**A stand alone D Test soil field indicator is both a hydric soil field indicator and a hydrologic indicator.**

**The hydric soil field indicators below indicate SHWT at or above the surface, and therefore may also be used as evidence of hydrologic data under subsection 62-340.500(8), F.A.C. per Soil and Water Relationships of Florida's Ecological Communities (Florida Soil Conservation Staff 1992 Adapted):**

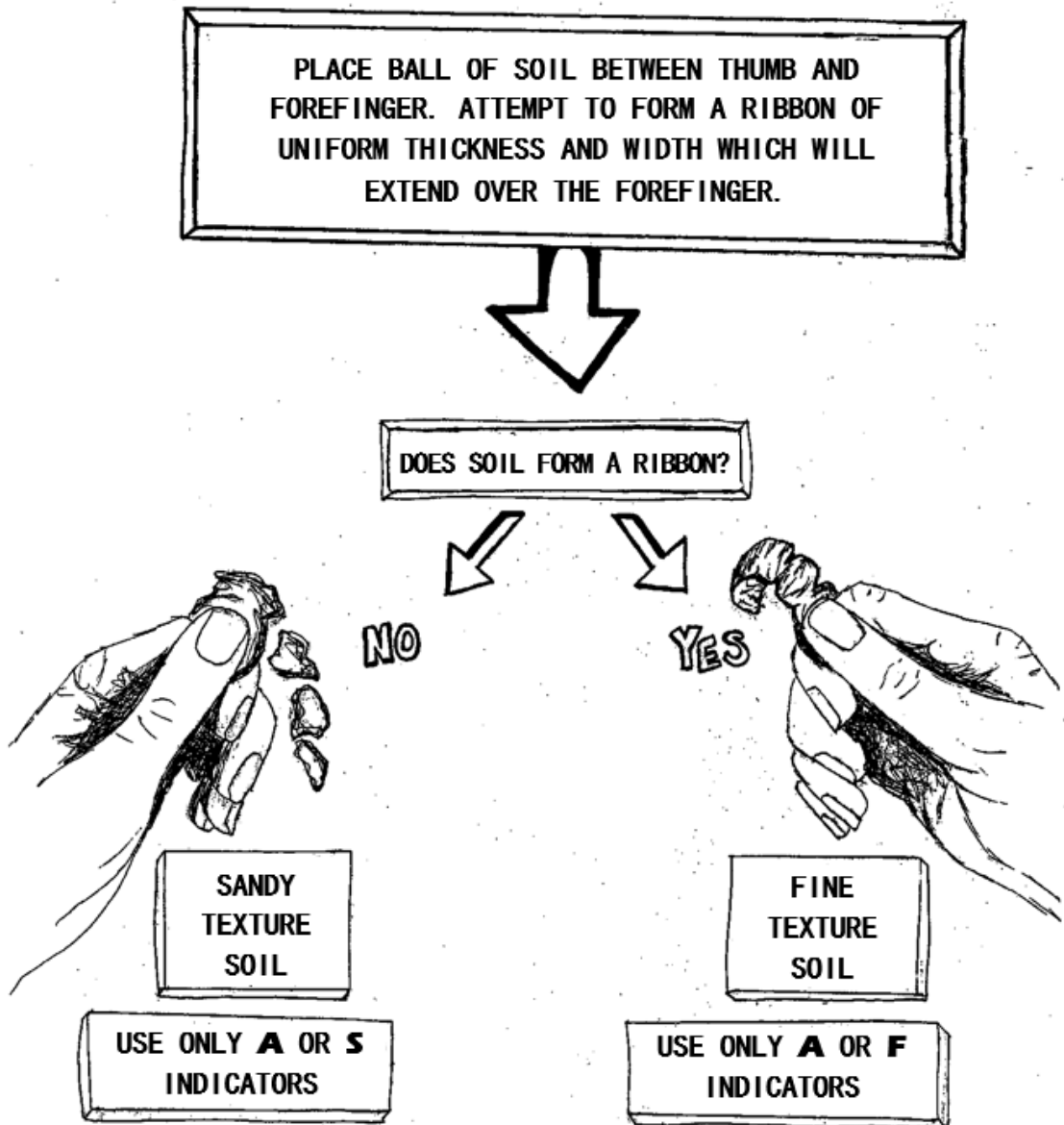
**A1 – Histosol or Histel  
A2 – Histic Epipedon  
A3 – Black Histic  
A4 – Hydrogen Sulfide  
A7 – 5 cm Mucky Mineral  
A8 – Muck Presence  
A9 – 1 cm Muck  
S4 – Sandy Gleyed Matrix  
F2 – Loamy Gleyed Matrix**

**Or any NRCS hydric soil field indicator** in which all requirements of that indicator are met starting at the soil surface (see SHWT Procedure above)

**The hydric soil field indicator below is also a hydrologic indicator under subsection 62-340.500(11), F.A.C. evidence of sediment deposition:**

**A5 - Stratified Layers**

# Field Determination of Soil Indicator Texture



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## Soil Textures and Their Hydric Soil Indicator Prefix Designations:

**A - All texture soils** "All soils" refers to soils with any USDA soil texture, including muck, mucky peat, and peat

**S - Sandy texture soils (soils that will not ribbon)** "Sandy soils" refers to those soils with a USDA soil texture of loamy fine sand and coarser, and does not include muck, mucky peat, or peat.

**F - Fine texture soils (soils that will ribbon)** "Loamy and clayey soils" refers to those soils with

USDA soil texture of loamy very fine sand and finer, and does not include muck, mucky peat, or peat.

## **Tips for Determining Texture of Soil Materials High in Organic Carbon**

### **“Five Rub Texture Test”**

If soil appears dark, gently (minimal pressure) rub wet soil material between forefinger and thumb and note how it feels.

| # of Rubs | Feeling              | Texture                                                                                                          |
|-----------|----------------------|------------------------------------------------------------------------------------------------------------------|
| ≤ 2       | Gritty               | Sandy Mineral <sup>1</sup>                                                                                       |
| 2         | Greasy               | <i>Continue to next rows</i>                                                                                     |
| 3 to ≤ 5  | Gritty               | Sandy Mucky Mineral <sup>1</sup>                                                                                 |
| 3 to ≤ 5  | Plastic <sup>2</sup> | Check % Organic Carbon <sup>3</sup> to determine if Fine Mineral <sup>1</sup> or Fine Mucky Mineral <sup>1</sup> |
| 5         | Greasy               | Muck <sup>1</sup>                                                                                                |

<sup>1</sup> Results of this test only indicate texture; check NRCS hydric soil field indicators to determine if all requirements of an indicator are met

<sup>2</sup> Plastic: able to be molded or deformed into various shapes by moderate pressure

<sup>3</sup> Sufficiency of organic carbon\* can be approximated using the “Color Test”<sup>4</sup>  
\*not to be confused with organic coating

### **“Ten Rub Fiber Test”**

If soil material is all or nearly all organic, firmly rub a moist sample 10 times in the palm of one hand with the thumb of the other and estimate proportion of fibers visible with a hand lens.

| Proportion of visible fibers <sup>5</sup> | Organic soil texture |
|-------------------------------------------|----------------------|
| Less than 1/6 (<17%)                      | Sapric (Muck)        |
| 1/6 to 3/4 (17% - 75%)                    | Hemic (Mucky Peat)   |
| More than 3/4 (>75%)                      | Fibric (Peat)        |

<sup>5</sup> Live roots are not considered

## **Tips for Approximating Composition of Soil**

### **“Decant Tests”**

Place a pea sized amount of soil in cupped palm of hand. Holding spray bottle close (~3 in.), thoroughly wet soil, filling but not overflowing palm.

Break apart soil material to make a souplike suspension of particles.

### **<sup>4</sup>“Color Test”**

Keeping solution in palm, note its color.  
(Helps to determine if suspended particles are organic or fine mineral.)

Black/Brown  
↓  
Organic Material

Gray/Cloudy  
↓  
Clay and/or Silt

### **“Sand Content Test”**

Gently decant liquid solution while keeping solid material in palm.

Spray, muddle, examine, drain, and repeat until solution runs nearly clear.

Spread remaining soil material across palm. Compare amount of sand in relation to original pea sized clump, considering relative loss of fine soil material (clay and silt) indicated by the “Color

Test”, to approximate organic vs. mineral (sand, silt, clay) content. See Fig. 7 pg. 60 for dry weight soil texture ratio requirements.

## Tips for Determining Boundary Types of Features in Soil

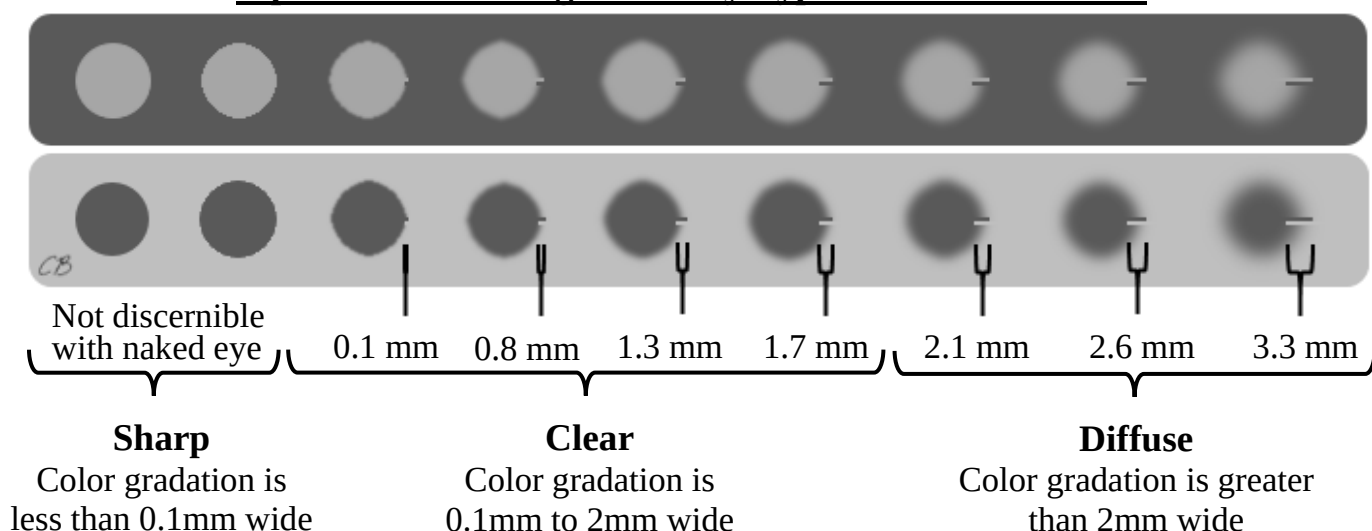


**Figure 1:** Diagram for determining boundary types of features in the matrix.

## Tips for Determining Contrast Between Soil Colors

| $\Delta$ Hue | $\Delta$ Value | $\Delta$ Chroma | Contrast  |
|--------------|----------------|-----------------|-----------|
| 0            | $\leq 2$       | $\leq 1$        | Faint     |
|              | $\leq 2$       | $>1$ to $<4$    | Distinct  |
|              | $>2$ to $<4$   | $<4$            | Distinct  |
|              | any            | $\geq 4$        | Prominent |
|              | $\geq 4$       | any             | Prominent |
| 1            | $\leq 1$       | $\leq 1$        | Faint     |
|              | $\leq 1$       | $>1$ to $<3$    | Distinct  |
|              | $>1$ to $<3$   | $<3$            | Distinct  |
|              | any            | $\geq 3$        | Prominent |
|              | $\geq 3$       | any             | Prominent |
| 2            | 0              | 0               | Faint     |
|              | 0              | $>0$ to $<2$    | Distinct  |
|              | $>0$ to $<2$   | $<2$            | Distinct  |
|              | any            | $\geq 2$        | Prominent |
|              | $\geq 2$       | any             | Prominent |
| 3+           | any            | any             | Prominent |

**Table 1:** Chart of delta hue (Figure 2), delta value, and delta chroma required for each level of color contrast. The last column in each row states what level of contrast exists between two colors when the  $\Delta$ hue,  $\Delta$ value, and  $\Delta$ chroma criteria within that row are met.

**\*Note: If both colors have value  $\leq 3$  and chroma  $\leq 2$ , the contrast is faint, regardless of the change in hue.**

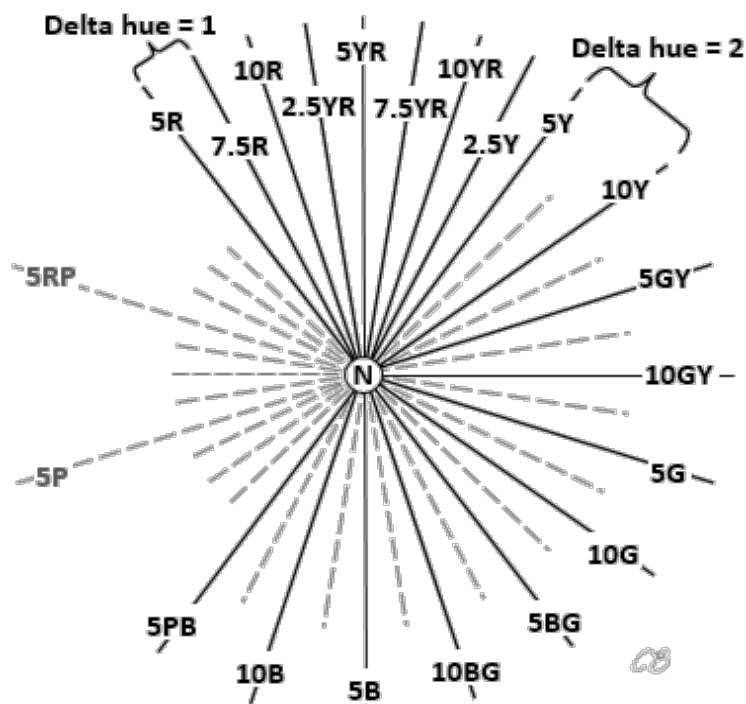


**Figure 2:** Relationships among the hues of the Munsell Color System. Solid lines represent hues contained in the *Munsell Soil Color Charts* (2009). Dotted lines represent all other possible 2.5 unit steps. Moving from one hue line to the adjacent hue line represents a delta hue of 1 (2.5 units). Moving from hue N to any other hue the delta hue is 1.

Adapted from the *Soil Survey Manual* (Soil Survey Staff, 1993)

## Tips for Determining Contrast Between Soil Colors (continued)

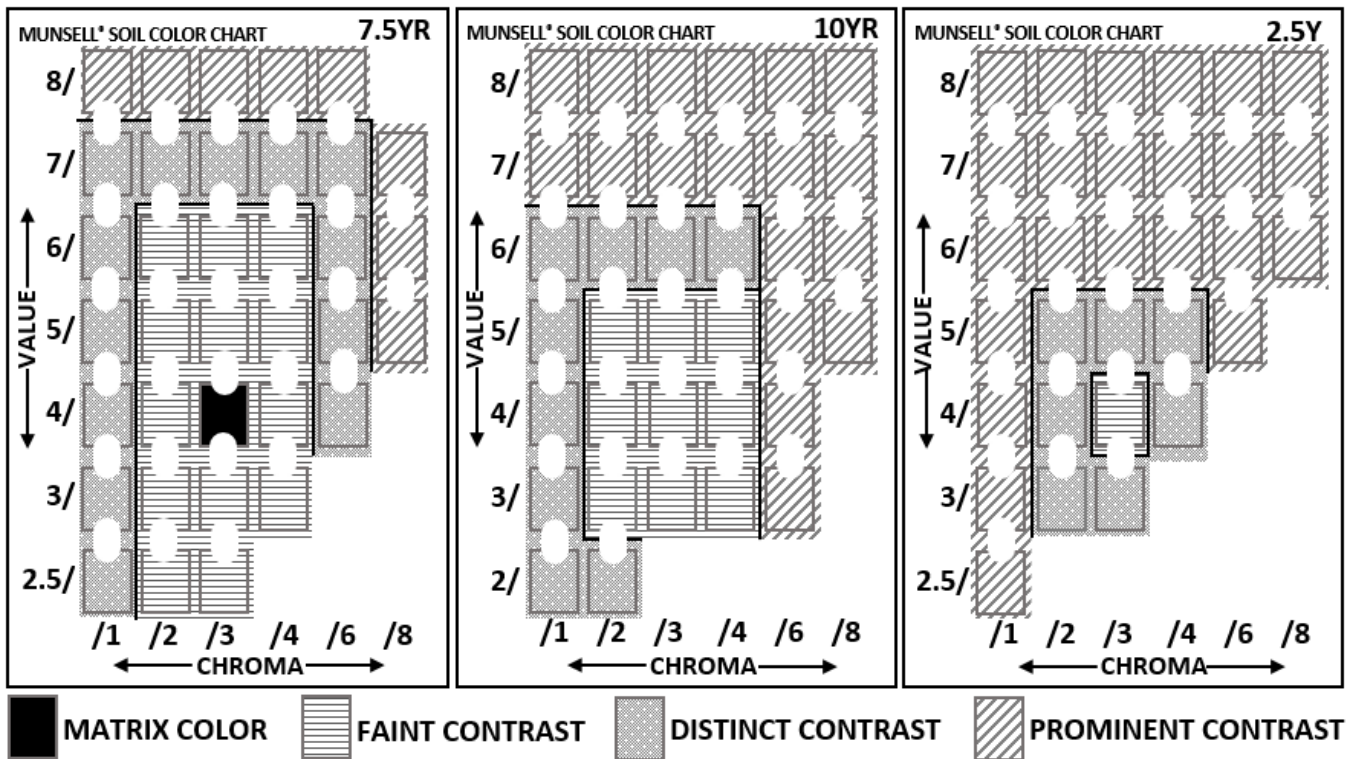


**Figure 3:** Using the 7.5 YR 4/3 color chip as an example matrix color, an illustration of faint, distinct, and prominent contrast between colors in relation to the matrix color in the *Munsell Soil Color Charts* (2009).

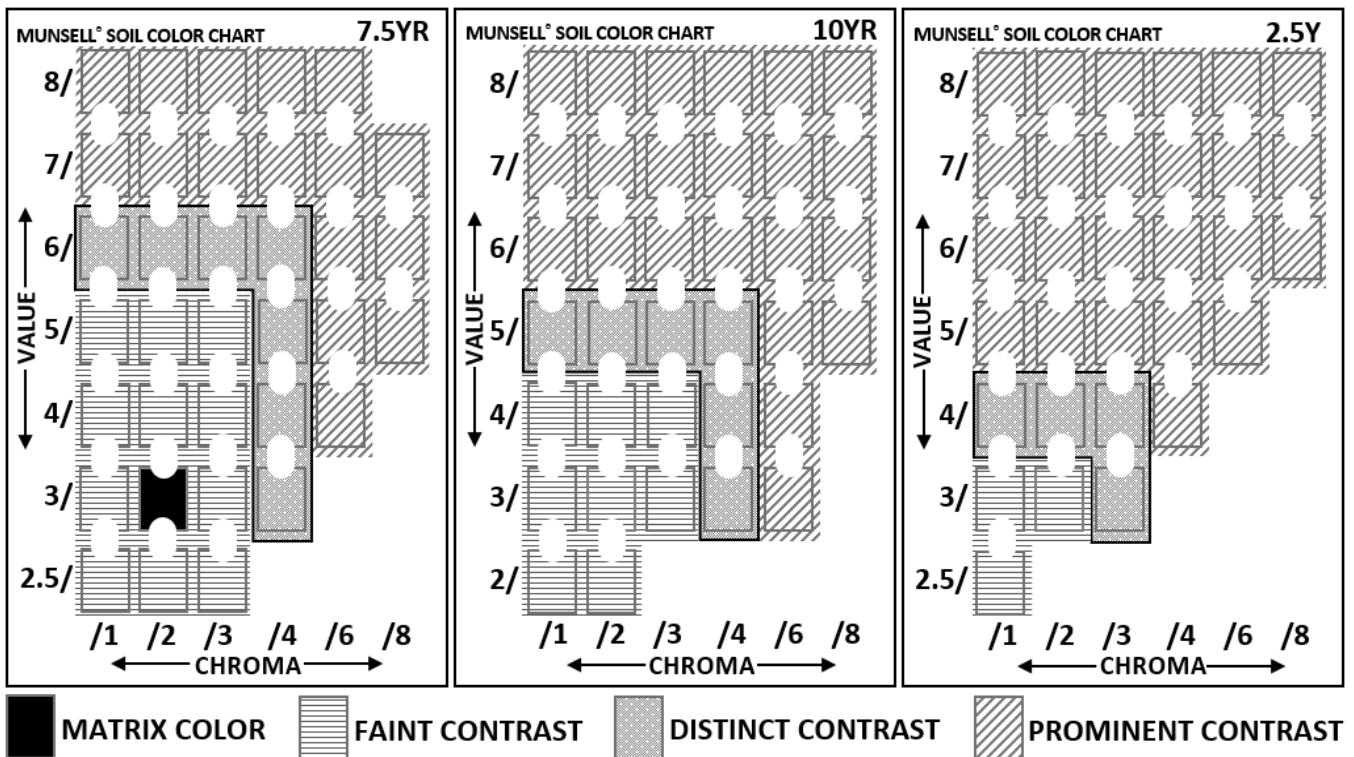
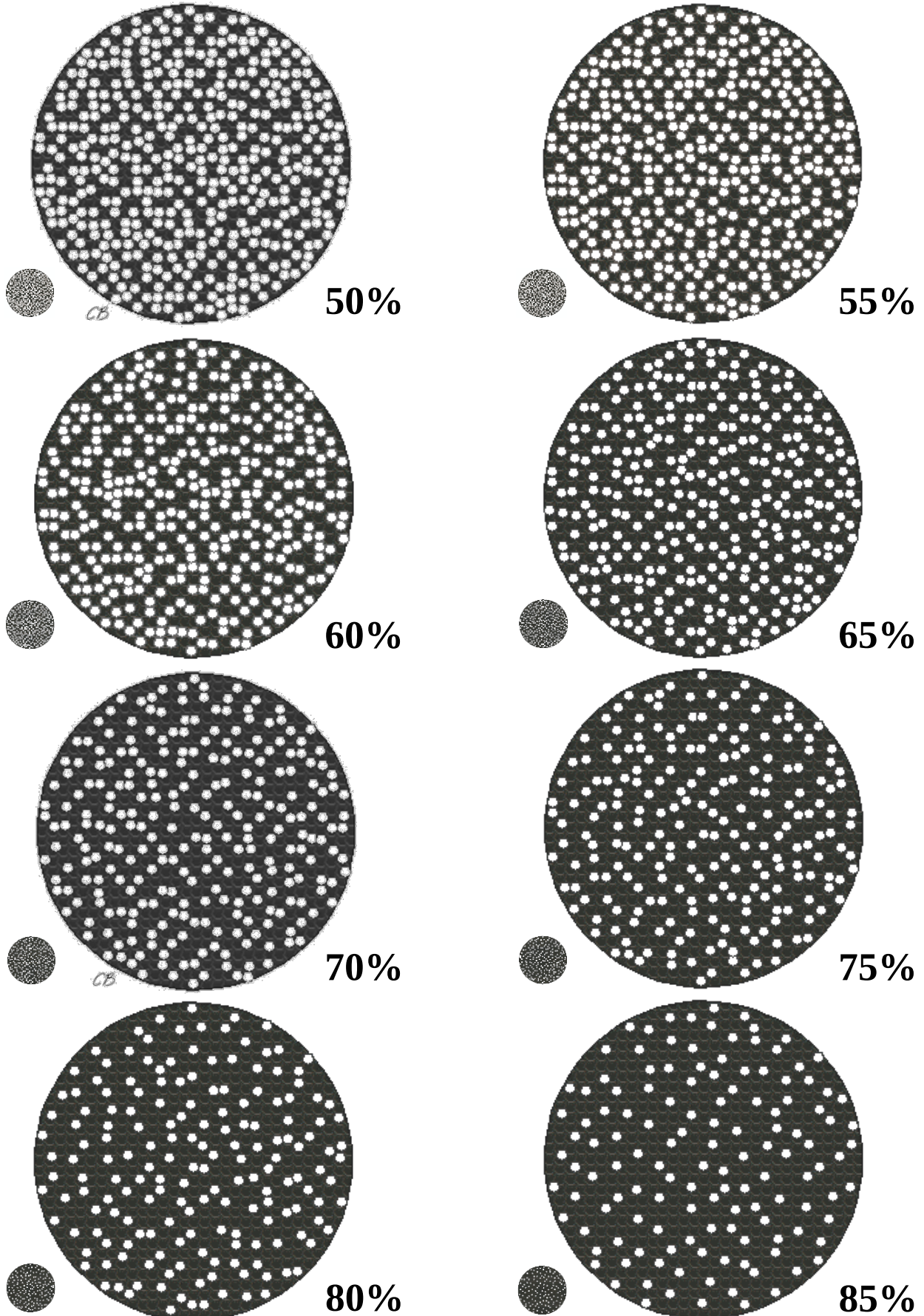
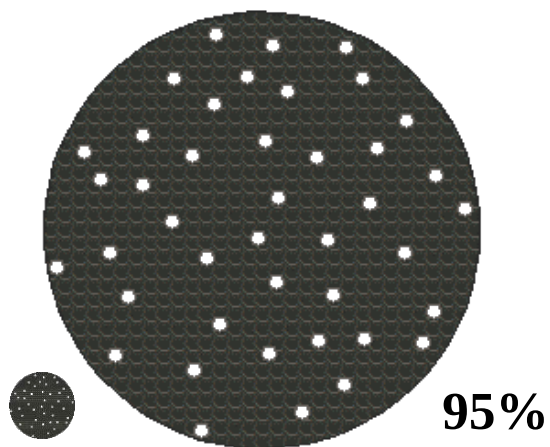
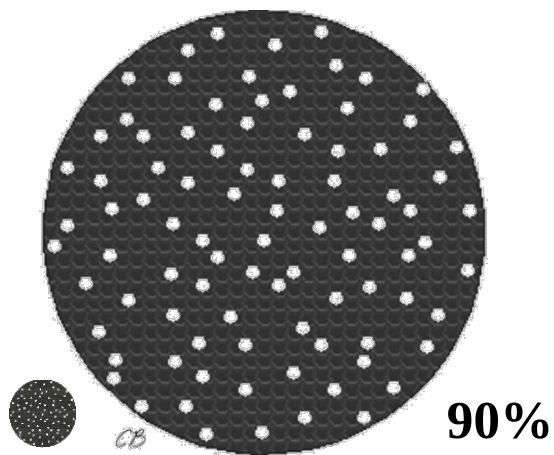


**Figure 4:** Using the 7.5 YR 3/2 color chip as an example matrix color, an illustration of faint, distinct, and prominent contrast between colors in relation to the matrix color in the *Munsell Soil Color Charts* (2009). Note that because the matrix has value  $\leq 3$  and chroma  $\leq 2$ , all other colors with value  $\leq 3$  and chroma  $\leq 2$  are faintly contrasting despite the change in hue.

### Estimating Percent Organic Coating

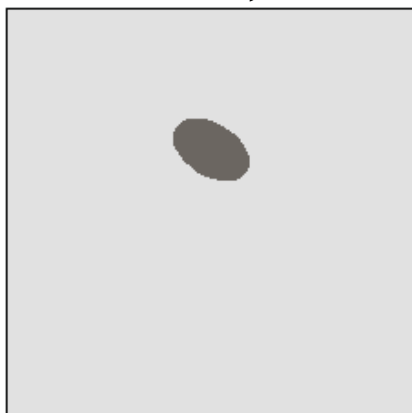
The round diagrams represent the appearance of uncoated (clear or white) sand grains versus coated (gray to black) sand grains within a ped face as viewed through a 10X hand lens.



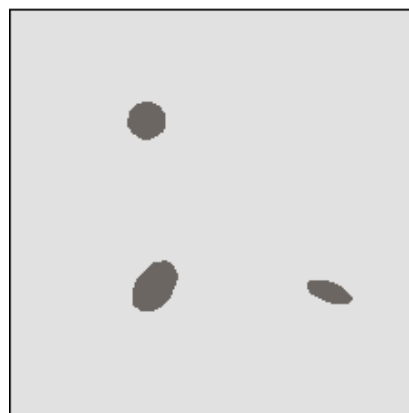


### Estimating Percent Volume

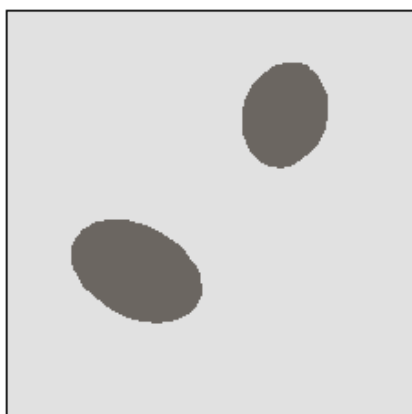
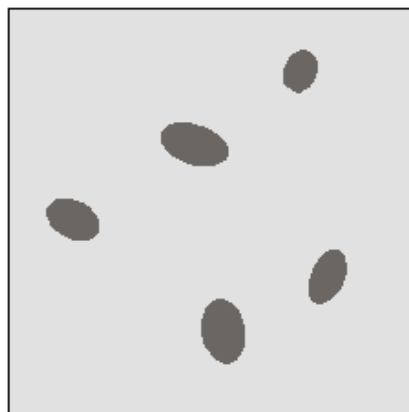
The squares represent part of a grid drawn on the soil profile to estimate volume of light areas, dark areas, or redox concentrations of larger and smaller sizes.



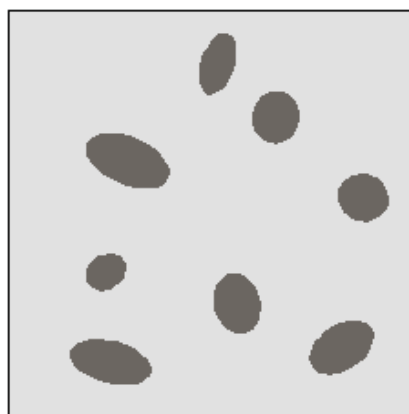
2%



5%

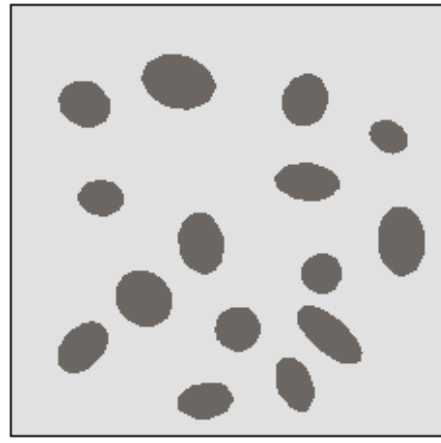


10%

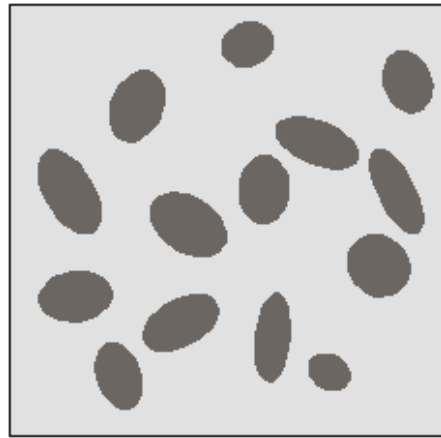




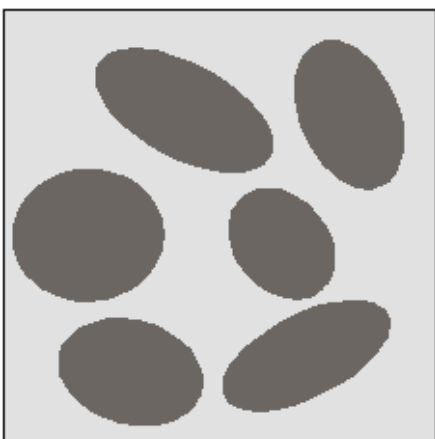
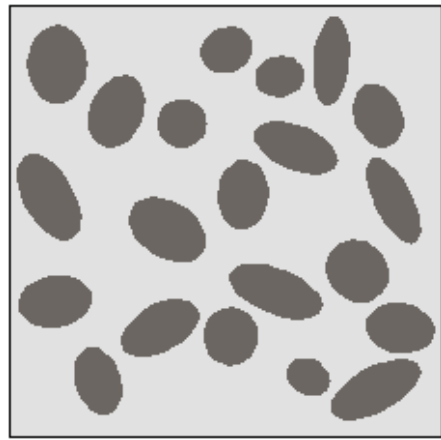
**15%**



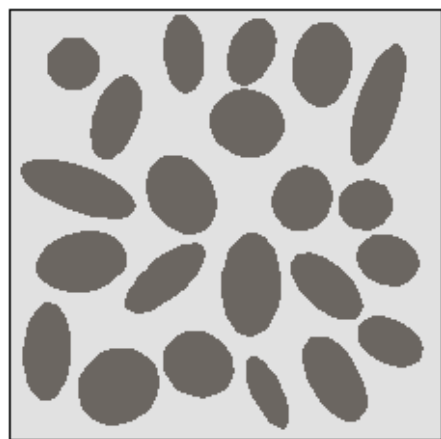
**20%**

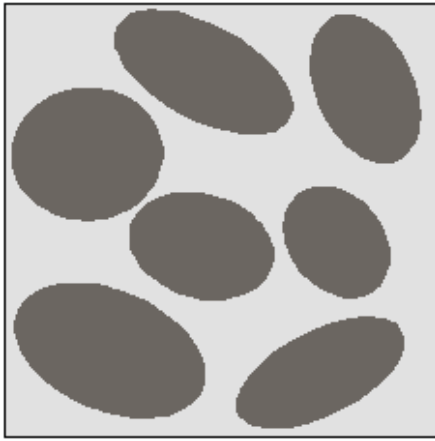


**30%**

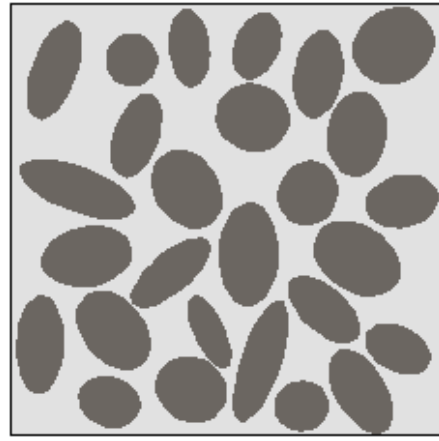


**40%**

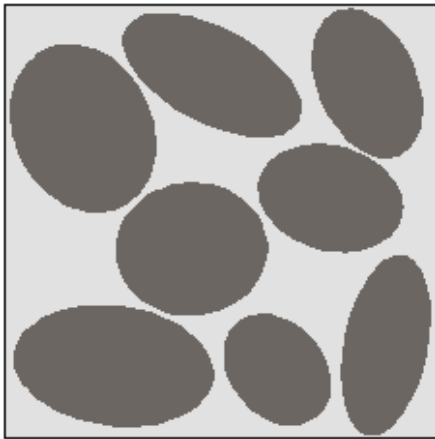




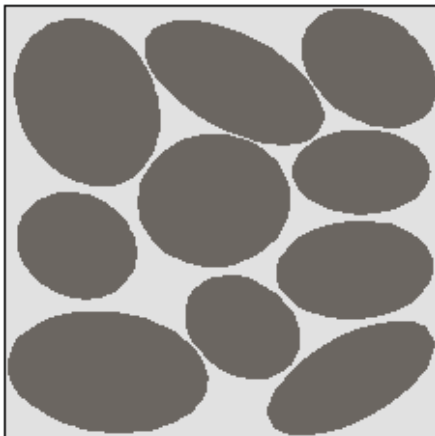
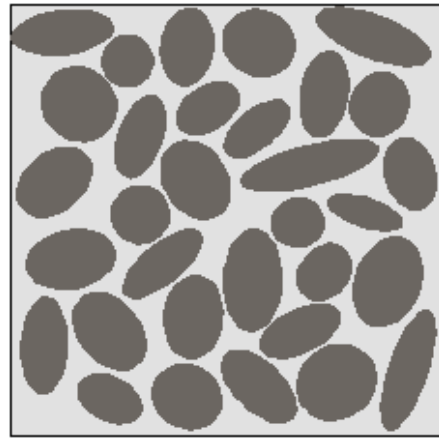
**50%**



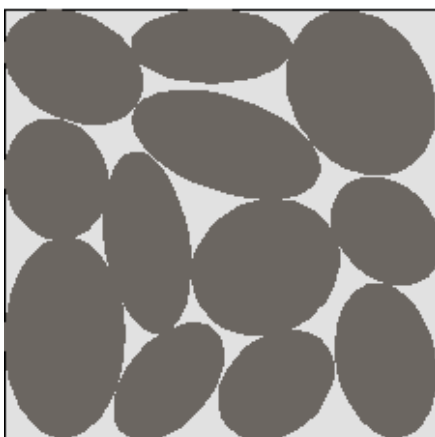
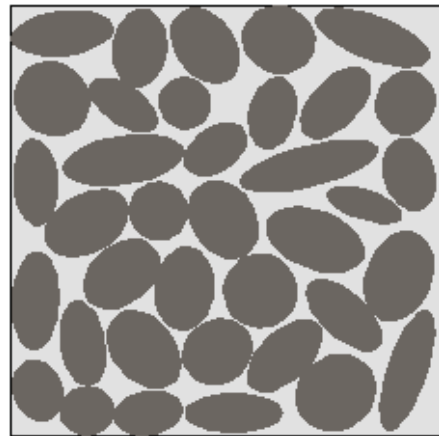
(Note: when a feature (e.g. stripped areas) composes more than 50% of the volume, its color is considered to be the matrix color of the soil profile. When more than two colors are present, the color composing the majority of the volume is the matrix color.)



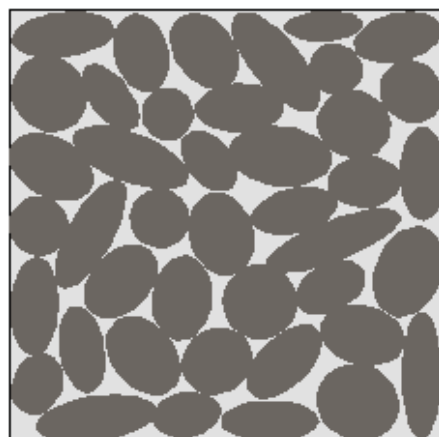
**60%**



**70%**



**80%**



The squares represent part of a grid drawn on the soil profile to estimate volume of plant fibers, oxidized rhizospheres, or other linear features.



**2%**



**5%**



**10%**



**17%**



**20%**



**30%**

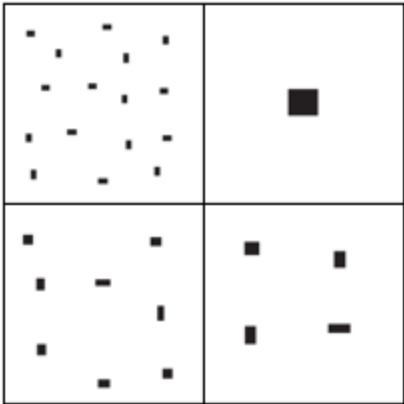


**40%**

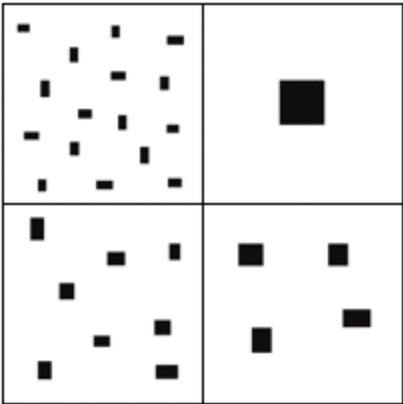


**50%**

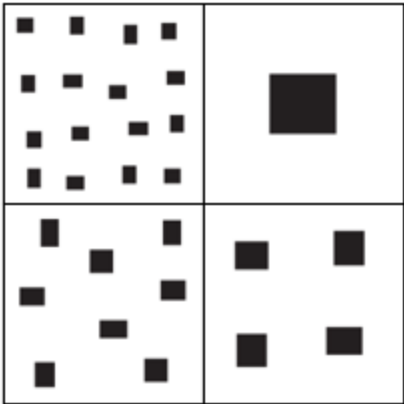
Each square is divided into quarters which depict the same percent volume using features of different sizes. These can also represent areal extents for plants.



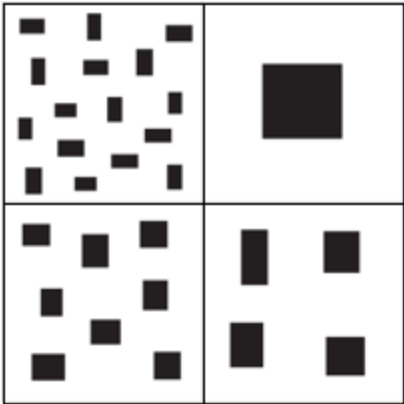
2%



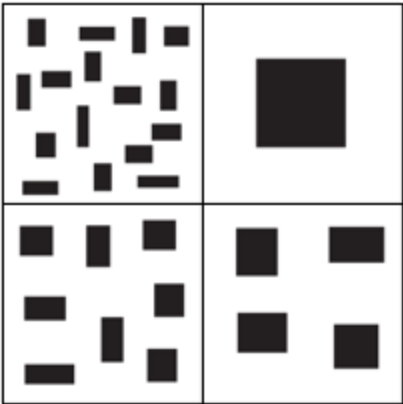
5%



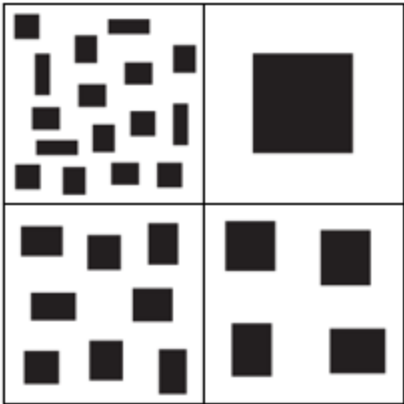
10%



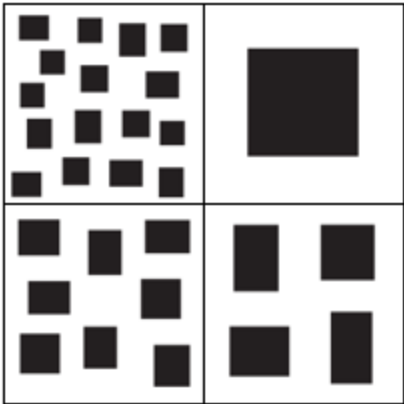
15%



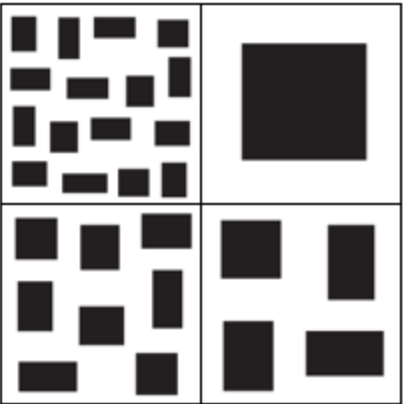
20%



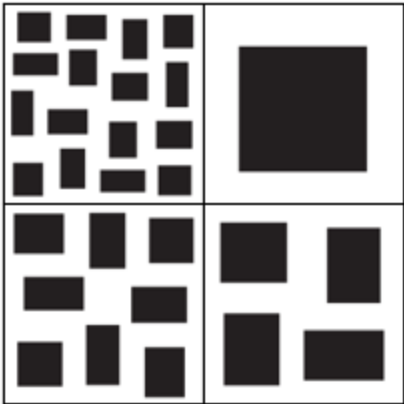
25%



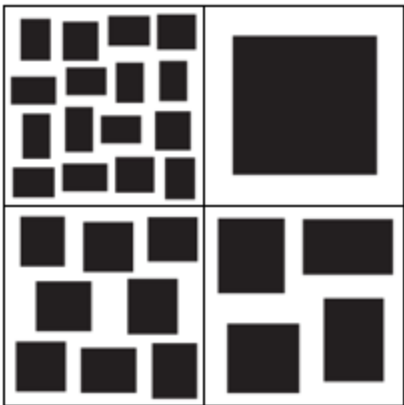
30%



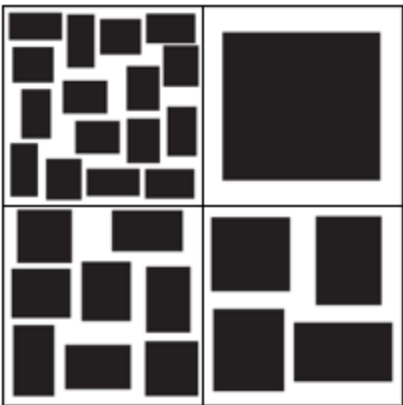
35%



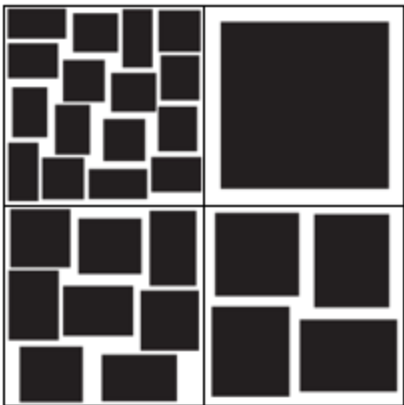
40%



50%

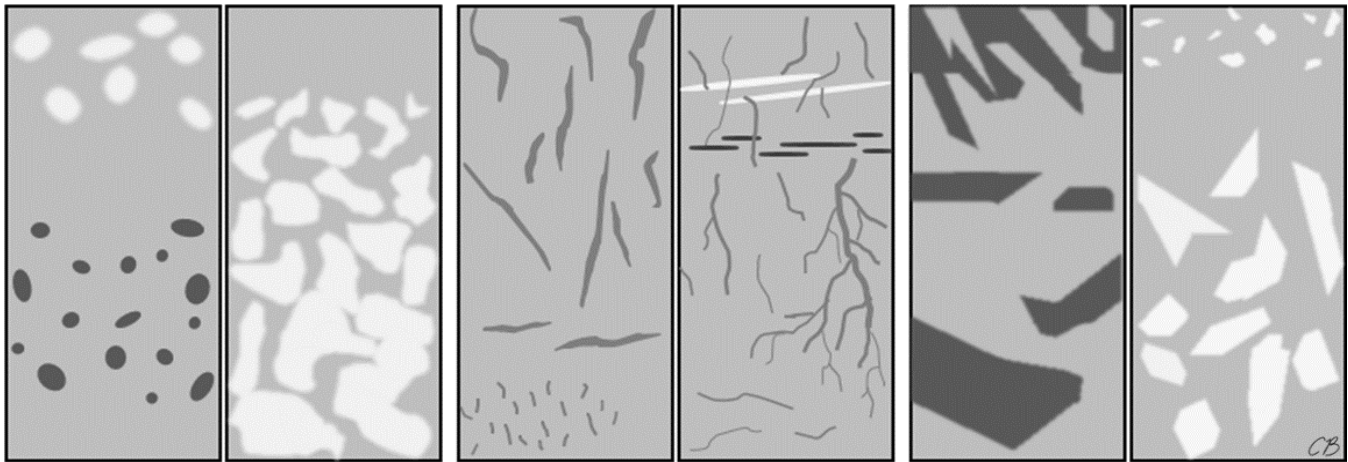


60%



70%

## Tips for Determining Shapes of Features in Soil



### **Rounded**

Features with generally curved outlines (do not have to be circular; often amorphous)

### **Linear**

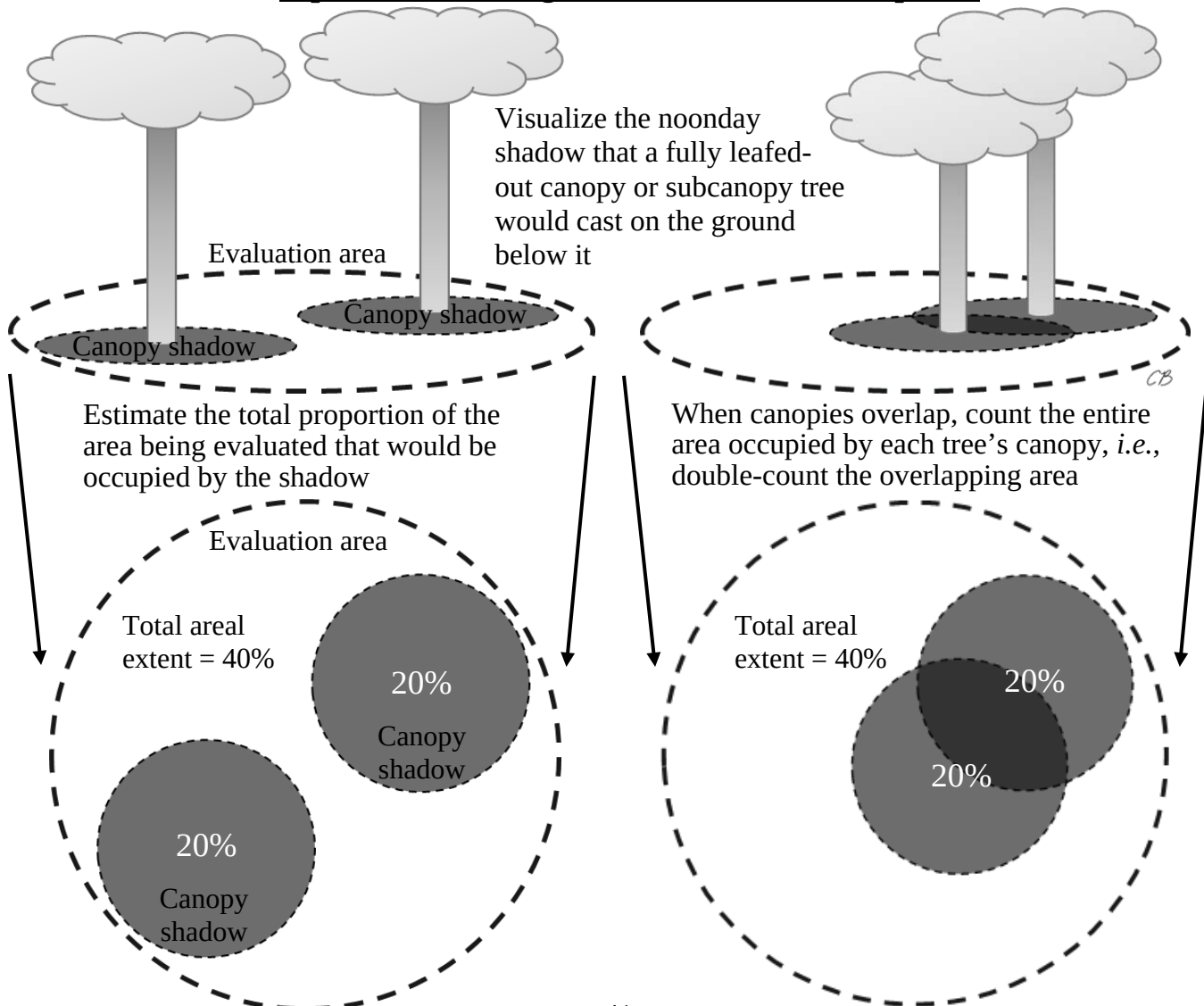
Features that are generally long & narrow (typically associated with roots or burrows, sometimes mixing or deposition)

### **Angular**

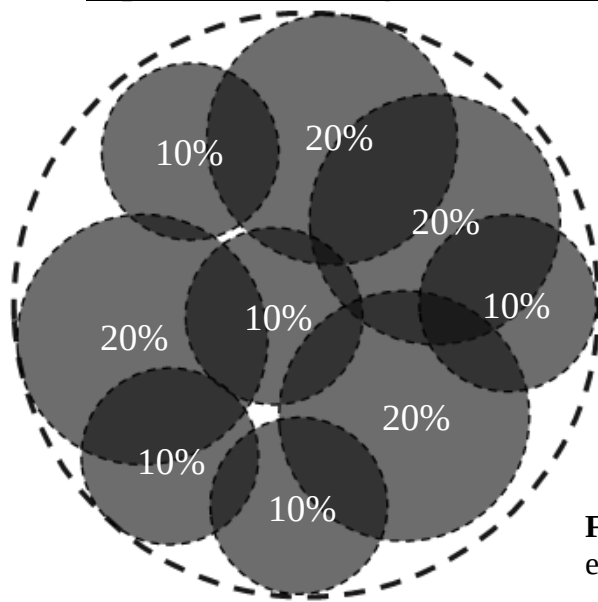
Features with generally straight outlines & defined angles (often resulting from physical mixing of soils)

**Figure 5:** Diagram for determining shape categories of features in the matrix.

## Tips for Estimating Areal Extent of Plant Species



## Tips for Estimating Areal Extent of Plant Species (continued)

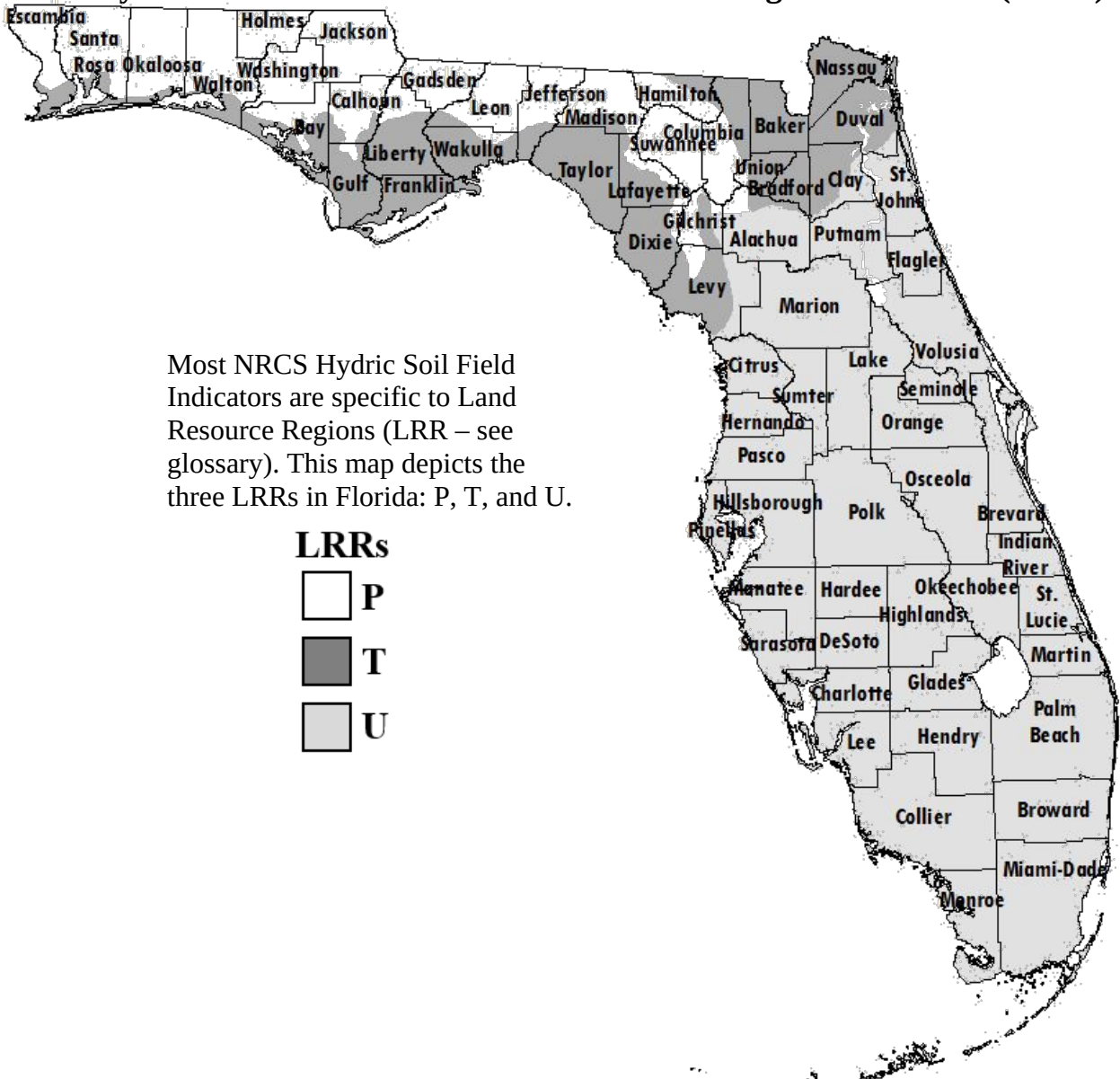


In a dense canopy where many trees overlap one another, the total areal extent of species in the evaluation area may exceed 100%, even if open sky is visible between some canopies

Total areal  
extent = 130%

**Figure 6:** Diagrams for estimating the areal extents of plants within an evaluation area.

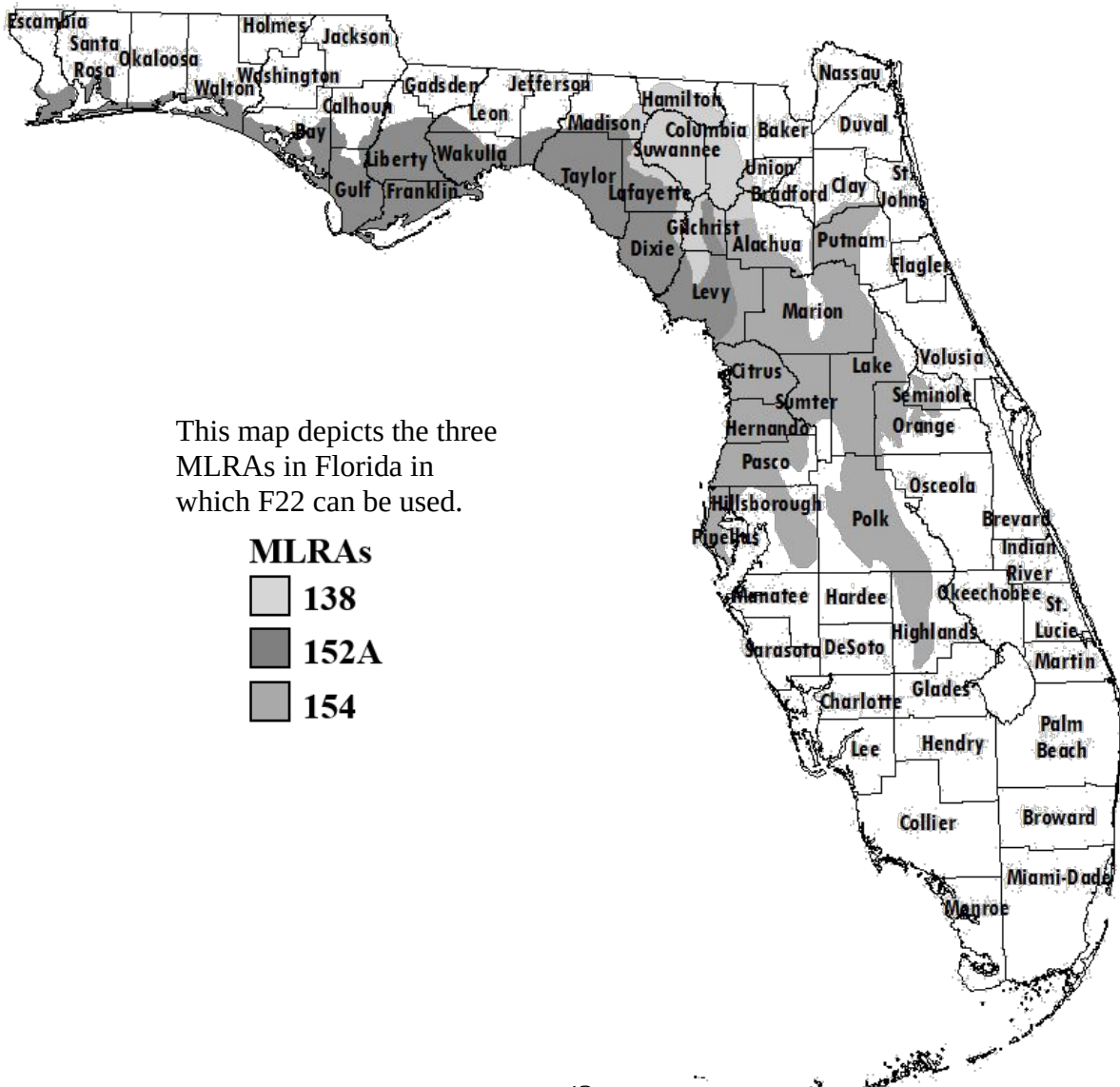
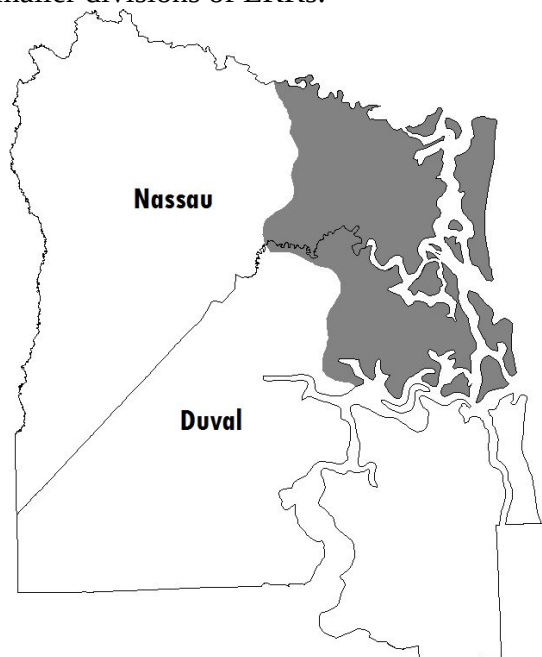
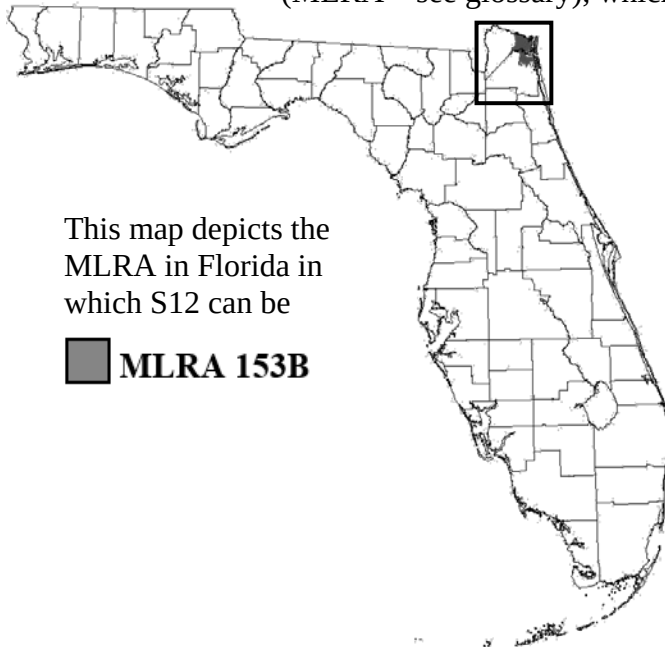
## **NRCS Hydric Soil Field Indicators Land Resource Regions of Florida (LRRs)**



Most NRCS Hydric Soil Field Indicators are specific to Land Resource Regions (LRR – see glossary). This map depicts the three LRRs in Florida: P, T, and U.

## Major Land Resource Areas (MLRAs)

Two Hydric Soil Field Indicators in Florida (S12 and F22) are specific to Major Land Resource Areas (MLRA – see glossary), which are smaller divisions of LRRs.



## Hydric Soil Field Indicators:

Adapted from **Field Indicators of Hydric Soils in the United States, Version 8.1 (USDA NRCS, 2017)** to include Florida-specific indicators per Rule 62-340.300(2)(a)1., (b)1., (c)3., and (d), F.A.C.

**These indicators are subdivided by prefix:**

**A** – for All texture soils

**S** – for Sandy texture soils

**F** – for Fine texture soils

**LRR or MLRA** – refer to the “Land Resource Region” or the “Major Land Resource Area” in which the indicator may be used

### **Data Form Guide Notes**

**Soil profile documentation:** The top of the uppermost muck (sapric) or mineral surface is the soil surface/0 inch depth for purposes of Chapter 62-340, F.A.C. Other materials, such as peat (fibric) or mucky peat (hemic) are documented by a “+” before the thickness in inches of each additional layer above the soil surface. (For example: +4 – 0 inches mucky peat, 0 – 3 inches muck)

**Overlying layer(s) requirement:** All mineral layers above any of the layers meeting the requirements of any indicators, except S6, F8, and F12, must have a dominant chroma of 2 or less, or the thickness of the layer(s) with a dominant chroma of more than 2 is less than 6 inches.

-----**For use in All texture soils**-----

#### **A1. Histosol - LRR: P, T, U**

*Note: This is a stand alone D-Test indicator*

**Classifies as a Histosol (except Folist).**

User Notes: In a Histosol, typically 40 cm (16 inches) or more of the upper 80 cm (32 inches) is organic soil material. Organic soil materials have organic-carbon contents (by weight) of 12 to 18 percent or more, depending on the clay content of the soil. These materials include muck (sapric soil material), mucky peat (hemic soil material), and peat (fibric soil material). See *Keys to Soil Taxonomy* (Soil Survey Staff, 2014) for a complete definition.

#### **A2. Histic Epipedon - LRR: P, T, U**

*Note: This is a stand alone D-Test indicator*

**A histic epipedon underlain by mineral soil material with chroma of 2 or less.**

User Notes: Most histic epipedons are surface horizons 20 cm (8 inches) or more thick of organic soil material. Aquic conditions or artificial drainage is required. See *Keys to Soil Taxonomy* (Soil Survey Staff, 2014) for a complete definition.

#### **A3. Black Histic - LRR: P, T, U**

*Note: This is a stand alone D-Test indicator*

**A layer of peat, mucky peat, or muck 20 cm (8 inches) or more thick that starts at a depth of ≤ 15 cm (6 inches) from the soil surface; has hue of 10YR or yellower, value of 3 or less, and chroma of 1 or less; and is underlain by mineral soil material with chroma of 2 or less.**

User Notes: Unlike indicator A2, this indicator does not require proof of aquic conditions or artificial drainage.

#### **A4. Hydrogen Sulfide - LRR: P, T, U**

*Note: This is a stand alone D-Test indicator*

**A hydrogen sulfide odor starting at a depth ≤ 30 cm (12 inches) from the soil surface.**

User Notes: This “rotten egg smell” indicates that sulfate-sulfur has been reduced and therefore the soil is anaerobic.

#### **A5. Stratified Layers - LRR: P, T, U**

*Note: This is a stand alone D-Test indicator (qualifies as sediment deposition)*

**Several stratified layers starting at a depth  $\leq 15$  cm (6 inches) from the soil surface. At least one of the layers has value of 3 or less and chroma of 1 or less, or it is muck, mucky peat, peat, or a mucky modified mineral texture. The remaining layers have chroma of 2 or less. For any sandy material that constitutes the layer with value of 3 or less and chroma of 1 or less, at least 70 percent of the visible soil particles must be masked with organic material, viewed through a 10x or 15x hand lens. Observed without a hand lens, the particles appear to be close to 100 percent masked.**

User Notes: Use of this indicator may require assistance from a trained soil scientist with local experience. A stratified layer is depositional and not pedogenic. The minimum organic-carbon content of at least one layer of this indicator is slightly less than is required for indicator A7 (5 cm Mucky Mineral). An undisturbed sample must be observed. Individual strata are dominantly less than 2.5 cm (1 inch) thick. A hand lens is an excellent tool to aid in the identification of this indicator. Many alluvial soils have stratified layers at greater depths; these soils do not meet the requirements of this indicator. Many alluvial soils have stratified layers at the required depths but do not have chroma of 2 or less; these do not meet the requirements of this indicator. The stratified layers occur in any soil texture.

#### **A6. Organic Bodies - LRR: P, T, U**

**Presence of 2 percent or more organic bodies of muck or a mucky modified mineral texture starting at a depth  $\leq 15$  cm (6 inches) from the soil surface.**

User Notes: Organic bodies typically occur at the tips of fine roots. In order to meet the Organic Bodies indicator, the organic carbon content in organic bodies must meet the requirements of muck or mucky modified textures. The size of the organic body is not specifically defined, but the bodies are commonly 1 to 3 cm (0.5 to 1 inch) in diameter. Many organic bodies do not have the required content of organic carbon and as a result do not meet this indicator. For example, organic bodies of mucky peat (hemic material) and/or peat (fibric material) do not meet the requirements of this indicator, nor does material consisting of partially decomposed root tissue. The Organic Bodies indicator includes the indicator previously named “accretions” (Florida Soil Survey Staff, 1992).

#### **A7. 5 cm Mucky Mineral - LRR: P, T, U**

*Note: This is a stand alone D-Test indicator*

**A layer of mucky modified mineral soil material 5 cm (2 inches) or more thick, starting at a depth  $\leq 15$  cm (6 inches) from the soil surface.**

User Notes: “Mucky” is a USDA texture modifier for mineral soils. The content of organic carbon is at least 5 percent and ranges to as high as 18 percent. The percentage required depends on the clay content of the soil; the higher the clay content, the higher the content of organic carbon required. For example, a mucky fine sandy soil contains between 5 and 12 percent organic carbon. When the amount of clay is increased as in a mucky sandy loam, the organic carbon content increases to between 7 and 14 percent.

#### **A8. Muck Presence - LRR: U**

*Note: This is a stand alone D-Test indicator*

**A layer of muck with value of 3 or less and chroma of 1 or less, starting at a depth  $\leq 15$  cm (6 inches) from the soil surface.**

User Notes: The presence of muck of any thickness at a depth  $\leq 15$  cm (6 inches) is the only requirement. Normally, this expression of anaerobiosis is at the soil surface; however, it may occur at any depth  $\leq 15$  cm (6 inches). Muck is sapric soil material with a minimum content of organic carbon that ranges from 12 to 18 percent, depending on the content of clay. Organic soil material is called muck if virtually all of the material has undergone sufficient decomposition to prevent the identification of plant parts. Mucky peat (hemic material) and/or peat (fibric material) do not qualify. Generally, muck is black and has a “greasy” feel; sand grains should not be evident.

**A9. 1 cm Muck - LRR: P, T**

*Note: This is a stand alone D-Test indicator*

**A layer of muck 1 cm (0.5 inch) or more thick with value of 3 or less and chroma of 1 or less and starting at a depth  $\leq$  15 cm (6 inches) from the soil surface.**

User Notes: Unlike indicator A8 (Muck Presence), this indicator has a minimum thickness requirement of 1 cm. Normally, this expression of anaerobiosis is at the soil surface; however, it may occur at any depth  $\leq$  15 cm (6 inches). Muck is sapric soil material with a minimum content of organic carbon that ranges from 12 to 18 percent, depending on the content of clay. Organic soil material is called muck if virtually all of the material has undergone sufficient decomposition to limit the recognition of plant parts. Mucky peat (hemic material) and/or peat (fibric material) do not qualify. Generally, muck is black and has a “greasy” feel; sand grains should not be evident.

**A11. Depleted Below Dark Surface - LRR: P, T, U**

**A layer with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less, starting at a depth  $\leq$  30 cm (12 inches) from the soil surface, and having a minimum thickness of either:**

**a. 15 cm (6 inches), or**

**b. 5 cm (2 inches) if the 5 cm consists of fragmental soil material.**

**Organic, loamy, or clayey layer(s) above the depleted or gleyed matrix must have value of 3 or less and chroma of 2 or less starting at a depth  $\leq$  15 cm (6 inches) from the soil surface and extend to the depleted or gleyed matrix. Any sandy material above the depleted or gleyed matrix must have value of 3 or less and chroma of 1 or less starting at a depth  $\leq$  15 cm (6 inches) from the soil surface and extend to the depleted or gleyed matrix. Viewed through a 10x or 15x hand lens, at least 70 percent of the visible sand particles must be masked with organic material. Observed without a hand lens, the sand particles appear to be close to 100 percent masked.**

User Notes: This indicator often occurs in Mollisols but also applies to soils with umbric epipedons and dark colored ochric epipedons. For soils with dark colored epipedons more than 30 cm (12 inches) thick, use indicator A12. A depleted matrix requires value of 4 or more and chroma of 2 or less. Redox concentrations, including soft iron-manganese masses and/or pore linings, are required in soils with matrix colors of 4/1, 4/2, or 5/2. A, E, and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix; however, they are excluded from the concept of depleted matrix unless the soil has common or many distinct or prominent redox concentrations occurring as soft masses or pore linings.

**A12. Thick Dark Surface - LRR: P, T, U**

**A layer at least 15 cm (6 inches) thick with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less starting below 30 cm (12 inches) of the surface. The layer(s) above the depleted or gleyed matrix and starting at a depth  $\leq$  15 cm (6 inches) from the soil surface must have value of 2.5 or less and chroma of 1 or less to a depth of at least 30 cm (12 inches) and value of 3 or less and chroma of 1 or less in any remaining layers above the depleted or gleyed matrix. In any sandy material above the depleted or gleyed matrix, at least 70 percent of the visible soil particles must be masked with organic material, viewed through a 10x or 15x hand lens. Observed without a hand lens, the particles appear to be close to 100 percent masked.**

User Notes: This indicator applies to soils that have a black layer 30 cm (12 inches) or more thick and have value of 3 or less and chroma of 1 or less in any remaining layers directly above a depleted or gleyed matrix. This indicator is most often associated with overthickened soils in concave landscape positions. A depleted matrix requires value of 4 or more and chroma of 2 or less. Redox concentrations, including soft iron-manganese masses and/or pore linings, are required in soils with matrix colors of 4/1, 4/2, or 5/2. A, E, and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix; however, they are excluded from the concept of depleted matrix unless the soil has common or many distinct or prominent redox concentrations occurring as soft masses or pore linings.

**S4. Sandy Gleyed Matrix - LRR: P, T, U**

*Note: This is a stand alone D-Test indicator*

**A gleyed matrix that occupies 60 percent or more of a layer starting at a depth  $\leq$  15 cm (6 inches) from the soil surface.**

User Notes: Gley colors are not synonymous with gray colors. They are the colors on the gley color pages in the Munsell color book (X-Rite, 2009) that have hue of N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB and value of 4 or more. For this indicator, the gleyed matrix only has to be present at a depth  $\leq$  15 cm (6 inches) from the surface. Soils with gleyed matrices are saturated for periods of a significant duration; as a result, there is no thickness requirement for the layer.

**S5. Sandy Redox - LRR: P, T, U**

**A layer starting at a depth  $\leq$  15 cm (6 inches) from the soil surface that is at least 10 cm (4 inches) thick and has a matrix with 60 percent or more chroma of 2 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings.**

User Notes: “Distinct” and “prominent” are defined in the Glossary. Redox concentrations include iron and manganese masses (reddish mottles) and pore linings (Vepraskas, 1994). Included within the concept of redox concentrations are iron-manganese bodies occurring as soft masses with diffuse boundaries. Common (2 to less than 20 percent) or many (20 percent or more) redox concentrations are required (USDA, NRCS, 2002). If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible.

This is a very common indicator of hydric soils and is often used to identify the hydric/nonhydric soil boundary in sandy soils.

**S6. Stripped Matrix - LRR: P, T, U**

**A layer starting at a depth  $\leq$  15 cm (6 inches) from the soil surface in which iron-manganese oxides and/or organic matter have been stripped from the matrix and the primary base color of the soil material has been exposed. The stripped areas and translocated oxides and/or organic matter form a faintly contrasting pattern of two or more colors with diffuse boundaries. The stripped zones are 10 percent or more of the volume and are rounded.**

User Notes: This indicator includes the indicator previously named “polychromatic matrix” as well as the term “streaking.” Common or many areas of stripped (unmasked) soil materials are required. The stripped areas are typically 1 to 3 cm (0.5 to 1 inch) in size but may be larger or smaller. Commonly, the stripped areas have value of 5 or more and chroma of 2 or less, and the unstripped areas have chroma of 3 and/or 4. The matrix (predominant color) may not have the material with chroma of 3 and/or 4. The mobilization and translocation of oxides and/or organic matter is the important process and should result in a splotchy pattern masked and unmasked soil areas. This may be a difficult pattern to recognize and is more evident when a horizontal slice is observed.

**S7. Dark Surface - LRR: P, T, U**

**A layer 10 cm (4 inches) thick, starting at a depth less than or equal to the upper 15 cm (6 inches) of the soil surface, with a matrix value of 3 or less and chroma of 1 or less. At least 70 percent of the visible soil particles must be masked with organic material, viewed through a 10x or 15x hand lens. Observed without a hand lens, the particles appear to be close to 100 percent masked. The matrix color of the layer directly below the dark layer must have the same colors as those described above or any color that has chroma of 2 or less.**

User Notes: An undisturbed sample must be observed. Many wet soils have a ratio of about 50 percent soil particles that are masked with organic matter and about 50 percent unmasked soil particles, giving the soils a salt-and-pepper appearance. Where the coverage is less than 70 percent, a Dark Surface indicator does not occur.

**S8. Polyvalue Below Surface - LRR: T, U**

**A layer with value of 3 or less and chroma of 1 or less starting at a depth  $\leq$  15 cm (6 inches) from the soil surface. At least 70 percent of the visible soil particles must be masked with organic material, viewed through a 10x or 15x hand lens. Observed without a hand lens, the particles appear to be close to 100 percent masked. Directly below this layer, 5 percent or more of the soil volume has value of 3 or less and chroma of 1 or less, and the remainder of the soil volume has value of 4 or more and chroma of 1 or less to a depth of 30 cm (12 inches) or to the spodic horizon, whichever is less.**

User Notes: This indicator applies to soils with a very dark gray or black surface or near-surface layer that is less than 10 cm (4 inches) thick and is underlain by a layer in which organic matter has been differentially distributed within the soils by water movement. The mobilization and translocation of organic matter result in splotchy coated and uncoated soil.

**S9. Thin Dark Surface - LRR: T, U**

**A layer 5 cm (2 inches) or more thick, starting at a depth  $\leq$  15 cm (6 inches) from the soil surface, with value of 3 or less and chroma of 1 or less. At least 70 percent of the visible soil particles must be masked with organic material, viewed through a 10x or 15x hand lens. Observed without a hand lens, the particles appear to be close to 100 percent masked. This layer is underlain by a layer or layers with value of 4 or less and chroma of 1 or less to a depth of 30 cm (12 inches) or to the spodic horizon, whichever is less.**

User Notes: This indicator applies to soils with a very dark gray or black near-surface layer that is at least 5 cm (2 inches) thick and is underlain by a layer in which organic matter has been carried downward by flowing water. The mobilization and translocation of organic matter result in an even distribution of organic matter in the eluvial (E) horizon. The chroma of 1 or less is critical because it limits application of this indicator to only those soils that are depleted of iron. This indicator commonly occurs in hydric Spodosols, but a spodic horizon is not required.

**S12. Barrier Islands 1 cm Muck - MLRA: 153B**

**In the swale portion of dune-and-swale complexes of barrier islands, a layer of muck 1 cm (0.5 inch) or more thick with value of 3 or less and chroma of 2 or less and starting at a depth  $\leq$  15 cm (6 inches) from the soil surface.**

User notes: This indicator is similar to A9 but allows chroma of greater than 1, but not greater than 2. The indicator is limited to dune-and-swale complexes on barrier islands.

-----*For use in Fine texture soils*-----

**F2. Loamy Gleyed Matrix - LRR: P, T, U**

*Note: This is a stand alone D-Test indicator*

**A gleyed matrix that occupies 60 percent or more of a layer starting at a depth  $\leq$  30 cm (12 inches) from the soil surface.**

User Notes: Gley colors are not synonymous with gray colors. They are the colors on the gley color pages of the Munsell color book (X-Rite, 2009). They have hue of N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB and value of 4 or more. The gleyed matrix only has to be present at a depth  $\leq$  30 cm (12 inches) from the surface. Soils with gleyed matrices are saturated for periods of a significant duration; as a result, there is no thickness requirement for the layer.

**F3. Depleted Matrix - LRR: P, T, U**

**A layer that has a depleted matrix with 60 percent or more chroma of 2 or less and that has a minimum thickness of either:**

- a. 5 cm (2 inches) if the 5 cm starts at a depth  $\leq$  10 cm (4 inches) from the soil surface, or
- b. 15 cm (6 inches), starting at a depth  $\leq$  25 cm (10 inches) from the soil surface.

User Notes: A depleted matrix requires a value of 4 or more and chroma of 2 or less. Redox concentrations, including soft iron-manganese masses and/or pore linings, are required in soils with matrix colors of 4/1, 4/2, or 5/2. A, E, and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix; however, they are excluded from the concept of depleted matrix unless the soil has common or many distinct or prominent redox concentrations occurring as soft masses or pore linings. The low-chroma matrix must be the result of wetness and not a weathering or parent material feature.

**F6. Redox Dark Surface - LRR: P, T, U**

**A layer that is at least 10 cm (4 inches) thick, starting at a depth  $\leq$  20 cm (8 inches) from the mineral soil surface, and has:**

- a. Matrix value of 3 or less and chroma of 1 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings, or**
- b. Matrix value of 3 or less and chroma of 2 or less and 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings.**

User Notes: This is a very common indicator used to delineate wetland soils that have a dark surface layer. Redox concentrations in mineral soils with a high content of organic matter and a dark surface layer are commonly small and difficult to see. The organic matter masks some or all of the concentrations that may be present. Careful examination is required to see what are commonly brownish redox concentrations in the darkened materials. If the soil is saturated at the time of sampling, it may be necessary to let it dry at least to a moist condition for redox features to become visible. Soils that are wet because of ponding or have a shallow, perched layer of saturation may have any color below the dark surface. It is recommended that delineators evaluate the hydrologic source and examine and describe the layer below the dark colored surface layer when applying this indicator.

**F7. Depleted Dark Surface - LRR: P, T, U**

**Redox depletions with value of 5 or more and chroma of 2 or less in a layer that is at least 10 cm (4 inches) thick, starting at a depth  $\leq$  20 cm (8 inches) from the mineral soil surface, and has:**

- a. Matrix value of 3 or less and chroma of 1 or less and 10 percent or more redox depletions, or**
- b. Matrix value of 3 or less and chroma of 2 or less and 20 percent or more redox depletions.**

User Notes: Care should be taken not to mistake mixing of an E or calcic horizon into the surface layer for depletions. The “pieces” of E and calcic horizons are not redox depletions. Knowledge of local conditions is required in areas where E and/or calcic horizons may be present. In soils that are wet because of subsurface saturation, the layer directly below the dark surface layer should have a depleted or gleyed matrix. Redox depletions should have associated redox concentrations that occur as Fe pore linings or masses within the depletion(s) or surrounding the depletion(s).

**F8. Redox Depressions - LRR: P, T, U**

**In closed depressions subject to ponding, 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings in a layer that is 5 cm (2 inches) or more thick and starts at a depth  $\leq$  10 cm (4 inches) from the soil surface.**

User Notes: This indicator occurs on depressional landforms, such as vernal pools, playa lakes, rainwater basins, “Grady” ponds, and potholes. It does not occur in microdepressions (approximately 1 m) on convex or plane landscapes.

**F10. Marl - LRR: U**

**A layer of marl with value of 5 or more and chroma 2 or less starting at a depth  $\leq$  10 cm (4 inches) from the soil surface.**

User Notes: Marl is a limnic material deposited in water by precipitation of  $\text{CaCO}_3$  by algae as defined in *Soil Taxonomy* (Soil Survey Staff, 1999). It has a Munsell value of 5 or more and reacts with dilute HCl to evolve  $\text{CO}_2$ . Marl is not the carbonatic substrate material associated with limestone bedrock. Some soils have materials with all of the properties of marl, except for the required Munsell value.

These soils are hydric if the required value is present at a depth  $\leq 10$  cm (4 inches) from the soil surface. Normally, this indicator occurs at the soil surface.

**F12. Iron/Manganese Masses - LRR: P, T**

**On flood plains, a layer 10 cm (4 inches) or more thick with 40 percent or more chroma of 2 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft iron-manganese masses with diffuse boundaries. The layer starts at a depth  $\leq 20$  cm (8 inches) from the soil surface. Iron-manganese masses have value and chroma of 3 or less. Most commonly, they are black. The thickness requirement is waived if the layer is the mineral surface layer.**

User Notes: These iron-manganese masses generally are small (2 to 5 mm in size) and have value and chroma of 3 or less. They can be dominated by manganese and therefore have a color approaching black. The low matrix chroma must be the result of wetness and not be a weathering or parent material feature. Iron-manganese masses should not be confused with the larger and redder iron nodules associated with plinthite or with concretions that have sharp boundaries. This indicator occurs on flood plains along rivers, such as the Apalachicola, Congaree, Mobile, Savannah, and Tennessee Rivers.

**F13. Umbric Surface - LRR: P, T, U**

**In depressions and other concave landforms, a layer 25 cm (10 inches) or more thick, starting at a depth  $\leq 15$  cm (6 inches) from the soil surface, in which the upper 15 cm (6 inches) has value of 3 or less and chroma of 1 or less and in which the lower 10 cm (4 inches) has the same colors as those described above or any other color that has chroma of 2 or less.**

User Notes: The thickness requirements may be slightly less than those for an umbric epipedon. Microlows (approximately 1 m) are not considered to be concave landforms. Umbric surfaces in the higher landscape positions, such as side slopes dominated by Humic Dystrudepts, are excluded.

**F22. Very Shallow Dark Surface - MLRA: 138, 152A, 154**

**In depressions and flood plains subject to frequent ponding and/or flooding, one of the following must be observed:**

- a. If bedrock occurs between 15 cm (6 inches) and 25 cm (10 inches) of the soil surface, a layer at least 15 cm (6 inches) thick starting at a depth  $\leq 10$  cm (4 inches) from the soil surface with value 2.5 or less and chroma 1 or less, and the remaining soil to bedrock must have the same colors as above or any other color that has chroma 2 or less. Or,
- b. If bedrock occurs at a depth  $\leq 15$  cm (6 inches) from the soil surface, more than half of the soil thickness must have value 2.5 or less and chroma 1 or less, and the remaining soil to bedrock must have the same colors as above or any other color that has a chroma 2 or less.

---

**NRCS Hydric Soil Field Indicators  
Deepest Starting Depth Summary Table**

| Depth (in)    | Indicator                                                          |
|---------------|--------------------------------------------------------------------|
| <b>0</b>      | A2                                                                 |
| <b>&lt; 3</b> | F22(b)                                                             |
| <b>4</b>      | F3(a), F8, F10, F22(a)                                             |
| <b>6</b>      | A3, A5, A6, A7, A8, A9, A11, A12, S4, S5, S6, S7, S8, S9, S12, F13 |
| <b>8</b>      | F6, F7, F12                                                        |
| <b>10</b>     | F3(b)                                                              |
| <b>12</b>     | A4, F2                                                             |
| <b>16</b>     | A1                                                                 |

## Hydric Soil Field Indicators Simplified Checklist:

Hydric Soil Field Indicators Simplified Checklist is adapted from Field Indicators of Hydric Soils in the United States, Version 8.1 (USDA NRCS, 2017) using Florida-specific indicators per Rule 62-340.300(2)(a)1., (b)1., (c)3., and (d), F.A.C. The checklist is composed of Yes/No questions for each indicator. If any question in an indicator is answered No then the indicator is not met. If all of the questions for an indicator are answered Yes then the indicator is met.

### Data Form Guide Notes:

Mineral soil texture refers to either sandy, fine, or mucky mineral textures.

Adjacent layers within a soil profile description may be combined to meet a hydric soil field indicator's layer thickness requirements provided the adjacent layers share the required properties referred to in the indicator (*E.g.*, 2 inches of sandy mucky mineral soil and 3 inches of sand with  $\geq 70\%$  organic coating may be combined to meet S7 provided both layers have matrix values of 3 or less and chromas of 1 or less.)

-----*For use in All texture soils*-----

### A1. Histosol

*Note: This is a stand alone D-Test indicator*

- ✓ Is there a layer(s) of organic soil material (peat, mucky peat, and/or muck soil texture)
- ✓ Does the layer(s) satisfy either **Option A or B**
  - A. Layer(s) is 16 inches or more thick  
AND  
Starts  $\leq 16$  inches from the ground surface (ground surface begins at the peat, mucky peat, muck, or mineral surface)
  - B. Organic soil material layer(s) constitutes 2/3 or more of the total thickness of the soil from the ground surface to a layer dense or cemented enough to inhibit root growth (e.g. bedrock, sandstone)  
AND  
Total combined thickness of any mineral soil texture layer(s) between the ground surface and the dense/cemented layer is 4 inches or less
- ✓ Above the starting depth of this indicator, is either **Option A, B, or C** satisfied:
  - A. There are no mineral soil layers above this indicator
  - B. All mineral soil above this indicator has a dominant chroma of 2 or less
  - C. There are less than 6 inches of mineral soil material with a dominant chroma of more than 2 above this indicator
- ❖ See Appendix B for complete requirements to classify as a Histosol

### A2. Histic Epipedon

*Note: This is a stand alone D-Test indicator*

- ✓ Is there a layer(s) of organic soil material (peat, mucky peat, and/or muck soil texture)
- ✓ Did the layer(s) form near the ground surface (ground surface begins at the peat, mucky peat, muck, or mineral surface)
- ✓ Is the layer(s) 8 to 16 inches thick
- ✓ Is the layer(s) underlain by mineral soil texture with chroma of 2 or less
- ✓ Above the starting depth of this indicator, is either **Option A, B, or C** satisfied:
  - A. There are no mineral soil layers above this indicator
  - B. All mineral soil above this indicator has a dominant chroma of 2 or less
  - C. There are less than 6 inches of mineral soil material with a dominant chroma of more than 2 above this indicator
- ❖ See Appendix B for complete requirements to classify as a histic epipedon

### **A3. Black Histic**

*Note: This is a stand alone D-Test indicator*

- ✓ Is there a layer(s) of organic soil material (peat, mucky peat, and/or muck soil texture)
- ✓ Does the layer(s) have matrix hue of 10YR or yellower, value of 3 or less, and chroma of 1 or less
- ✓ Is the layer(s) 8 inches or more thick
- ✓ Does the layer(s) start  $\leq 6$  inches from the ground surface (ground surface begins at the peat, mucky peat, muck, or mineral surface)
- ✓ Is the layer(s) underlain by mineral soil texture with chroma of 2 or less

### **A4. Hydrogen Sulfide**

*Note: This is a stand alone D-Test indicator*

- ✓ Is there a hydrogen sulfide odor (rotten egg smell)
- ✓ Does the hydrogen sulfide odor start  $\leq 12$  inches from the soil surface
- ✓ Above the starting depth of this indicator, is either **Option A, B, or C** satisfied:
  - A. There are no mineral soil layers above this indicator
  - B. All mineral soil above this indicator has a dominant chroma of 2 or less
  - C. There are less than 6 inches of mineral soil material with a dominant chroma of more than 2 above this indicator

### **A5. Stratified Layers**

*Note: This is a stand alone D-Test indicator (as sediment deposition)*

- ✓ Are there several stratified layers due to the alternating deposition of organic matter and mineral soil material deposited by flowing water
- ✓ Do one or more of the stratified layers satisfy either **Option A, B, and/or C**
  - A. Layer(s) is composed of organic soil material (peat, mucky peat, and/or muck soil texture)
  - B. Layer(s) is composed of mucky mineral soil texture
  - C. Layer(s) is composed of sandy or fine soil texture
    - AND
    - Has value of 3 or less and chroma of 1 or less
    - AND
    - If layer(s) texture is sandy at least 70% of the visible sand particles are masked with organic material when viewed through a 10x or 15x hand lens
- ✓ Other than the layer(s) meeting Option A, B, and/or C, do all of the remaining stratified layers have chroma of 2 or less
- ✓ Do the stratified layers start  $\leq 6$  inches from the soil surface

### **A6. Organic Bodies**

- ✓ Is there a layer(s) with organic bodies composed of muck or mucky mineral soil texture
- ✓ Are there 2% or more organic bodies within the layer(s)
- ✓ Does the layer(s) start  $\leq 6$  inches from the soil surface

### **A7. 5 cm Mucky Mineral**

*Note: This is a stand alone D-Test indicator*

- ✓ Is there a layer(s) of mucky mineral soil texture
- ✓ Is the layer(s) 2 inches or more thick
- ✓ Does the layer(s) start  $\leq 6$  inches from the soil surface

### **A8. Muck Presence**

*Note: This is a stand alone D-Test indicator*

- ✓ Is the soil profile located within Land Resource Region U
- ✓ Is there a layer(s) of muck soil texture
- ✓ Does the layer(s) have value of 3 or less and chroma of 1 or less

- ✓ Does the layer(s) start  $\leq 6$  inches from the soil surface

#### **A9. 1 cm Muck**

*Note: This is a stand alone D-Test indicator*

- ✓ Is the soil profile located within Land Resource Region P or T
- ✓ Is there a layer(s) of muck soil texture
- ✓ Does the layer(s) have value of 3 or less and chroma of 1 or less
- ✓ Is the layer(s) 0.5 inch or more thick
- ✓ Does the layer(s) start  $\leq 6$  inches from the soil surface

#### **A11. Depleted Below Dark Surface**

- ✓ Is there a dark layer(s) that satisfies either **Option A and/or B**
  - A. Layer(s) is composed of muck, fine mucky mineral, and/or fine soil texture  
AND  
Has value of 3 or less and chroma of 2 or less
  - B. Layer(s) is composed of sandy and/or sandy mucky mineral soil texture  
AND  
Has value of 3 or less and chroma of 1 or less  
AND  
Has at least 70% of the visible sand particles masked with organic material when viewed through a 10x or 15x hand lens
- ✓ Does the dark layer(s) start  $\leq 6$  inches from the soil surface
- ✓ Does the layer(s) immediately below the dark layer(s) satisfy either **Option A and/or B**
  - A. The layer(s) has a gleyed matrix (value of 4 or more on the Gley 1 or Gley 2 page in the Munsell Soil Color Book, 2009)
  - B. The layer(s) has a depleted matrix (value of 4 or more and chroma of 2 or less, along with 2% or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings, or a reduced matrix)
- ✓ Does the underlying layer(s) with the gleyed or depleted matrix have 60% or more chroma of 2 or less
- ✓ Does the underlying layer(s) satisfy either **Option A or B**
  - A. Layer(s) is 6 inches or more thick
  - B. Layer(s) is 2 inches or more thick  
AND  
Is composed of fragmental soil material
- ✓ Does the underlying layer(s) with the gleyed or depleted matrix start  $\leq 12$  inches from the soil surface

#### **A12. Thick Dark Surface**

- ✓ Is there a dark layer(s) that has value of 2.5 or less and chroma of 1 or less
- ✓ Does the dark layer(s) satisfy either **Option A and/or B**
  - A. Layer(s) is composed of muck, fine mucky mineral, and/or fine soil texture
  - B. Layer(s) is composed of sandy and/or sandy mucky mineral soil texture  
AND  
Has at least 70% of the visible sand particles masked with organic material when viewed through a 10x or 15x hand lens
- ✓ Does the dark layer(s) start  $\leq 6$  inches from the soil surface and extend to a depth of at least 12 inches
- ✓ Is there a layer(s) below the dark layer(s) that satisfies either **Option A and/or B**
  - A. The layer(s) has a gleyed matrix (value of 4 or more on the Gley 1 or Gley 2 page in the Munsell Soil Color Book, 2009)
  - B. The layer(s) has a depleted matrix (value of 4 or more and chroma of 2 or less, along with 2% or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings, or a reduced matrix)

- ✓ Does the lower layer(s) with the gleyed or depleted matrix have 60% or more chroma of 2 or less
- ✓ Is the lower layer(s) with the gleyed or depleted matrix 6 inches or more thick
- ✓ Do all remaining layers between the aforementioned dark layer(s) and the layer(s) with the gleyed or depleted matrix have value of 3 or less and chroma of 1 or less

-----*For use in Sandy texture soils*-----

#### **S4. Sandy Gleyed Matrix**

*Note: This is a stand alone D-Test indicator*

- ✓ Is there a layer(s) of sandy soil texture in which 60% or more of the layer is a gleyed matrix (value of 4 or more on the Gley 1 or Gley 2 page in the Munsell Soil Color Book, 2009)
- ✓ Does the layer(s) start  $\leq$  6 inches from the soil surface

#### **S5. Sandy Redox**

- ✓ Is there a layer(s) of sandy and/or sandy mucky mineral soil texture with 2% or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings
- ✓ Does the matrix of the layer(s) have 60% or more chroma of 2 or less
- ✓ Is the layer(s) 4 inches or more thick
- ✓ Does the layer(s) start  $\leq$  6 inches from the soil surface

#### **S6. Stripped Matrix**

- ✓ Is there a layer(s) of sandy and/or sandy mucky mineral soil texture with two or more **faintly**<sup>1</sup> **contrasting** colors (Contrast is due to organic matter and/or iron-manganese oxides having been stripped away from the matrix and the primary base color of the soil material has been exposed)
- ✓ Are there rounded, diffuse<sup>2</sup> boundaries between the faintly contrasting colors
- ✓ Do the stripped (lighter colored) areas of the faintly contrasting colors compose 10% or more of the layer(s)'s volume
- ✓ Does the layer(s) start  $\leq$  6 inches from the soil surface

<sup>1</sup> See Table 1 (p 32) to determine if contrast is faint

<sup>2</sup> See Figure 1 (p 32) to determine if boundaries are diffuse

#### **S7. Dark Surface**

- ✓ Is there a dark layer(s) of sandy, sandy mucky mineral, and/or muck soil texture with matrix value of 3 or less and chroma of 1 or less
- ✓ Does the dark layer(s)'s matrix have at least 70% of the visible sand particles masked with organic material when viewed through a 10x or 15x hand lens
- ✓ Does the dark layer(s) satisfy either **Option A or B**
  - A. The dark layer(s) is more than 4 inches thick
  - B. The dark layer(s) is exactly 4 inches thick
- AND
- The layer directly below has chroma of 2 or less
- ✓ Does the dark layer(s) start  $\leq$  6 inches from the soil surface

#### **S8. Polyvalue Below Surface**

- ✓ Is the soil profile located within Land Resource Region T or U
- ✓ Is there a dark layer(s) of sandy, sandy mucky mineral, and/or muck soil texture with value of 3 or less and chroma of 1 or less
- ✓ Does the dark layer(s) have at least 70% of the visible sand particles masked with organic material when viewed through a 10x or 15x hand lens
- ✓ Does the dark layer(s) start  $\leq$  6 inches from the soil surface
- ✓ Does the soil volume directly below this dark layer(s) to a depth of 12 inches from the soil surface or to the spodic horizon, whichever is less, meet both **Criteria 1 and 2**
  - 1. 5% or more of the soil volume has value of 3 or less and chroma of 1 or less

AND

2. The remainder of the soil volume has value of 4 or more and chroma of 1 or less

**S9. Thin Dark Surface**

- ✓ Is the soil profile located within Land Resource Region T or U
- ✓ Is there a dark layer(s) of sandy, sandy mucky mineral, and/or muck soil texture with value of 3 or less and chroma of 1 or less
- ✓ Does the dark layer(s) have at least 70% of the visible sand particles masked with organic material when viewed through a 10x or 15x hand lens
- ✓ Is the dark layer(s) 2 inches or more thick
- ✓ Does the dark layer(s) start  $\leq$  6 inches from the soil surface
- ✓ Directly below this dark layer(s) is there a layer(s) with value of 4 or less and chroma of 1 or less
- ✓ Does the underlying layer(s) extend to a depth of 12 inches from the soil surface or to the spodic horizon, whichever is less

**S12. Barrier Islands 1 cm Muck**

- ✓ Is the soil profile located within the swale portion of dune-and-swale complexes of barrier islands in Major Land Resource Area 153B (See p 42)
- ✓ Is there a layer(s) of muck soil texture
- ✓ Does the layer(s) have value of 3 or less and chroma of 2 or less
- ✓ Is the layer(s) 0.5 inch or more thick
- ✓ Does the layer(s) start  $\leq$  6 inches from the soil surface

-----***For use in Fine texture soils***-----

**F2. Loamy Gleyed Matrix**

*Note: This is a stand alone D-Test indicator*

- ✓ Is there a layer(s) of fine soil texture in which 60% or more of the layer is a gleyed matrix (value of 4 or more on the Gley 1 or Gley 2 page in the Munsell Soil Color Book, 2009)
- ✓ Does the layer(s) start  $\leq$  12 inches from the soil surface
- ✓ Above the starting depth of this indicator, is either **Option A, B, or C** satisfied:
  - A. There are no mineral soil layers above this indicator
  - B. All mineral soil above this indicator has a dominant chroma of 2 or less
  - C. There are less than 6 inches of mineral soil material with a dominant chroma of more than 2 above this indicator

**F3. Depleted Matrix**

- ✓ Is there a layer(s) of fine soil texture with a depleted matrix (value of 4 or more and chroma of 2 or less, along with 2% or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings, or a reduced matrix)
- ✓ Does the layer(s)'s matrix have 60% or more chroma of 2 or less
- ✓ Does the layer(s) satisfy either **Option A or B**
  - A. Layer(s) is 2 inches or more thick  
AND  
Starts  $\leq$  4 inches from the soil surface
  - B. Layer(s) is 6 inches or more thick  
AND  
Starts  $\leq$  10 inches from the soil surface
- ✓ Above the starting depth of this indicator, is either **Option A, B, or C** satisfied:
  - A. There are no mineral soil layers above this indicator

- B. All mineral soil above this indicator has a dominant chroma of 2 or less
- C. There are less than 6 inches of mineral soil material with a dominant chroma of more than 2 above this indicator

**F6. Redox Dark Surface**

- ✓ Is there a layer(s) of fine and/or fine mucky mineral soil texture with distinct or prominent redox concentrations occurring as soft masses and/or pore linings
- ✓ Does the layer(s) with redox concentrations satisfy either **Option A or B**
  - A. Layer(s)'s matrix has value of 3 or less and chroma of 1 or less  
AND  
Has 2% or more redox concentrations
  - B. Layer(s)'s matrix has value of 3 or less and chroma of 2 or less  
AND  
Has 5% or more redox concentrations
- ✓ Is the layer(s) 4 inches or more thick
- ✓ Does the layer(s) start  $\leq$  8 inches from the soil surface
- ✓ Above the starting depth of this indicator, is either **Option A, B, or C** satisfied:
  - A. There are no mineral soil layers above this indicator
  - B. All mineral soil above this indicator has a dominant chroma of 2 or less
  - C. There are less than 6 inches of mineral soil material with a dominant chroma of more than 2 above this indicator

**F7. Depleted Dark Surface**

- ✓ Is there a layer(s) of fine and/or fine mucky mineral soil texture with redox depletions (lighter areas with associated redox concentrations)
- ✓ Do the redox depletions have value of 5 or more and chroma of 2 or less
- ✓ Does the layer(s) with redox depletions satisfy either **Option A and/or B**
  - A. Layer(s)'s matrix has value of 3 or less and chroma of 1 or less  
AND  
Has 10% or more distinct or prominent redox depletions
  - B. Layer(s)'s matrix has value of 3 or less and chroma of 2 or less  
AND  
Has 20% or more distinct or prominent redox depletions
- ✓ Is the layer(s) 4 inches or more thick
- ✓ Does the layer(s) start  $\leq$  8 inches from the soil surface
- ✓ Above the starting depth of this indicator, is either **Option A, B, or C** satisfied:
  - A. There are no mineral soil layers above this indicator
  - B. All mineral soil above this indicator has a dominant chroma of 2 or less
  - C. There are less than 6 inches of mineral soil material with a dominant chroma of more than 2 above this indicator

**F8. Redox Depressions**

- ✓ Is the soil profile located within a closed depression subject to ponding
- ✓ Is there a layer(s) of fine and/or fine mucky mineral soil texture with 5% or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings
- ✓ Is the layer(s) 2 inches or more thick
- ✓ Does the layer(s) start  $\leq$  4 inches from the soil surface

**F10. Marl**

- ✓ Is the soil profile located within Land Resource Region U
- ✓ Is there a layer(s) of marl material

- ✓ Does the layer(s) have value of 5 or more and chroma of 2 or less
- ✓ Does the layer(s) start  $\leq$  4 inches from the soil surface

#### **F12. Iron/Manganese Masses**

- ✓ Is the soil profile located within Land Resource Region P or T
- ✓ Is the soil profile located within a flood plain
- ✓ Is there a layer(s) of fine and/or fine mucky mineral soil texture with 2% or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings
- ✓ Do the redox concentrations occur as soft iron-manganese masses
- ✓ Do the iron-manganese masses have value and chroma of 3 or less
- ✓ Do the iron-manganese masses have diffuse<sup>3</sup> boundaries
- ✓ Does 40% or more of the layer(s) have chroma of 2 or less
- ✓ Does the layer(s) with iron-manganese masses satisfy either **Option A or B**
  - A.** Layer(s) starts at the soil surface
  - B.** Layer(s) is 4 inches or more thick

AND

Starts  $\leq$  8 inches from the soil surface

<sup>3</sup> See Figure 1 (p 32) to determine if boundaries are diffuse

#### **F13. Umbric Surface**

- ✓ Is the soil profile located within a depression or other concave landform
- ✓ Is there a layer(s) of fine, fine mucky mineral, and/or muck soil texture
- ✓ Is the layer(s) 10 inches or more thick
- ✓ Does the layer(s) satisfy both **Criteria 1 and 2**
  - 1.** The upper 6 inches of the layer(s) has value of 3 or less and chroma of 1 or less

AND

  - 2.** The lower 4 inches of the layer(s) has chroma of 2 or less
- ✓ Does the layer(s) start  $\leq$  6 inches from the soil surface

#### **F22. Very Shallow Dark Surface**

- ✓ Is the soil profile located within Major Land Resource Area 138, 152A, or 154 (See p 42)
  - ✓ Is the soil profile located within a depression or flood plain subject to frequent ponding and/or flooding
  - ✓ Is there a dark layer(s) of fine, fine mucky mineral, and/or muck soil texture with value of 2.5 or less and chroma of 1 or less
  - ✓ Does bedrock occur  $\leq$  10 inches from the soil surface
  - ✓ Does the soil profile satisfy either **Option A or B**
    - A.** The bedrock occurs between 6 and 10 inches from the soil surface

AND

The dark layer(s) is 6 inches or more thick

AND

Starts  $\leq$  4 inches from the soil surface
  - B.** The bedrock occurs  $\leq$  6 inches from the soil surface
- AND
- The dark layer(s) constitutes more than half of the soil thickness
- ✓ Does all remaining soil between the dark layer(s) and the bedrock have chroma of 2 or less

### **Glossary from NRCS Field Indicators of Hydric Soils in the United States** **Version 8.1, 2017**

As defined in this Glossary, terms marked with an asterisk (\*) have definitions that are slightly different from the definitions in the referenced materials. The definitions in the Glossary are intended to assist users of this document and are not intended to add to or replace definitions in the referenced materials.

**Data Form Guide Note: Definitions expressed in Chapter 62-340, F.A.C. supersede all other definitions contained within this guide when applying the rule.**

**A horizon.** A mineral soil horizon that formed at the surface or below an O horizon where organic material is accumulating. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**Accreting areas.** Landscape positions in which soil material accumulates through deposition from higher elevations or upstream positions more rapidly than the rate at which soil material is being lost through erosion.

**Anaerobic.** A condition in which molecular oxygen is virtually absent from the soil.

**Anaerobiosis.** Microbiological activity under anaerobic conditions.

**Aquic conditions.** Conditions in the soil represented by depth of saturation, occurrence of reduction, and redoximorphic features. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**\*Artificial drainage.** The use of human efforts and devices to remove free water from the soil surface or from the soil profile. The hydrology may also be modified by levees and dams, which keep water from entering a site.

**CaCO<sub>3</sub> equivalent.** The acid neutralizing capacity of a soil expressed as a weight percentage of CaCO<sub>3</sub> (molecular weight of CaCO<sub>3</sub> equals 100).

**Calcic horizon.** An illuvial horizon in which carbonates have accumulated to a significant extent. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**Calcium carbonate.** Calcium carbonate has the chemical formula CaCO<sub>3</sub>. It effervesces when treated with cold hydrochloric acid.

**Closed depressions.** Low-lying areas that are surrounded by higher ground and have no natural outlet for surface drainage.

**COE.** U.S. Army Corps of Engineers.

**Common.** When referring to redox concentrations, redox depletions, or both, “common” represents 2 to 20 percent of the observed surface.

**Concave landscapes.** Landscapes in which the surface curves downward.

**\*Depleted matrix.** For loamy and clayey material (and sandy material in areas of indicators A11 and A12), a depleted matrix refers to the volume of a soil horizon or subhorizon in which the processes of reduction and translocation have removed or transformed iron, creating colors of low chroma and high value. A, E, and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix; however, they are excluded from the concept of depleted matrix unless the soil has common or many distinct or prominent redox concentrations occurring as soft masses or pore linings. In some areas the depleted matrix may change color upon exposure to air (see Reduced matrix); this phenomenon is included in the concept of depleted matrix. The following combinations of value and chroma identify a depleted matrix:

1. Matrix value of 5 or more and chroma of 1 or less with or without redox concentrations occurring as soft masses and/or pore linings; or
2. Matrix value of 6 or more and chroma of 2 or less with or without redox concentrations occurring as soft masses and/or pore linings; or
3. Matrix value of 4 or 5 and chroma of 2 and 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings; or
4. Matrix value of 4 and chroma of 1 and 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings.

**Diffuse boundary.** (Figure 1 p.32) Used to describe redoximorphic features that grade gradually from one color to another. The color grade is commonly more than 2 mm wide. “Clear” is used to describe boundary color gradations intermediate between sharp and diffuse.

**Distinct.**<sup>1</sup> (Table 1 p.32) Readily seen but contrasting only moderately with the color to which compared. The contrast is distinct if:

1. Delta hue<sup>2</sup> = 0, then a) Delta value  $\leq 2$  and delta chroma  $> 1$  to  $< 4$ , or  
b) Delta value  $> 2$  to  $< 4$  and delta chroma  $< 4$ .
2. Delta hue = 1, then a) Delta value  $\leq 1$  and delta chroma  $> 1$  to  $< 3$ , or  
b) Delta value  $> 1$  to  $< 3$  and delta chroma  $< 3$ .
3. Delta hue = 2, then a) Delta value = 0 and delta chroma  $> 0$  to  $< 2$ , or  
b) Delta value  $> 0$  to  $< 2$  and delta chroma  $< 2$ .

<sup>1</sup> Regardless of the magnitude of hue difference, where both colors have value  $\leq 3$  and chroma  $\leq 2$ , the contrast is faint.

<sup>2</sup> Data Form Guide Note: A delta hue of 1 is equal to 2.5 units (Figure 2 p.32), as defined in the *Soil Survey Manual* (Soil Survey Staff, 1993)

**E horizon.** A mineral horizon in which the dominant process is loss of silicate clay, iron, and/or aluminum, leaving a concentration of sand and silt particles. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**EPA.** U.S. Environmental Protection Agency.

**Epipedon.** A horizon that has developed at the soil surface. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**Faint.** (Table 1 p.32) Evident only on close examination. The contrast is faint if:

1. Delta hue = 0, then delta value  $\leq 2$  and delta chroma  $\leq 1$ , or
2. Delta hue = 1, then delta value  $\leq 1$  and delta chroma  $\leq 1$ , or
3. Delta hue = 2, then delta value = 0 and delta chroma = 0, or

Any delta hue if both colors have value  $\leq 3$  and chroma  $\leq 2$ .

**Fe-Mn concretions.** Firm to extremely firm, irregularly shaped bodies with sharp to diffuse boundaries. When broken in half, concretions have concentric layers. See Vepraskas (1994) for a complete discussion.

**Fe-Mn nodules.** Firm to extremely firm, irregularly shaped bodies with sharp to diffuse boundaries.

When broken in half, nodules do not have visibly organized internal structure. See Vepraskas (1994) for a complete discussion.

**Few.** When referring to redox concentrations, depletions, or both, “few” represents less than 2 percent of the observed surface.

**Fibric.** See Peat.

**Flood plain.** The nearly level plain that borders a stream and is subject to inundation under flood-stage conditions unless protected artificially. It is usually a constructional landform built of sediment deposited during overflow and lateral migration of the stream.

**Fragmental soil material.** Soil material that consists of 90 percent or more rock fragments. Less than 10 percent of the soil consists of particles 2 mm or smaller.

**Frequently flooded or ponded.** A frequency class in which flooding or ponding is likely to occur often under usual weather conditions (a chance of more than 50 percent in any year, or more than 50 times in 100 years).

**FWS.** U.S. Department of the Interior, Fish and Wildlife Service.

**\*g.** A horizon suffix indicating that the horizon is gray because of wetness but not necessarily that it is gleyed. All gleyed matrices (defined below) should have the suffix “g”; however, not all horizons with the “g” suffix are gleyed. For example, a horizon with the color 10YR 6/2 that is at least seasonally wet, with or without other redoximorphic features, should have the “g” suffix.

**Glaucinitic.** Refers to a mineral aggregate that contains a micaceous mineral resulting in a characteristic green color, e.g., glauconitic shale or clay.

**\*Gleyed matrix.** Soils with a gleyed matrix have the following combinations of hue, value, and chroma (the soils are not glauconitic):

1. 10Y, 5GY, 10GY, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value of 4 or more and chroma of 1; or

2. 5G with value of 4 or more and chroma of 1 or 2; or

3. N with value of 4 or more

In some places the gleyed matrix may change color upon exposure to air. (See Reduced matrix). This phenomenon is included in the concept of gleyed matrix.

**\*Hemic.** See Mucky peat.

**Histels.** Organic soils that overlie permafrost and show evidence of cryoturbation. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**Histic epipedon.** A thick (20- to 60-cm, or 8- to 24- inch) organic soil horizon that is saturated with water at some period of the year (unless the soil is artificially drained) and that is at or near the surface of a mineral soil.

**Histosols.** Organic soils that have organic soil materials in more than half of the upper 80 cm (32 inches) or that have organic materials of any thickness if they overlie rock or fragmental materials that have interstices filled with organic soil materials. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**Horizon.** A layer, approximately parallel to the surface of the soil, distinguishable from adjacent layers by a distinctive set of properties produced by soil-forming processes. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**Hydric soil definition (1994).** (See also Ch 62-340, *F.A.C. definition*) A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

**Hydrogen sulfide odor.** The odor of H<sub>2</sub>S. It is similar to the smell of rotten eggs.

**Hydromorphic features.** Features in the soil caused or formed by water.

**Layer(s).** A horizon, subhorizon, or combination of contiguous horizons or subhorizons sharing at least one property referred to in the indicators.

**Lithologic discontinuity.** Occurs in a soil that has developed in more than one type of parent material. Commonly determined by a significant change in particle-size distribution, mineralogy, etc. that indicates a difference in material from which the horizons formed.

**LRR.** Land resource region. LRRs are geographic areas characterized by a particular pattern of soils, climate, water resources, and land use. Each LRR is assigned a different letter of the alphabet (A-Z). LRRs are defined in U.S. Department of Agriculture Handbook 296 (USDA, NRCS, 2006b).

**Many.** When referring to redox concentrations, depletions, or both, “many” represents more than 20 percent of the observed surface.

**Marl.** An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions; formed primarily under freshwater lacustrine conditions. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**\*Masked.** Through redoximorphic processes, the color of soil particles is hidden by organic material, silicate clay, iron, aluminum, or some combination of these.

**Matrix.** The dominant soil volume that is continuous in appearance. When three colors occur, such as when a matrix, depletions, and concentrations are present, the matrix may represent less than 50 percent of the total soil volume.

**MLRA.** Major land resource areas. MLRAs are geographically associated divisions of land resource regions. MLRAs are defined in U.S. Department of Agriculture Handbook 296 (USDA, NRCS, 2006b).

**Mollic epipedon.** A mineral surface horizon that is relatively thick, dark colored, and humus rich and has high base saturation. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**Mollisols.** Mineral soils that have a mollic epipedon. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**\*Muck.** Sapric organic soil material in which virtually all of the organic material is so decomposed that identification of plant forms is not possible. Bulk density is normally 0.2 or more. Muck has less than one-sixth fibers after rubbing, and its sodium pyrophosphate solution extract color has lower value and chroma than 5/1, 6/2, and 7/3.

**\*Mucky modified mineral soil material.** (Figure 7) A USDA soil texture modifier, e.g., mucky sand. Mucky modified mineral soil material that has 0 percent clay has between 5 and 12 percent organic carbon. Mucky modified mineral soil material that has 60 percent clay has between 12 and 18 percent organic carbon. Soils with an intermediate amount of clay have intermediate amounts of organic carbon. Where the organic component is peat (fibric material) or mucky peat (hemic material), mucky mineral soil material does not occur.

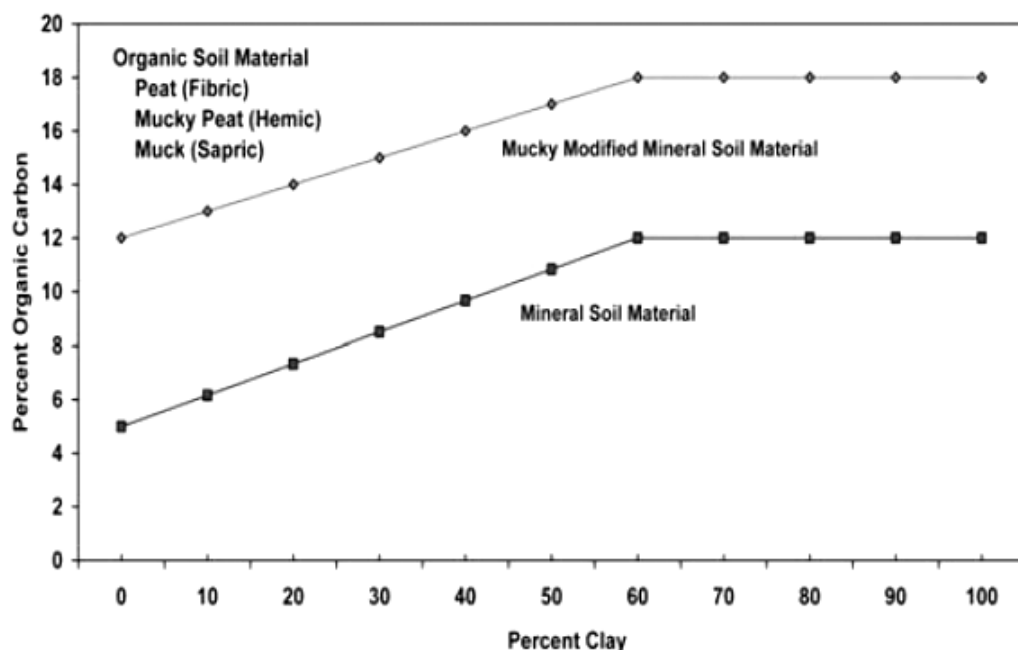


**Figure 7:** Percent organic carbon required for organic soil material, mucky modified mineral soil material, and mineral soil material as it is related to content of clay.

**\*Mucky peat.** Hemic organic material, which is characterized by decomposition that is intermediate between that of peat (fibric material) and that of muck (sapric material). Bulk density is normally between 0.1 and 0.2 g/cm<sup>3</sup>. Mucky peat does not meet the fiber content (after rubbing) or sodium pyrophosphate solution extract color requirements for either peat (fibric) or muck (sapric) soil material.

**Nodules.** See Fe-Mn nodules.

**NRCS.** USDA, Natural Resources Conservation Service (formerly Soil Conservation Service).

**NTCHS.** National Technical Committee for Hydric Soils.

**Organic matter.** Plant and animal residue in the soil in various stages of decomposition.

**Organic soil material.** (Figure 7) Soil material that is saturated with water for long periods or artificially drained and, excluding live roots, has 18 percent or more organic carbon with 60 percent or more clay or 12 percent or more organic carbon with 0 percent clay. Soils with an intermediate amount of clay have an intermediate amount of organic carbon. If the soil is never saturated for more than a few days, it contains 20 percent or more organic carbon. Organic soil material includes muck, mucky peat, and peat.

**Data Form Guide Note: Generally, organic soil material is 2 cm or smaller and decomposing.**

**\*Peat.** Fibric organic soil material. The plant forms can be identified in virtually all of the organic material. Bulk density is normally <0.1. Peat has three-fourths or more fibers after rubbing, or it has two-fifths or more fibers after rubbing and has sodium pyrophosphate solution extract color of 7/1, 7/2, 8/2, or 8/3.

**Ped.** A unit of soil structure such as a block, column, granule, plate, or prism, formed by natural processes (in contrast with a clod, which is formed artificially).

**Plinthite.** The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete discussion.

**Ponding.** Standing water in a closed depression that is removed only by percolation, evaporation, or transpiration. The ponding lasts for more than 7 days.

**Pore linings.** Zones of accumulation that may be either coatings on a ped or pore surface or impregnations of the matrix adjacent to the pore or ped. See Vepraskas (1994) for a complete discussion.

**Prominent.** (Table 1 *p.*32) Contrasts strongly in color. Color contrasts more contrasting than faint and distinct are prominent.

**Red parent material.** The parent material with a natural inherent reddish color attributable to the presence of iron oxides, typically hematite (Elless and Rabenhorst, 1994; Elless et al., 1996), occurring as coatings on and occluded within mineral grains. Soils that formed in red parent material have conditions that greatly retard the development and extent of the redoximorphic features that normally occur under prolonged aquic conditions. They typically have a Color Change Propensity Index (CCPI) of <30 (Rabenhorst and Parikh, 2000). Most commonly, the material consists of dark red, consolidated Mesozoic or Paleozoic sedimentary rocks, such as shale, siltstone, and sandstone, or alluvial materials derived from such rocks. Assistance from a local soil scientist may be needed to determine where red parent material occurs.

**Redox concentrations.** Bodies of apparent accumulation of Fe-Mn oxides. Redox concentrations include soft masses, pore linings, nodules, and concretions. For the purposes of the indicators, nodules and concretions are excluded from the concept of redox concentrations unless otherwise specified by specific indicators. See Vepraskas (1994) for a complete discussion.

**Redox depletions.** Bodies of low chroma (2 or less) having value of 4 or more where Fe- Mn oxides have been stripped or where both Fe-Mn oxides and clay have been stripped. Redox depletions contrast distinctly or prominently with the matrix. See Vepraskas (1994) for a complete discussion.

**Redoximorphic features.** Features formed by the processes of reduction, translocation, and/or oxidation of Fe and Mn oxides; formerly called mottles and low-chroma colors. See Vepraskas (1994) for a complete discussion.

**Reduced matrix.** A soil matrix that has low chroma and high value, but in which the color changes in hue or chroma when the soil is exposed to air. See Vepraskas (1994) for a complete discussion.

**\*Reduction.** For the purpose of the indicators, reduction occurs when the redox potential (Eh) is below the ferric-ferrous iron threshold as adjusted for pH. In hydric soils, this is the point when the transformation of ferric iron (Fe<sup>3+</sup>) to ferrous iron (Fe<sup>2+</sup>) occurs.

**Relict features.** Soil morphological features that reflect past hydrologic conditions of saturation and anaerobiosis. See Vepraskas (1994) for a complete discussion.

**\*Sapric.** See Muck.

**Saturation.** (See also Ch 62-340, *F.A.C. definition*) Wetness characterized by zero or positive pressure of the soil water. Almost all of the soil pores are filled with water.

**Sharp boundary.** Used to describe redoximorphic features that grade sharply from one color to another. The color grade is commonly less than 0.1 mm wide.

**Soft masses.** Noncemented redox concentrations, frequently within the soil matrix, that are of various shapes and cannot be removed as discrete units.

**Soil texture.** The relative proportions, by weight, of sand, silt, and clay particles in the soil material less than 2 mm in size.

**Spodic horizon.** A mineral soil horizon that is characterized by the illuvial accumulation of amorphous materials consisting of aluminum and organic carbon with or without iron. The spodic horizon has a minimum thickness, a minimum quantity of oxalate extractable carbon plus aluminum, and/or specific color requirements.

**Stream Terrace.** Flat-topped landforms in a stream valley that flank and are parallel to the stream channel, originally formed by a previous stream level, and representing the abandoned flood plain, stream bed, or valley floor produced during a past state of fluvial erosion or deposition (i.e., currently very rarely or never flooded; inactive cut and fill and/or scour and fill processes). Stream terraces may occur singularly or as a series. Erosional surfaces cut into bedrock and thinly mantled with stream deposits (alluvium) are called "strath terraces." Remnants of constructional valley floors thickly mantled with alluvium are called alluvial terraces.

**Umbric epipedon.** A thick, dark mineral surface horizon with base saturation of less than 50 percent.

See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**Vertisol.** A mineral soil with 30 percent or more clay in all layers. These soils expand and shrink, depending on moisture content, and have slickensides or wedge-shaped pedis. See *Soil Taxonomy* (Soil Survey Staff, 1999) for a complete definition.

**\*Wetland.** (See also Ch 62-340, F.A.C. definition) An area that has hydrophytic vegetation, hydric soils, and wetland hydrology, as per the “National Food Security Act Manual” and the 1987 *Corps of Engineers Wetlands Delineation Manual* (United States Army Corps of Engineers, 1987).

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## Data Form Guide Notes:

### Surface Water Definitions

*Definition from §373.019(19) Florida Statutes*

“**Surface water**” means water upon the surface of the earth, whether contained in bounds created naturally or artificially or diffused. Water from natural springs shall be classified as surface water when it exits from the spring onto the earth’s surface.

*Definition from §373.019(14) Florida Statutes*

“**Other watercourse**” means any canal, ditch, or other artificial watercourse in which water usually flows in a defined bed or channel. It is not essential that the flowing be uniform or uninterrupted.

*Definition from §62.340.200(15) Florida Administrative Code*

“**Seasonal High Water**” means the elevation to which the ground and surface water can be expected to rise due to a normal wet season.

*From The Florida Wetlands Delineation Manual pg. 37*

**Ordinary high water** is that point on the slope or bank where the surface water from the water body ceases to exert a dominant influence on the character of the surrounding vegetation and soils. The OHWL frequently encompasses areas dominated by non-listed vegetation and non-hydric soils. When the OHWL is not at a wetland edge, the general view of the area may present an “upland” appearance.

*Definition from §403.803(14) Florida Statutes*

“**Swale**” means a manmade trench which:

- (a) Has a top width-to-depth ratio of the cross-section equal to or greater than 6:1, or side slopes equal to or greater than 3 feet horizontal to 1 foot vertical;
- (b) Contains contiguous areas of standing or flowing water only following a rainfall event;
- (c) Is planted with or has stabilized vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake; and
- (d) Is designed to take into account the soil erodibility, soil percolation, slope, slope length, and drainage area so as to prevent erosion and reduce pollutant concentration of any discharge.

## Appendix B: Histosol and Histic Epipedon Definition

From *Keys to Soil Taxonomy* (Soil Survey Staff, 2014)

### Histosols

1. Do not have andic soil properties in 60 percent or more of the thickness between the soil surface and either a depth of 60 cm or a densic, lithic, or paralithic contact or duripan if shallower; *and*

2. Have organic soil materials that meet *one or more* of the following:
  - a. Overlie cindery, fragmental, or pumiceous materials and/or fill their interstices *and* directly below these materials, have a densic, lithic, or paralithic contact; *or*
  - b. When added with the underlying cindery, fragmental, or pumiceous materials, total 40 cm or more between the soil surface and a depth of 50 cm; *or*
  - c. Constitute two-thirds or more of the total thickness of the soil to a densic, lithic, or paralithic contact *and* have no mineral horizons or have mineral horizons with a total thickness of 10 cm or less; *or*
  - d. Are saturated with water for 30 days or more per year in normal years (or are artificially drained), have an upper boundary within 40 cm of the soil surface, and have a total thickness of *either*:
    - 1) 60 cm or more if three-fourths or more of their volume consists of moss fibers or if their bulk density, moist, is less than 0.1 g/cm<sup>3</sup>; *or*
    - 2) 40 cm or more if they consist either of Sapric or hemic materials, or of fibric materials with less than three-fourths (by volume) moss fibers and a bulk density, moist, of 0.1 g/cm<sup>3</sup> or more.

**Folists** (excluded from meeting indicator A1): Histosols that are saturated with water for less than 30 cumulative days during normal years (and are not artificially drained).

### **Histic Epipedon**

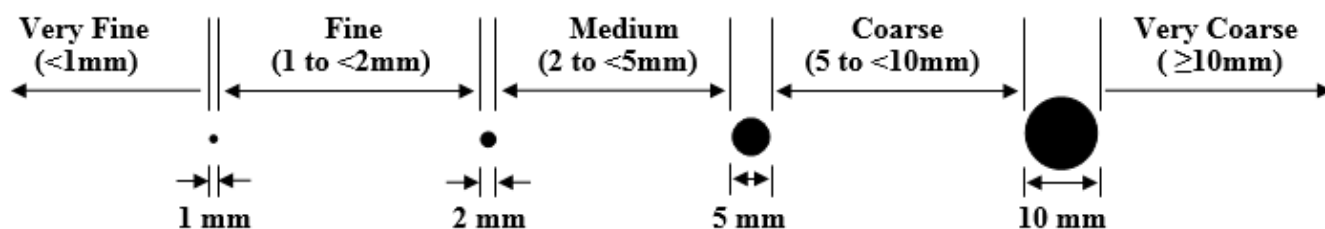
The histic epipedon is a layer (one or more horizons) that is characterized by saturation (for 30 days or more, cumulative) and reduction for some time during normal years (or is artificially drained) and *either*:

1. Consists of organic soil material that:
  - a. Is 20 to 60 cm thick and either contains 75 percent or more (by volume) *Sphagnum* fibers or has a bulk density, moist, of less than 0.1; *or*
  - b. Is 20 to 40 cm thick; *or*
2. Is an Ap horizon that, when mixed to a depth of 25 cm, has an organic-carbon content (by weight) of:
  - a. 16 percent or more if the mineral fraction contains 60 percent or more clay; *or*
  - b. 8 percent or more if the mineral fraction contains no clay; *or*
  - c. 8 + (clay percentage divided by 7.5) percent or more if the mineral fraction contains less than 60 percent clay.

Most histic epipedons consist of organic soil material. Item 2 provides for a histic epipedon that is an Ap horizon consisting of mineral soil material. A Histic epipedon consisting of mineral soil material can also be part of a mollic or umbric epipedon.

### **Root Size Estimation Chart**

Adapted from *Field Book for Describing Sampling Soils* version 3.0 (NRCS 2012)



### **Quantity Classes for Redox Features or Roots**

| Quantity Class                        | Few           | Common             | Many             |
|---------------------------------------|---------------|--------------------|------------------|
| <b>Redox: % of Observed Surface</b>   | Less than 2%  | 2% to 20%          | Greater than 20% |
| <b>Roots: Average Count per Area*</b> | < 1 per area* | 1 to < 5 per area* | ≥ 5 per area*    |

\*Root assessment area = 1x1cm for <2mm roots, 10x10cm for 2 to <10mm, 100x100cm for ≥10mm

### **NRCS National Technical Committee for Hydric Soils**

Hydric Soils Technical Notes contain National Technical Committee for Hydric Soils (NTCHS) updates, insights, and clarifications of the publication "Field Indicators of Hydric Soils in the United States" (USDA, NRCS, 1996 and 1998).

## Hydric Soils Technical Note 4: Indicator Insights for Hydric Soil Identification

**Question:** I have a soil with layers that meet the color and redoximorphic requirements of several indicators; however, they do not meet any of the thickness requirements. What guidance is there regarding combining layers to meet a hydric soil indicator?

**Answer:** If layers/indicators are combined, the combination needs to meet the most stringent depth/thickness requirements of the combined indicators.

**Example** (The following table and guidance were adapted by FDEP staff to summarize Technical Note 4 and do not contain the exact text from this Note):

| Layer | Depth  | Matrix Color | Matrix Texture | Notes (RC = redox concentrations)     |
|-------|--------|--------------|----------------|---------------------------------------|
| 1     | 0-6    | 10YR 2/1     | fine           | None                                  |
| 2     | 6-8    | 10YR 3/1     | fine           | RC: 10YR 6/8, 5%, diffuse boundaries  |
| 3     | 8-12   | 10YR 5/2     | fine           | RC: 10YR 6/8, 10%, diffuse boundaries |
| 4     | 12-20+ | 10YR 6/3     | fine           | RC: 10YR 6/8, 15%, diffuse boundaries |

In this example, Layer 2 meets the requirements (except thickness) of indicator F6 – Redox Dark Surface. Layer 3 meets the requirements (except thickness) of indicator F3 – Depleted Matrix. Examining the indicator language, F6 requires a layer 4 inches thick starting within 8 inches; F3 requires a layer 6 inches thick starting within 10 inches. In this case, the soil has F6 starting within 8 inches (at 6) and has F3 starting within 10 inches (at 8); the combined thickness is 6 inches. Therefore, this soil meets the combined color, depth, and thickness requirements and should be documented as meeting hydric soil indicator(s) F6 and F3 (combined).

## Hydric Soils Technical Note 13: Altered Hydric Soils

The following tables were created by FDEP staff to summarize Technical Note 13 and do not contain the exact text from this Note:

| Altered Hydric Soil Type | What was modified? | Modified by what?   | Modified how?                      | Soil status* | Example                                 |
|--------------------------|--------------------|---------------------|------------------------------------|--------------|-----------------------------------------|
| Artificial               | Hydrology or Soil  | Human activities    | Wetter or lower surface elevation  | Hydric       | Excavation/irrigation/water impoundment |
| Drained/protected        | Hydrology          | Human activities    | Drier or barriers against flooding | Hydric       | Ditches/roads/dams/pumps/levees         |
| Historic/ buried         | Soil               | Human activities    | Soil placed on ground surface      | Not hydric   | Fill/erosional depositions              |
| Relict                   | Hydrology          | Geologic activities | Hydrology gone by natural means    | Not hydric   | Stream downcutting/seismic activity     |

\*See Appendix B for NRCS Hydric Soil Criteria

Soils that are no longer hydric may still exhibit redoximorphic features (called relict features), but these can be differentiated from those in contemporary (currently) hydric soils by the following characteristics:

| Feature             | Boundary | Nodule and Concretion Surfaces                 | Macropore Associated Depletions   | Pore Linings                       | Value and Chroma                  |
|---------------------|----------|------------------------------------------------|-----------------------------------|------------------------------------|-----------------------------------|
| <b>Contemporary</b> | Diffuse  | Irregular, or Smooth with red to yellow corona | Not overlain by iron rich coating | Continuous around live roots       | Value $\geq 4$<br>Chroma $\geq 4$ |
| <b>Relict</b>       | Sharp    | Smooth                                         | Overlain by iron rich coating     | Broken and unrelated to live roots | Value $< 4$<br>Chroma $< 4$       |

## Appendix C: Hydric Soils Criteria and Technical Standard

Note: Hydric soil criteria, standards, and definitions used by the NRCS may differ from and do not supersede the criteria, standards, and definitions outlined in Chapter 62-340, F.A.C. to identify and delineate wetlands in Florida.

Soils are considered hydric by the NRCS if they:

1. Have a hydric soil indicator, or
2. Meet hydric soils list criteria 3 or 4, or
3. By data meet the Hydric Soil Technical Standard (HSTS).

### **Hydric Soils List Criteria** (Updated by NTCHS February 2012)

1. All Histels except Folistels and Histosols except Folists; or
2. Map unit components in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, or Andic, Cumulic, Pachic, or Vitrandic subgroups that:
  - a. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
  - b. Show evidence that the soil meets the definition of a hydric soil;
3. Map unit components that are frequently ponded for long duration or very long duration during the growing season that:
  - a. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
  - b. Show evidence that the soil meets the definition of a hydric soil;
4. Map unit components that are frequently flooded for long duration or very long duration during the growing season that:
  - a. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
  - b. Show evidence that the soils meet the definition of a hydric soil.

### **Glossary of Terms Used in Hydric Soils List Criteria**

*Flooded* means a condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow from the high tides, or any combination of sources.

*Frequently flooded, ponded, saturated:* a frequency class in which flooding, ponding, or saturation is likely to occur often under usual weather conditions (more than 50 percent chance in any year, or more than 50 times in 100 years).

*Ponded* means a condition in which water stands in a closed depression. The water is removed only by percolation, evaporation, or transpiration.

*Long duration* means a duration class in which inundation for a single event ranges from 7 days to 1 month.

*Map unit components* means the collection of soils and miscellaneous areas found within a map unit.

*Very long duration* means a duration class in which inundation for a single event is greater than 1 month.

### **Hydric Soil Technical Standard (HSTS)** (Updated by NTCHS December 2015)

For a soil to be considered hydric by the Natural Resources Conservation Service (NRCS), Anaerobic Conditions and Saturated Conditions must exist for at least 14 consecutive days.

1. Anaerobic Conditions (as documented by a, b, or c below)
  - a. Indicator of Reduction in Soils (IRIS) tubes
  - b. Oxidation-reduction potential (Eh) measurements using platinum electrodes
  - c. Alpha-alpha-dipyridyl dye
2. Saturated Conditions
  - Confirmed by piezometer data.
  - NTCHS recommends that the piezometer data be verified by open well data.

(Onsite precipitation data are needed to confirm normal rainfall conditions)

#### **Data Form Guide Note:**

#### **SUPPLEMENTAL SOIL DATA**

#### **HORIZON CRITERIA – MASTER HORIZON DESIGNATIONS**

**O** Organic soil materials (not limnic)

**A** Mineral; organic matter (humus) accumulation, loss of Fe, Al, clay

**E** Mineral; loss of Fe, Al, clay, or organic matter  
**B** Subsurface accumulation of clay, Fe, Al, Si, humus, CaCO<sub>3</sub>, CaSO<sub>4</sub>; or loss of CaCO<sub>3</sub>; or accumulation of sesquioxides; or subsurface soil structure  
**C** Little or no pedogenic alteration, unconsolidated earthy material, soft bedrock  
**L** Limnic soil materials  
**R** Bedrock, Strongly Cemented to Indurated

#### **HORIZON CRITERIA – SUFFIX DESIGNATIONS**

|                                                            |                                                                  |
|------------------------------------------------------------|------------------------------------------------------------------|
| <b>a</b> Highly decomposed organic matter                  | <b>n</b> Pedogenic, exchangeable sodium accumulation             |
| <b>b</b> Buried genetic horizon (not used with C horizons) | <b>o</b> Residual sesquioxide accumulation (pedogenic)           |
| <b>c</b> Concretions or nodules                            | <b>p</b> Plow layer or other artificial disturbance              |
| <b>e</b> Moderately decomposed organic matter              | <b>r</b> Weathered or soft bedrock                               |
| <b>g</b> Strong gley                                       | <b>s</b> Illuvial sesquioxide accumulation                       |
| <b>h</b> Illuvial organic matter accumulation              | <b>t</b> Illuvial accumulation of silicate clay                  |
| <b>i</b> Slightly decomposed organic matter                | <b>v</b> Plinthite                                               |
| <b>k</b> Pedogenic carbonate accumulation                  | <b>w</b> Weak color or structure within B (used only with B)     |
| <b>m</b> Strong cementation (pedogenic, massive)           | <b>z</b> Pedogenic accumulation of salt more soluble than gypsum |
| <b>ma</b> Marl (Used only with L)                          |                                                                  |

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#### **FLORIDA NATURAL COMMUNITIES OF FLORIDA**

##### **HARDWOOD FORESTED**

##### **UPLANDS**

Slope Forest  
 Upland Hardwood Forest  
 Mesic Hammock  
 Rockland Hammock  
 Xeric Hammock

##### **HIGH PINE AND SCRUB**

Upland Mixed Woodland  
 Upland Pine  
 Sandhill

##### **SCRUB**

##### **PINE FLATWOODS AND DRY PRAIRIE**

Wet Flatwoods  
 Mesic Flatwoods  
 Scrubby Flatwoods  
 Pine Rockland  
 Dry Prairie

##### **COASTAL UPLANDS**

Beach Dune  
 Coastal Berm  
 Coastal Grassland  
 Coastal Strand  
 Maritime Hammock  
 Shell Mound

##### **SINKHOLES AND OUTCROP**

##### **COMMUNITIES**

Upland Glade  
 Sinkhole

##### **LIMESTONE OUTCROP**

Keys Cactus Barren

##### **FRESHWATER NON-FORESTED WETLANDS**

##### **PRAIRIES AND BOGS**

Seepage Slope  
 Wet Prairie

Marl Prairie

Shrub Bog

##### **MARSHES**

Depression Marsh  
 Basin Marsh  
 Coastal Interdunal Swale  
 Floodplain Marsh  
 Slough Marsh  
 Glades Marsh  
 Slough

##### **FRESHWATER FORESTED WETLANDS**

##### **CYPRESS/TUPELO**

Dome Swamp  
 Basin Swamp  
 Strand Swamp  
 Floodplain Swamp

##### **HARDWOOD**

Baygall  
 Hydric Hammock  
 Bottomland Forest

##### **ALLUVIAL FOREST**

##### **MARINE AND ESTUARINE VEGETATED WETLANDS**

Salt Marsh  
 Mangrove Swamp  
 Keys Tidal Rock Barren

##### **LACUSTRINE**

Clastic Upland Lake  
 Coastal Dune Lake  
 Coastal Rockland Lake  
 Flatwoods/Prairie Lake and Marsh Lake

River Floodplain Lake and Swamp Lake

Sandhill Upland Lake

Sinkhole Lake

##### **RIVERINE**

Alluvial Stream  
 Blackwater Stream  
 Seepage Stream  
 Spring-run Stream

#### **Appendix A2: subsection 62-340.450(1), (2), (3), F.A.C. Vegetative Index Plant List by Common Name**

**Common Name / Botanical Name / Wetland Status**

|                                      |                                    |      |
|--------------------------------------|------------------------------------|------|
| <b>acacia, ear-leaved</b>            | <i>Acacia auriculiformis</i>       | FAC  |
| <b>alder, hazel</b>                  | <i>Alnus serrulata</i>             | OBL  |
| <b>algal bulrush</b>                 | <i>Websteria confervoides</i>      | OBL  |
| <b>allamanda, wild</b>               | <i>Urechites lutea</i>             | FACW |
| <b>alligator flag</b>                | <i>Thalia geniculata</i>           | OBL  |
| <b>alligator-weed</b>                | <i>Alternanthera philoxeroides</i> | OBL  |
| <b>alligator-weed, sessile</b>       | <i>Alternanthera sessilis</i>      | OBL  |
| <b>amaranth, Florida</b>             | <i>Amaranthus floridanus</i>       | OBL  |
| <b>amaranth, southern</b>            | <i>Amaranthus australis</i>        | OBL  |
| <b>amaranth, tidemarch</b>           | <i>Amaranthus cannabinus</i>       | OBL  |
| <b>anise, Florida</b>                | <i>Illicium floridanum</i>         | OBL  |
| <b>anise, star</b>                   | <i>Illicium parviflorum</i>        | FACW |
| <b>arrowhead</b>                     | <i>Sagittaria</i> spp.             | OBL  |
| <b>arrow-wood</b>                    | <i>Viburnum dentatum</i>           | FACW |
| <b>arum</b>                          | <i>Peltandra</i> spp.              | OBL  |
| <b>ash</b>                           | <i>Fraxinus</i> spp.               | OBL  |
| <b>ash, white</b>                    | <i>Fraxinus americana</i>          | U    |
| <b>aster, bog</b>                    | <i>Aster spinulosus</i>            | FACW |
| <b>aster, bushy</b>                  | <i>Aster dumosus</i>               | FAC  |
| <b>aster, calico</b>                 | <i>Aster lateriflorus</i>          | FACW |
| <b>aster, climbing</b>               | <i>Aster carolinianus</i>          | OBL  |
| <b>aster, coyote-thistle</b>         | <i>Aster eryngiifolius</i>         | FACW |
| <b>aster, Elliott's</b>              | <i>Aster elliotii</i>              | OBL  |
| <b>aster, flat-top white</b>         | <i>Aster umbellatus</i>            | FAC  |
| <b>aster, saltmarsh</b>              | <i>Aster subulatus</i>             | OBL  |
| <b>aster, saltmarsh</b>              | <i>Aster tenuifolius</i>           | OBL  |
| <b>aster, savannah</b>               | <i>Aster chapmanii</i>             | FACW |
| <b>aster, small white</b>            | <i>Aster vimineus</i>              | FACW |
| <b>Australian pine</b>               | <i>Casuarina</i> spp.              | FAC  |
| <b>axilflower</b>                    | <i>Mecardonia</i> spp.             | FACW |
| <b>azalea, swamp</b>                 | <i>Rhododendron viscosum</i>       | FACW |
| <b>baby tears</b>                    | <i>Micranthemum</i> spp.           | OBL  |
| <b>baby-blue-eyes, small-flower</b>  | <i>Nemophila aphylla</i>           | FACW |
| <b>balsam-scale, Pan-American</b>    | <i>Elionurus tripsacoides</i>      | FACW |
| <b>bantam-buttons</b>                | <i>Syngonanthus flavidulus</i>     | FACW |
| <b>barbara's-buttons, grass-leaf</b> | <i>Marshallia graminifolia</i>     | FACW |
| <b>barbara's-buttons, slim-leaf</b>  | <i>Marshallia tenuifolia</i>       | FACW |
| <b>basswood, American</b>            | <i>Tilia americana</i>             | FACW |
| <b>bay, swamp</b>                    | <i>Persea palustris</i>            | OBL  |
| <b>bayberry, evergreen</b>           | <i>Myrica heterophylla</i>         | FACW |
| <b>bayberry, odorless</b>            | <i>Myrica inodora</i>              | FACW |
| <b>bayberry, southern</b>            | <i>Myrica cerifera</i>             | FAC  |
| <b>bay-cedar</b>                     | <i>Suriana maritima</i>            | FAC  |
| <b>beach alternanthera</b>           | <i>Alternanthera maritima</i>      | FACW |
| <b>beach creeper</b>                 | <i>Ernodea littoralis</i>          | FAC  |
| <b>bedstraw, stiff marsh</b>         | <i>Galium tinctorium</i>           | FACW |
| <b>beefwood</b>                      | <i>Guapira discolor</i>            | FAC  |
| <b>beggar-ticks</b>                  | <i>Bidens</i> spp.                 | OBL  |

This index is for reference purposes only. Scientific names shall be used in all applications of Ch. 62-340, F.A.C. This index contains all plant species in subsection 62-340.450(1), (2), (3), F.A.C., listed alphabetically by their most widely used common names. In this index, plant species within a genus that has a consistent common name are listed by the common name of their genus, followed by the descriptor. For example, *Quercus nigra* is listed as oak, water. For families or larger taxonomic divisions in which all members are collectively referred to by a consistent common name, such as grasses, sedges, palms, orchids, and ferns, all members are listed under that group name, with the last member alphabetically being underlined to denote the end of the group. Plant species may appear multiple times within this list, as many have multiple common names. However, this list is not exhaustive.

**beggar-ticks, white** *Bidens pilosa* (B. alba) FAC  
**bellflower, American** *Campanula americana* FAC  
**bellflower, Florida** *Campanula floridana* OBL  
**bellwort, Florida** *Uvularia floridana* FACW  
**bindweed, dwarf** *Evolvulus convolvuloides* FACW  
**bindweed, silky** *Evolvulus sericeus* FACW  
**birch, river** *Betula nigra* OBL  
**birds-in-a-nest** *Macbridea* spp. FACW  
**bitter-cress** *Cardamine bulbosa* OBL  
**black senna** *Seymeria cassioides* FAC  
**blackbead** *Pithecellobium keyensis* FAC  
**blackbead, catclaw** *Pithecellobium unguis-cati* FAC  
**blackberry** *Rubus* spp. FAC  
**blackgum** *Nyssa sylvatica* var. *biflora* OBL  
**bladdernut, American** *Staphylea trifolia* FACW  
**bladderpod** *Sesbania* spp. FAC  
**bladderwort** *Utricularia* spp. OBL  
**blazing star** *Liatris gracilis* FAC  
**blolly** *Guapira discolor* FAC  
**blueberry, Elliott** *Vaccinium elliotii* FAC  
**blueberry, highbush** *Vaccinium corymbosum* FACW  
**blue-eye-grass** *Sisyrinchium capillare* FACW  
**blue-eye-grass, eastern** *Sisyrinchium atlanticum* FACW  
**blue-eye-grass, Michaux's** *Sisyrinchium mucronatum* FACW  
**bluestar, eastern** *Amsonia tabernaemontana* FACW  
**bluethread** *Burmannia* spp. OBL  
**bluets, water** *Oldenlandia* spp. FACW  
**bog hemp** *Boehmeria cylindrica* OBL  
**bogbutton, Engler's** *Lachnocaulon engleri* OBL  
**bogbutton, pineland** *Lachnocaulon digynum* OBL  
**bogbutton, Small's** *Lachnocaulon minus* OBL  
**bogbutton, southern** *Lachnocaulon beyrichianum* FACW  
**bogbutton, white-head** *Lachnocaulon anceps* FACW  
**boneset** *Eupatorium perfoliatum* FACW  
**box briar** *Randia aculeata* FAC  
**box-elder** *Acer negundo* FACW  
**bractspike, yellow** *Yeatesia viridiflora* FACW  
**Brazilian pepper-tree** *Schinus terebinthifolius* FAC  
**broomspurge, spreading** *Euphorbia humistrata* FACW  
**buckwheat-tree** *Cliftonia monophylla* FACW  
**bugleweed** *Lycopus* spp. OBL  
**bully, buckthorn** *Bumelia lycioides* FAC  
**bully, Florida** *Bumelia reclinata* FAC  
**bumelia, buckthorn** *Bumelia lycioides* FAC  
**bumelia, coastal** *Bumelia celastrina* FAC  
**bumelia, smooth** *Bumelia reclinata* FAC  
**bunchflower, Virginia** *Melanthium virginicum* OBL  
**burhead** *Echinodorus* spp. OBL  
**burnweed, American** *Erechtites hieraciifolia* FAC  
**burreed** *Sparganium americanum* OBL  
**bushy goldenrod** *Euthamia* spp. FAC

**butter-cup** *Ranunculus* spp. FACW  
**butterweed** *Senecio glabellus* OBL  
**butterwort** *Pinguicula* spp. OBL  
**buttonbush** *Cephalanthus occidentalis* OBL  
**button-plant, smooth** *Spermacoce glabra* FACW  
**button-weed** *Diodia virginiana* FACW  
**buttonwood** *Conocarpus erectus* FACW  
**cajeput** *Melaleuca quinquenervia* FAC  
**camphor-weed** *Pluchea* spp. FACW  
**canker-berry** *Solanum bahamense* FACW  
**canna** *Canna* spp. OBL  
**canna, common** *Canna x generalis* FAC  
**caperonia** *Caperonia* spp. FACW  
**caper-tree** *Capparis flexuosa* FACW  
**cardinal flower** *Lobelia cardinalis* OBL  
**carrotwood** *Cupaniopsis anacardioides* FAC  
**catsclaw** *Pithecellobium unguis-cati* FAC  
**cattail** *Typha* spp. OBL  
**cayaponia, five-lobe** *Cayaponia quinqueloba* FAC  
**celestial lily** *Nemastylis floridana* FACW  
**chaff-flower, beach** *Alternanthera maritima* FACW  
**chaffhead, bristle-leaf** *Carphephorus pseudoliatris* FACW  
**chaffhead, hairy** *Carphephorus paniculatus* FAC  
**chaffhead, pineland** *Carphephorus carnosus* FACW  
**chamber-bitter** *Phyllanthus urinaria* FAC  
**chicken-spike** *Sphenoclea zeylandica* FACW  
**chickweed, West Indian** *Drymaria cordata* FAC  
**chocolate-weed** *Melochia corchorifolia* FAC  
**chokeberry, red** *Aronia arbutifolia* FACW  
**Christmas berry** *Lycium carolinianum* OBL  
**clearweed** *Pilea* spp. FACW  
**climbing-dogbane** *Trachelospermum difforme* FACW  
**clubmoss** *Lycopodium* spp. FACW  
**cocoplum** *Chrysobalanus icaco* FACW  
**coinwort** *Centella asiatica* FACW  
**colic-root** *Aletris* spp. FAC  
**colicwood** *Myrsine guianensis* FAC  
**coneflower, cut-leaf** *Rudbeckia laciniata* FACW  
**coneflower, grass-leaf** *Rudbeckia graminifolia* FACW  
**coneflower, Mohr's** *Rudbeckia mohrii* OBL  
**coneflower, orange** *Rudbeckia fulgida* FACW  
**coneflower, Shiny** *Rudbeckia nitida* FACW  
**coralberry** *Ardisia* spp. FAC  
**corkwood** *Leitneria floridana* OBL  
**corkwood** *Stillingia aquatica* OBL  
**cottonwood, eastern** *Populus deltoides* FACW  
**cottonwood, swamp** *Populus heterophylla* OBL  
**coughbush** *Ernodea littoralis* FAC  
**cowbane** *Oxypolis* spp. OBL  
**cow-lily, yellow** *Nuphar luteum* OBL  
**coyote-thistle, Baldwin's** *Eryngium baldwinii* FAC  
**coyote-thistle, blue-flower** *Eryngium integrifolium* FACW

coyote-thistle, creeping *Eryngium prostratum* FACW  
 creeping ox-eye *Wedelia trilobata* FAC  
 croton, Elliott's *Croton elliotii* FACW  
 crow poison *Zigadenus densus* FACW  
 crownbeard, Chapman's *Verbesina chapmanii* FACW  
 crownbeard, diverse-leaf *Verbesina heterophylla* FACW  
 crownbeard, white *Verbesina virginica* FAC  
 culver's-root *Veronicastrum virginicum* FACW  
 cupseed *Calyccarpum lyonii* FACW  
 cypress, bald *Taxodium distichum* OBL  
 cypress, pond *Taxodium ascendens* OBL  
 dangleberry *Gaylussacia frondosa* FAC  
 danglepod *Sesbania* spp. FAC  
 darling-plum *Reynosa septentrionalis* FAC  
 dasheen *Colocasia esculenta* OBL  
 dayflower *Commelina* spp. FACW  
 dayflower, sandhill *Commelina erecta* U  
 deathcamas, Atlantic *Zigadenus glaberrimus* FACW  
 deer-tongue *Carphephorus paniculatus* FAC  
 desert-thorn, Carolina *Lycium carolinianum* OBL  
 devil's claws *Pisonia rotundata* FAC  
 dewberry *Rubus* spp. FAC  
 dewflower *Murdannia* spp. FAC  
 ditch stonecrop *Penthorum sedoides* OBL  
 dock *Rumex* spp. FACW  
 dog-fennel *Eupatorium capillifolium* FAC  
 dog-hobble *Leucothoe* spp. FACW  
 dogwood, silky *Cornus amomum* OBL  
 dogwood, swamp *Cornus foemina* FACW  
 dollarweed *Hydrocotyle* spp. FACW  
 doll's daisy *Boltonia* spp. FACW  
 dragon-head, false *Physostegia virginiana* FACW  
 dragon-head, Godfrey's *Physostegia godfreyi* OBL  
 dragon-head, purple *Physostegia purpurea* FACW  
 dragon-head, slender-leaf *Physostegia leptophylla* OBL  
 drymary *Drymaria cordata* FAC  
 duck potato *Sagittaria* spp. OBL  
 dwarf morning-glory, bindweed *Evolvulus convolvuloides* FACW  
 dwarf morning-glory, silver *Evolvulus sericeus* FACW  
 elder, American *Sambucus canadensis* FAC  
 elderberry *Sambucus canadensis* FAC  
 elephant's ear *Colocasia esculenta* OBL  
 elephant's ear *Xanthosoma sagittifolium* FACW  
 elm *Ulmus* spp. FACW  
 elm, slippery *Ulmus rubra* U  
 false buttonweed, smooth *Spermacoce glabra* FACW  
 false daisy *Eclipta alba* FACW  
 false indigo, bastard *Amorpha fruticosa* FACW  
 false-asphodel, coastal *Tofieldia racemosa* OBL  
 false-croton *Caperonia* spp. FACW  
 falsefennel *Eupatorium leptophyllum* OBL  
 false-fiddle-leaf *Hydrolea* spp. OBL

**false-foxglove** *Agalinis pinetorum* FACW  
**false-foxglove, flax-leaf** *Agalinis linifolia* OBL  
**false-foxglove, large purple** *Agalinis purpurea* FACW  
**false-foxglove, saltmarsh** *Agalinis maritima* OBL  
**false-foxglove, scale-leaf** *Agalinis aphylla* FACW  
**false-nettle** *Boehmeria cylindrica* OBL  
**false-pimpernel** *Lindernia* spp. FACW  
**false-pimpernel, Malayan** *Lindernia crustacea* FAC  
**false-willow, broom-bush** *Baccharis dioica* FAC  
**false-willow, eastern** *Baccharis halimifolia* FAC  
**false-willow, saltwater** *Baccharis angustifolia* OBL  
**feather-bells, eastern** *Stenanthium gramineum* FACW

## **FERNS**

**bead fern** *Hypolepis repens* FACW  
**Boston fern** *Nephrolepis exaltata* FAC  
**brake, giant** *Pteris tripartita* FACW  
**bramble fern, creeping** *Hypolepis repens* FACW  
**chainfern, netted** *Woodwardia aereolata* OBL  
**chainfern, Virginia** *Woodwardia virginica* FACW  
**cinnamon fern** *Osmunda cinnamomea* FACW  
**comb fern, brown-hair** *Ctenitis submarginalis* FACW  
**lady fern, subarctic** *Athyrium filix-femina* FACW  
**leather fern** *Acrostichum* spp. OBL  
**maiden fern** *Thelypteris* spp. FACW  
**marsh fern** *Thelypteris* spp. FACW  
**royal fern** *Osmunda regalis* OBL  
**sensitive fern** *Onoclea sensibilis* FACW  
**shield fern** *Thelypteris* spp. FACW  
**swamp fern** *Blechnum serrulatum* FACW  
**sword fern** *Nephrolepis* spp. FAC  
**wood fern, southern** *Dryopteris ludoviciana* FACW

**fetter-bush** *Lyonia lucida* FACW  
**fetter-bush, climbing** *Pieris phillyreifolia* FACW  
**fever-tree** *Pinckneya bracteata* OBL  
**fig, Florida strangler** *Ficus aurea* FAC  
**fire flag** *Thalia geniculata* OBL  
**fireweed** *Erechtites hieraciifolia* FAC  
**flameflower** *Macranthera flammea* OBL  
**flatop goldenrod** *Euthamia* spp. FAC  
**flax, Carter's** *Linum carteri* FACW  
**flax, Florida yellow** *Linum floridanum* FAC  
**flax, ridged yellow** *Linum striatum* FACW  
**flax, stiff yellow** *Linum medium* FAC  
**flax, West's** *Linum westii* OBL  
**fleabane, early whitetop** *Erigeron vernus* FACW  
**fleabane, oakleaf** *Erigeron quercifolius* FAC  
**floating hearts** *Nymphoides* spp. OBL  
**frogbit** *Limnobia spongia* OBL  
**frog-fruit** *Phyla* spp. FAC  
**frostweed** *Verbesina virginica* FAC  
**gayfeather, garber's** *Liatris garberi* FACW  
**gayfeather, slender** *Liatris gracilis* FAC

**gayfeather, spiked** *Liatris spicata* FAC  
**gentian** *Gentiana* spp. FACW  
**germander, American** *Teucrium canadense* FACW  
**ginger** *Hedychium coronarium* FACW  
**gingerlily, white** *Hedychium coronarium* FACW  
**glasswort** *Salicornia* spp. OBL  
**goat-weed** *Scoparia dulcis* FAC  
**golden club** *Orontium aquaticum* OBL  
**golden creeper** *Ernodea littoralis* FAC  
**golden-crest** *Lophiola americana* FACW  
**golden-rod, Elliott's** *Solidago elliottii* OBL  
**golden-rod, leavenworth's** *Solidago leavenworthii* FACW  
**golden-rod, marsh** *Solidago fistulosa* FACW  
**golden-rod, rough-leaf** *Solidago patula* OBL  
**golden-rod, seaside** *Solidago sempervirens* FACW  
**golden-rod, willow-leaf** *Solidago stricta* FACW  
**golden-rod, wrinkled** *Solidago rugosa* FAC  
**grass-of-parnassus** *Parnassia* spp. OBL  
**grasswort** *Lilaeopsis* spp. OBL

### **GRASSES**

**arrowfeather grass** *Aristida purpurascens* FACW  
**arrow-grass** *Triglochin striatam* OBL  
**barnyardgrass** *Echinochloa* spp. FACW  
**basketgrass** *Oplismenus setarius* FAC  
**blue maidencane** *Amphicarpum muhlenbergianum* FACW  
**bluestem** *Schizachyrium* spp. FAC  
**bluestem, big** *Andropogon gerardii* FAC  
**bluestem, broom-sedge** *Andropogon virginicus* FAC  
**bluestem, bushy** *Andropogon glomeratus* FACW  
**bluestem, Mohr's** *Andropogon liebmanii* var. *pungensis* (*A. mohrii*) FACW  
**bluestem, savannah** *Andropogon arctatus* FAC  
**bluestem, short-spike** *Andropogon brachystachys* FAC  
**bluestem, slim** *Andropogon perangustatus* FAC  
**bristlegrass** *Setaria geniculata* FAC  
**broom-sedge** *Andropogon virginicus* FAC  
**Burma reed** *Neyraudia reynaudiana* FAC  
**carpet grass** *Axonopus* spp. FAC  
**cockspur grass** *Echinochloa* spp. FACW  
**common reed** *Phragmites australis* OBL  
**cordgrass, big** *Spartina cynosuroides* OBL  
**cordgrass, gulf** *Spartina spartinae* OBL  
**cordgrass, saltmarsh** *Spartina alterniflora* OBL  
**cordgrass, saltmeadow** *Spartina patens* FACW  
**cordgrass, sand** *Spartina bakeri* FACW  
**crabgrass, dwarf** *Digitaria serotina* FAC  
**crabgrass, twospike** *Digitaria pauciflora* FACW  
**cupgrass** *Eriochloa* spp. FACW  
**cupscale, American** *Sacciolepis striata* OBL  
**cupscale, Indian** *Sacciolepis indica* FAC  
**cutgrass** *Leersia* spp. OBL  
**cut-throat grass** *Panicum abscissum* FACW  
**dallisgrass** *Paspalum dilatatum* FAC

dropseed, Florida *Sporobolus floridanus* FACW  
 dropseed, seashore *Sporobolus virginicus* OBL  
 elephantgrass *Pennisetum purpureum* FAC  
 everglades grass *Digitaria pauciflora* FACW  
 fingergrass, pinewoods *Eustachys petraea* FAC  
 fingergrass, saltmarsh *Eustachys glauca* FACW  
 fluffgrass, pineland *Tridens ambiguus* FACW  
 foxtail, giant *Setaria magna* OBL  
 foxtail, knotroot *Setaria geniculata* FAC  
 foxtail, tufted *Alopecurus carolinianus* FAC  
 gamagrass, eastern *Tripsacum dactyloides* FAC  
 giant cane *Arundinaria gigantea* FACW  
 giant cutgrass *Zizaniopsis miliacea* OBL  
 giant reed *Arundo donax* FAC  
 hilograss *Paspalum conjugatum* FAC  
 indian rice *Zizania aquatica* OBL  
 jointgrass; jointtailgrass *Manisuris* spp. FACW  
 jointgrass, pitted *Manisuris cylindrica* FAC  
 jungle-rice *Echinochloa* spp. FACW  
 keygrass *Monanthochloe littoralis* OBL  
 kissimmeegrass *Paspalidium geminatum* OBL  
 knotgrass *Paspalum distichum* OBL  
 lovegrass *Eragrostis* spp. FAC  
 maidencane *Panicum hemitomon* OBL  
 mannagrass, fowl *Glyceria striata* OBL  
 muhly grass, hairawn *Muhlenbergia capillaris* OBL  
 muhly grass, nimblewill *Muhlenbergia schreberi* FACW  
 muhly, cutover *Muhlenbergia expansa* FAC  
 napiergrass *Pennisetum purpureum* FAC  
 needlegrass, Florida *Stipa avenacioides* FACW  
 panic grass, cypress *Panicum ensifolium* OBL  
 panicum, beaked *Panicum anceps* FAC  
 panicum, bluejoint *Panicum tenerum* OBL  
 panicum, Eaton's *Panicum spretum* FACW  
 panicum, fall *Panicum dichotomiflorum* FACW  
 panicum, fringed *Panicum strigosum* FAC  
 panicum, Ft Myers *Panicum pinetorum* FACW  
 panicum, gaping *Panicum hians* FAC  
 panicum, red-top *Panicum rigidulum* FACW  
 panicum, savannah *Panicum gymnocarpon* OBL  
 panicum, shining *Panicum dichotomum* FACW  
 panicum, tall thin *Panicum longifolium* OBL  
 panicum, variable *Panicum commutatum* FAC  
 panicum, velvet *Panicum scoparium* FACW  
 panicum, warty *Panicum verrucosum* FACW  
 panicum, white-edge *Panicum tenue* FAC  
 panicum, woolly *Panicum scabriusculum* OBL  
 paragrass *Brachiaria purpurascens* FACW  
 paspalum, brook *Paspalum acuminatum* FACW  
 paspalum, brown-seed *Paspalum plicatulum* FAC  
 paspalum, bull *Paspalum boscianum* FACW  
 paspalum, early *Paspalum praecox* OBL

paspalum, field *Paspalum laeve* FACW  
 paspalum, Florida *Paspalum floridanum* FACW  
 paspalum, gulf *Paspalum monostachyum* OBL  
 paspalum, hairy-seed *Paspalum pubiflorum* FACW  
 paspalum, joint *Paspalum distichum* OBL  
 paspalum, mudbank *Paspalum dissectum* OBL  
 paspalum, Panama *Paspalum fimbriatum* FAC  
 paspalum, sour *Paspalum conjugatum* FAC  
 paspalum, thin *Paspalum setaceum* FAC  
 paspalum, water *Paspalum repens* OBL  
 plumegrass, narrow *Erianthus strictus* OBL  
 plumegrass, short-beard *Erianthus brevibarbus* FACW  
 plumegrass, sugarcane *Erianthus giganteus* OBL  
 rabbit-foot grass *Polypogon* spp. FAC  
 redtop *Agrostis stolonifera* FACW  
 reed grass, Curtiss' *Calamovilfa curtissii* FACW  
 reimargrass, Florida *Reimarochloa oligostachya* FACW  
 rice, cultivated *Oryza sativa* FAC  
 saltgrass, seashore *Distichlis spicata* OBL  
 sandgrass, Curtiss' *Calamovilfa curtissii* FACW  
 silk reed *Neyraudia reynaudiana* FAC  
 silky-scale, purple *Anthaenantia rufa* FACW  
 spanglegrass *Chasmanthium* spp. FACW  
 spanglegrass, indian *Chasmanthium latifolium* FAC  
 spanglegrass, long-leaf *Chasmanthium sessiliflorum* FAC  
 switchcane *Arundinaria gigantea* FACW  
 switchgrass *Panicum virgatum* FACW  
 three-awn grass, bottlebrush *Aristida spiciformis* FAC  
 three-awn grass, long-leaf *Aristida affinis* OBL  
 three-awn grass, pineland *Aristida stricta* FAC  
 three-awn grass, rhizomatous *Aristida rhizomophora* FAC  
 three-awn grass, wand-like *Aristida purpurascens* FACW  
 toothache grass *Ctenium* spp. FACW  
 torpedograss *Panicum repens* FACW  
 tridens, long-spike *Tridens strictus* FACW  
 tridens, savannah *Tridens ambiguus* FACW  
 trompetilla *Hymenachne amplexicaulis* OBL  
 vaseygrass *Paspalum urvillei* FAC  
 watergrass *Hydrochloa caroliniensis* OBL  
 West Indian marsh grass *Hymenachne amplexicaulis* OBL  
 wildrice, annual *Zizania aquatica* OBL  
 wildrice, southern *Zizaniopsis miliacea* OBL  
 wiregrass *Aristida stricta* FAC  
 witchgrass, cypress *Panicum ensifolium* OBL  
 witchgrass, erect-leaf *Panicum erectifolium* OBL  
 witchgrass, roughhair *Panicum strigosum* FAC  
 witchgrass, shining *Panicum dichotomum* FACW  
 witchgrass, variable *Panicum commutatum* FAC  
 witchgrass, velvet *Panicum scoparium* FACW  
 witchgrass, woolly *Panicum scabriusculum* OBL  
 woodoats *Chasmanthium* spp. FACW  
 woodoats, indian *Chasmanthium latifolium* FAC

**woodoats, long-leaf** *Chasmanthium sessiliflorum* FAC  
**woodsgrass** *Oplismenus setarius* FAC  
**green-dragon** *Arisaema* spp. FACW  
**green-haw** *Crataegus viridis* FACW  
**gregory wood** *Bucida buceras* FAC  
**groundsel tree** *Baccharis glomeruliflora* FAC  
**guava, strawberry** *Psidium cattleianum* FAC  
**hackberry** *Celtis laevigata* FACW  
**hardscale, one flower** *Sclerolepis uniflora* FACW  
**Harper's beauty** *Harperocallis flava* FACW  
**hartwrightia, Florida** *Hartwrightia floridana* FACW  
**hatpin** *Eriocaulon* spp. OBL  
**hatpins, yellow** *Syngonanthus flavidulus* FACW  
**haw, green** *Crataegus viridis* FACW  
**haw, may** *Crataegus aestivalis* OBL  
**haw, parsley** *Crataegus marshallii* FACW  
**hazel-alder** *Alnus serrulata* OBL  
**hedgelyssop** *Gratiola* spp. FACW  
**hedgelyssop, rough** *Gratiola hispida* FAC  
**hedgenettle** *Stachys lythroides* OBL  
**heliotrope, four-spike** *Heliotropium procumbens* FACW  
**heliotrope, pineland** *Heliotropium polyphyllum* FAC  
**heliotrope, seaside** *Heliotropium curassavicum* FAC  
**hickory, water** *Carya aquatica* OBL  
**hobble-bush** *Agarista populifolia* FACW  
**holly, American** *Ilex opaca* var. *opaca* FAC  
**holly, bay-gall** *Ilex coriacea* FACW  
**holly, dahoon** *Ilex cassine* OBL  
**holly, deciduous** *Ilex decidua* FACW  
**holly, myrtle** *Ilex myrtifolia* OBL  
**holly, sarvis** *Ilex amelanchar* OBL  
**holly, yaupon** *Ilex vomitoria* FAC  
**honeycomb-head, one-flower** *Balduina uniflora* FACW  
**honeycomb-head, purple** *Balduina atropurpurea* FACW  
**honey-locust** *Gleditsia triacanthos* FACW  
**hornbeam, American** *Carpinus caroliniana* FACW  
**hornpod** *Mitreola* spp. FACW  
**horse-purslane** *Trianthema portulacastrum* FACW  
**horsetail** *Equisetum hyemale* FACW  
**huckleberry, dwarf** *Gaylussacia dumosa* FAC  
**hummingbird-flower** *Macranthera flammea* OBL  
**hygrophila** *Hygrophila* spp. OBL  
**hyssop, hispid** *Gratiola hispida* FAC  
**indian-plantain, egg-leaf** *Arnoglossum ovatum* FACW  
**indian-plantain, Georgia** *Arnoglossum sulcatum* OBL  
**indian-plantain, sweet-scent** *Cacalia suaveolens* FACW  
**indian-plantain, variable-leaf** *Arnoglossum diversifolium* FACW  
**indigoberry, white** *Randia aculeata* FAC  
**indigo-bush** *Amorpha fruticosa* FACW  
**iris** *Iris* spp. OBL  
**iris, dwarf** *Iris verna* U  
**ironweed** *Vernonia* spp. FACW

**ironweed, narrow-leaf** *Vernonia angustifolia* U  
**ironwood** *Carpinus caroliniana* FACW  
**ixia, Bartram's** *Sphenostigma coelestinum* FACW  
**ixia, fall-flowering** *Nemastylis floridana* FACW  
**jack-in-the-pulpit** *Arisaema* spp. FACW  
**Java plum** *Syzygium* spp. FAC  
**jessamine, day** *Cestrum diurnum* FAC  
**jewel weed** *Impatiens capensis* OBL  
**joe-pye-weed** *Eupatoriadelphus fistulosus* FACW  
**Joewood** *Jacquinia keyensis* FAC  
**joint-vetch, India** *Aeschynomene indica* FACW  
**joint-vetch, meadow** *Aeschynomene pratensis* OBL  
**joyweed, seaside** *Alternanthera maritima* FACW  
**joyweed, sessile** *Alternanthera sessilis* OBL  
**joyweed, smooth** *Alternanthera paronychioides* FAC  
**jumpseed** *Polygonum virginianum* FACW  
**juniperleaf** *Polypremum procumbens* FAC  
**justiceweed** *Eupatorium leucolepis* FACW  
**keygrass** *Monanthochloe littoralis* OBL  
**lakecress** *Armoracia aquatica* OBL  
**large gallberry** *Ilex coriacea* FACW  
**latherleaf** *Colubrina asiatica* FAC  
**leaf-flower, Carolina** *Phyllanthus caroliniensis* FACW  
**leaf-flower, Florida** *Phyllanthus liebmannianus* FACW  
**leaf-flower, water** *Phyllanthus urinaria* FAC  
**lily, atamasco** *Zephyranthes atamasco* FACW  
**lily, panhandle** *Lilium iridollae* OBL  
**lily, southern red** *Lilium catesbaei* FAC  
**lizard's tail** *Saururus cernuus* OBL  
**lobelia** *Lobelia* spp. FACW  
**lobelia, Florida** *Lobelia floridana* OBL  
**loblolly-bay** *Gordonia lasianthus* FACW  
**locust-berry** *Byrsonima lucida* FAC  
**loosestrife** *Lysimachia* spp. OBL  
**loosestrife, marsh** *Lythrum* spp. OBL  
**lotus, American** *Nelumbo* spp. OBL  
**magnolia, sweetbay** *Magnolia virginiana* var. *australis* OBL  
**Malabar plum** *Syzygium* spp. FAC  
**maleberry** *Lyonia ligustrina* FAC  
**mallow, coastal** *Kosteletzkya pentasperma* FAC  
**mallow, mangrove** *Pavonia spicata* FACW  
**mallow, seashore** *Kosteletzkya virginica* OBL  
**mangrove, black** *Avicennia germinans* OBL  
**mangrove, red** *Rhizophora mangle* OBL  
**mangrove, white** *Laguncularia racemosa* OBL  
**maple, red** *Acer rubrum* FACW  
**maple, silver** *Acer saccharinum* OBL  
**marlberry** *Ardisia* spp. FAC  
**marsh elder** *Iva frutescens* OBL  
**marsh elder, little** *Iva microcephala* FACW  
**marsh loosestrife** *Lythrum* spp. OBL  
**marsh St. John's-wort** *Triadenum* spp. OBL

**marsh-gentian** *Eustoma exaltatum* FACW  
**marshpennywort** *Hydrocotyle* spp. FACW  
**marshweed** *Limnophila* spp. OBL  
**mayhaw** *Crataegus aestivalis* OBL  
**mayten, Florida** *Maytenus phyllanthoides* FAC  
**meadow-beauty** *Rhexia* spp. FACW  
**meadow-beauty, panhandle** *Rhexia salicifolia* OBL  
**meadow-beauty, white** *Rhexia parviflora* OBL  
**meadow-rue** *Thalictrum* spp. FACW  
**melonleaf, five-lobe** *Cayaponia quinqueloba* FAC  
**mermaid-weed** *Proserpinaca* spp. OBL  
**milkweed, aquatic** *Asclepias perennis* OBL  
**milkweed, fen-flower** *Asclepias lanceolata* OBL  
**milkweed, large-flower** *Asclepias connivens* FACW  
**milkweed, long-leaf** *Asclepias longifolia* FACW  
**milkweed, red** *Asclepias rubra* OBL  
**milkweed, savannah** *Asclepias pedicellata* FACW  
**milkweed, southern** *Asclepias viridula* FACW  
**milkweed, swamp** *Asclepias incarnata* OBL  
**milkwort** *Polygala* spp. FACW  
**milkwort, racemed** *Polygala polygama* U  
**milkwort, sandhill** *Polygala leptostachys* U  
**milkwort, scrub** *Polygala lewtonii* U  
**milkwort, tall** *Polygala cymosa* OBL  
**milkwort, whorled** *Polygala verticillata* U  
**mille graines** *Oldenlandia* spp. FACW  
**mimosa, black** *Mimosa pigra* FAC  
**mistflower** *Conoclinium coelestinum* FAC  
**miterwort** *Mitreola* spp. FACW  
**mock bishop-weed** *Ptilimnium capillaceum* FACW  
**monkey-flower** *Mimulus alatus* OBL  
**mountain-laurel** *Kalmia latifolia* FACW  
**mountain-mint, coastal-plain** *Pycnanthemum nudum* FACW  
**mouse-tail, tiny** *Myosurus minimus* FAC  
**mudflower** *Micranthemum* spp. OBL  
**mud-plantain, kidney-leaf** *Heteranthera reniformis* OBL  
**mudwort, wild** *Dicliptera brachiata* FACW  
**mulberry, red** *Morus rubra* FAC  
**musclewood** *Carpinus caroliniana* FACW  
**musky mint** *Hyptis alata* FACW  
**myrsine, guiana** *Myrsine guianensis* FAC  
**nakedwood, Asian** *Colubrina asiatica* FAC  
**necklacepod, yellow** *Sophora tomentosa* FACW  
**nettletree** *Trema* spp. FAC  
**neverwet** *Orontium aquaticum* OBL  
**nightshade, Bahama** *Solanum bahamense* FACW  
**nightshade, shrub** *Solanum erianthum* FACW  
**nodding nixie** *Apteria aphylla* FACW  
**oak, cherry-bark** *Quercus pagoda* FACW  
**oak, laurel** *Quercus laurifolia* FACW  
**oak, overcup** *Quercus lyrata* OBL  
**oak, swamp chestnut** *Quercus michauxii* FACW

**oak, water** *Quercus nigra* FACW  
**oak, willow** *Quercus phellos* FACW  
**obedient plant** *Physostegia virginiana* FACW  
**ORCHIDS**  
**adder's-mouth, Florida** *Malaxis spicata* OBL  
**fringed orchid** *Platanthera* spp. OBL  
**grass-pinks** *Calopogon* spp. FACW  
**hidden orchid** *Maxillaria crassifolia* OBL  
**jug orchid** *Erythrodes querceticola* FACW  
**ladies'-tresses** *Spiranthes* spp. FACW  
**liparis, tall** *Liparis elata* OBL  
**noddingcaps** *Triphora* spp. FACW  
**pogonia, rose** *Pogonia ophioglossoides* OBL  
**pogonias, nodding** *Triphora* spp. FACW  
**rein orchid** *Habenaria* spp. FACW  
**rosebud orchid** *Cleistes divaricata* OBL  
**shadow-witch** *Ponthieva racemosa* FACW  
**snakemouth orchid** *Pogonia ophioglossoides* OBL  
**twayblade** *Listera* spp. FACW  
**widelip orchid** *Liparis elata* OBL  
**wild coco** *Eulophia alta* FACW  
**ox-eye, creeping** *Wedelia trilobata* FAC  
**oxeye, seaside** *Borrichia* spp. OBL  
**PALMS**  
**palm, bluestem** *Sabal minor* FACW  
**palm, cabbage** *Sabal palmetto* FAC  
**palm, Florida thatch** *Thrinax radiata* FAC  
**palm, needle** *Rhapidophyllum hystrix* FACW  
**palm, paurotis** *Acoelorrhaphe wrightii* OBL  
**palm, royal** *Roystonea* spp. FACW  
**palmetto, dwarf** *Sabal minor* FACW  
**panal** *Cypselea humifusa* FAC  
**paperbark tree** *Melaleuca quinquenervia* FAC  
**parsley-haw** *Crataegus marshallii* FACW  
**peatmoss** *Sphagnum* spp. OBL  
**pellitory** *Parietaria* spp. FAC  
**pennywort** *Hydrocotyle* spp. FACW  
**penny-wort, floating** *Hydrocotyle ranunculoides* OBL  
**pentodon, Hall's** *Pentodon pentandrus* OBL  
**persimmon, common** *Diospyros virginiana* FAC  
**pickerelweed** *Pontederia cordata* OBL  
**picklewort** *Salicornia* spp. OBL  
**pimpernel, Florida** *Anagallis pumila* FAC  
**pimpernel, water** *Samolus* spp. OBL  
**pine, pond** *Pinus serotina* FACW  
**pine, spruce** *Pinus glabra* FACW  
**pineland daisy** *Chaptalia tomentosa* FACW  
**pineweed** *Hypericum gentianoides* U  
**pink-root** *Spigelia loganioides* FACW  
**pipestem** *Agarista populifolia* FACW  
**pipewort** *Eriocaulon* spp. OBL  
**pitcher-plant** *Sarracenia* spp. OBL

**pitcher-plant, hooded** *Sarracenia minor* FACW  
**planer tree** *Planera aquatica* OBL  
**planetree, American** *Platanus occidentalis* FACW  
**pleatleaf, fall-flowering** *Nemastylis floridana* FACW  
**poison sumac** *Toxicodendron vernix* FACW  
**poisonwood** *Metopium toxiferum* FAC  
**pond apple** *Annona glabra* OBL  
**pondberry** *Lindera melissaefolia* OBL  
**pondlily, yellow** *Nuphar luteum* OBL  
**pondspice** *Litsea aestivalis* OBL  
**pony-foot** *Dichondra caroliniensis* FAC  
**popcorn tree** *Sapium sebiferum* FAC  
**portia tree** *Thespesia populnea* FAC  
**possum-haw** *Viburnum nudum* FACW  
**potatotree** *Solanum erianthum* FACW  
**prairie-gentian** *Eustoma exaltatum* FACW  
**pride-of-Big-Pine** *Strumpfia maritima* FACW  
**primrosewillow** *Ludwigia* spp. OBL  
**privet, swamp** *Forestiera acuminata* FACW  
**punk tree** *Melaleuca quinquenervia* FAC  
**queen's-delight, marsh** *Stillingia sylvatica* var. *tenuis* FAC  
**quillwort** *Isoetes* spp. OBL  
**ragwort, golden** *Senecio aureus* OBL  
**rainlily** *Zephyranthes atamasco* FACW  
**raspberry** *Rubus* spp. FAC  
**rattlebox; rattle-bush** *Sesbania* spp. FAC  
**rattlesnake master** *Eryngium yuccifolium* FACW  
**rayless golden-rod** *Bigelowia nudata* FACW  
**redgal** *Morinda royoc* FACW  
**redroot** *Lachnanthes caroliniana* FAC  
**redstem** *Ammannia* spp. OBL  
**rose myrtle, downy** *Rhodomyrtus tomentosus* FAC  
**rose, swamp** *Rosa palustris* OBL  
**rose-apple** *Syzygium* spp. FAC  
**rose-gentian** *Sabatia* spp. FACW  
**rose-gentian, Bartram's** *Sabatia bartramii* OBL  
**rose-gentian, coast** *Sabatia calycina* OBL  
**rose-gentian, large** *Sabatia dodecandra* OBL  
**rosemallow** *Hibiscus aculeatus* FACW  
**rosemallow, crimson-eyed** *Hibiscus moscheutos* OBL  
**rosemallow, halberd-leaf** *Hibiscus laevis* OBL  
**rosemallow, scarlet** *Hibiscus coccineus* OBL  
**rosemallow, sea** *Hibiscus tiliaceus* FAC  
**rosemallow, swamp** *Hibiscus grandiflorus* OBL  
**rush** *Juncus* spp. OBL  
**rush, grassleaf** *Juncus marginatus* FACW  
**rush, path** *Juncus tenuis* FAC  
**rush, shore** *Juncus marginatus* FACW  
**rush-featherling** *Pleea tenuifolia* OBL  
**rustweed** *Polypremum procumbens* FAC  
**sachsia** *Sachsia polycephala* FACW  
**saffron plum** *Bumelia celastrina* FAC

**saltbush** *Baccharis halimifolia* FAC  
**saltbush, halberd-leaf** *Atriplex patula* FACW  
**saltwort** *Batis maritima* OBL  
**sandmat, spreading** *Euphorbia humistrata* FACW  
**sandspurry, saltmarsh** *Spergularia marina* OBL  
**sandwort, Godfrey's** *Arenaria godfreyi* FACW  
**savory, Brown's** *Micromeria brownei* OBL  
**sawgrass** *Cladium* spp. OBL  
**scaly-stem, Carolina** *Elytraria caroliniensis* FAC  
**scouring-rush** *Equisetum hyemale* FACW  
**screwstem** *Bartonia* spp. FACW  
**sea myrtle** *Baccharis halimifolia* FAC  
**sea oxeye** *Borrchia* spp. OBL  
**sea-blite** *Suaeda* spp. OBL  
**sea-lavender** *Limonium carolinianum* OBL  
**sea-purslane** *Sesuvium* spp. FACW  
**seaside mahoe** *Thespesia populnea* FAC  
**sebastian-bush, gulf** *Sebastiana fruticosa* FAC

### **SEDGES**

**baldrush** *Psilocarya* spp. OBL  
**beakrush** *Rhynchospora* spp. FACW  
**beakrush, Chapman's** *Rhynchospora chapmanii* OBL  
**beakrush, clustered** *Rhynchospora cephalantha* OBL  
**beakrush, few-flower** *Rhynchospora oligantha* OBL  
**beakrush, giant-fruited** *Rhynchospora megalocarpa* U  
**beakrush, Gray's** *Rhynchospora grayi* U  
**beakrush, Harper's** *Rhynchospora harperi* OBL  
**beakrush, horned** *Rhynchospora inundata* OBL  
**beakrush, large** *Rhynchospora macra* OBL  
**beakrush, millet** *Rhynchospora miliacea* OBL  
**beakrush, mingled** *Rhynchospora mixta* OBL  
**beakrush, narrow** *Rhynchospora stenophylla* OBL  
**beakrush, pinebarren** *Rhynchospora intermedia* U  
**beakrush, short-bristle** *Rhynchospora corniculata* OBL  
**beakrush, southern** *Rhynchospora microcarpa* OBL  
**beakrush, spreading** *Rhynchospora divergens* OBL  
**beakrush, swamp-forest** *Rhynchospora decurrens* OBL  
**beakrush, Tracy's** *Rhynchospora tracyi* OBL  
**black-sedge** *Schoenus nigricans* FACW  
**bogrush, black** *Schoenus nigricans* FACW  
**bulrush** *Scirpus* spp. OBL  
**dwarf-bulrush** *Hemicarpha* spp. FACW  
**fimbry** *Fimbristylis* spp. OBL  
**fimbry, annual** *Fimbristylis annua* FACW  
**fimbry, hairy** *Fimbristylis puberula* FACW  
**flatsedge** *Cyperus* spp. FACW  
**flatsedge, alternate-leaf** *Cyperus alternifolius* OBL  
**flatsedge, Asian** *Cyperus metzii* FAC  
**flatsedge, baldwin** *Cyperus globulosus* FAC  
**flatsedge, bentawn** *Cyperus reflexus* U  
**flatsedge, black** *Cyperus huarmensis* FAC  
**flatsedge, coastal-plain** *Cyperus cuspidatus* FAC

flatsedge, Drummond's *Cyperus drummondii* OBL  
 flatsedge, epiphytic *Cyperus lanceolatus* OBL  
 flatsedge, giant *Cyperus giganteus* FAC  
 flatsedge, globe *Cyperus ovularis* U  
 flatsedge, hammock *Cyperus tetragonus* U  
 flatsedge, jointed *Cyperus articulatus* OBL  
 flatsedge, marshland *Cyperus distinctus* OBL  
 flatsedge, papyrus *Cyperus papyrus* OBL  
 flatsedge, pinebarrenf *Cyperus retrorsus* FAC  
 flatsedge, purple *Cyperus rotundus* FAC  
 flatsedge, red-root *Cyperus erythrorhizos* OBL  
 flatsedge, rough *Cyperus retrofractus* U  
 flatsedge, sandhill *Cyperus filiculmis* U  
 flatsedge, sheathed *Cyperus haspan* OBL  
 flatsedge, variable *Cyperus difformis* OBL  
 flatsedge, woodrush *Cyperus entrerianus* OBL  
 flatsedge, yellow *Cyperus esculentus* FAC  
 flatspike rush *Abildgaardia ovata* FACW  
 fringe-rush *Fimbristylis* spp. OBL  
 fringe-rush, annual *Fimbristylis annua* FACW  
 fringe-rush, Vahl's *Fimbristylis puberula* FACW  
 halfchaff sedge *Lipocarpa* spp. FACW  
 hurricane-grass *Fimbristylis spathacea* FAC  
 nut-grass, purple *Cyperus rotundus* FAC  
 nut-grass, yellow *Cyperus esculentus* FAC  
 nutrush *Scleria* spp. FACW  
 sedge *Carex* spp. FACW  
 sedge, bearded *Carex comosa* OBL  
 sedge, bristly-stalk *Carex leptalea* OBL  
 sedge, cypress-knee *Carex decomposita* OBL  
 sedge, Elliott's *Carex elliotii* OBL  
 sedge, fringed *Carex crinita* OBL  
 sedge, hop *Carex lupulina* OBL  
 sedge, Howe's *Carex howei* OBL  
 sedge, large *Carex gigantea* OBL  
 sedge, long *Carex folliculata* OBL  
 sedge, Louisiana *Carex louisianica* OBL  
 sedge, prickly bog *Carex atlantica* OBL  
 sedge, raven-foot *Carex crus-corvi* OBL  
 sedge, shallow *Carex lurida* OBL  
 sedge, shoreline *Carex hyalinolepis* OBL  
 sedge, stalk-grain *Carex stipata* OBL  
 sedge, Walter's *Carex walteriana* OBL  
 spikerush *Eleocharis* spp. OBL  
 three-way sedge *Dulichium arundinaceum* OBL  
 umbrella-sedge *Fuirena* spp. OBL  
 white-top sedge, Everglades *Dichromena floridensis* FACW  
 white-top sedge, giant *Dichromena latifolia* OBL  
white-top sedge, starbrush *Dichromena colorata* FACW  
 seedbox *Ludwigia* spp. OBL  
 seedbox, hairy *Ludwigia hirtella* FACW  
 seedbox, headed *Ludwigia suffruticosa* FACW

**seedbox, savanna** *Ludwigia virgata* FACW  
**seedbox, seaside** *Ludwigia maritima* FACW  
**seepweed** *Suaeda* spp. OBL  
**seven-sisters** *Crinum americanum* OBL  
**shaggytuft** *Stenandrium floridanum* FACW  
**she-oak** *Casuarina* spp. FAC  
**shrimp plant** *Justicia brandegeana* U  
**silver-bell** *Halesia diptera* FACW  
**silverhead** *Philoxerus vermicularis* FACW  
**silverling** *Baccharis glomeruliflora* FAC  
**skullcap, blue** *Scutellaria lateriflora* OBL  
**skullcap, Florida** *Scutellaria floridana* FAC  
**skullcap, rough** *Scutellaria integrifolia* FAC  
**skullcap, South American** *Scutellaria racemosa* OBL  
**skyflower** *Hydrolea* spp. OBL  
**slimpod, eastern** *Amsonia tabernaemontana* FACW  
**slimpod, stiff** *Amsonia rigida* FACW  
**smartweed** *Polygonum* spp. OBL  
**smartweed, silversheath** *Polygonum argyrocoleon* U  
**smooth chaff-flower** *Alternanthera paronychioides* FAC  
**snakeherb, swamp** *Dyschoriste humistrata* FACW  
**snakeroot, corn** *Eryngium aquaticum* OBL  
**snakewood, Asian** *Colubrina asiatica* FAC  
**sneezeweed** *Helenium* spp. FACW  
**sneezeweed, pasture** *Helenium amarum* FAC  
**snowbell** *Styrax americana* OBL  
**snowberry** *Chiococca* spp. FAC  
**spadeleaf** *Centella asiatica* FACW  
**Spanish needles** *Bidens bipinnata* U  
**spatterdock** *Nuphar luteum* OBL  
**speedwell, water** *Veronica anagallis-aquatica* OBL  
**sphagnum moss** *Sphagnum* spp. OBL  
**spicebush, northern** *Lindera benzoin* FACW  
**spicebush, southern** *Lindera melissaefolia* OBL  
**spider-lily** *Hymenocallis* spp. OBL  
**spiderwort, trailing** *Tradescantia fluminensis* FAC  
**spike-moss, meadow** *Selaginella apoda* FACW  
**spindle-root** *Ludwigia hirtella* FACW  
**spoon flower** *Peltandra* spp. OBL  
**spotflower, creeping** *Spilanthes americana* FACW  
**sprangle-top** *Leptochloa* spp. FACW  
**sprangle-top, tropic** *Leptochloa virgata* FAC  
**spring-cress** *Cardamine pensylvanica* OBL  
**spurge, Florida** *Euphorbia inundata* FACW  
**spurge, many-leaved** *Euphorbia polyphylla* FACW  
**squarestem** *Melanthera nivea* FACW  
**St. Andrew's cross** *Hypericum hypericoides* FAC  
**St. John's-wort** *Hypericum* spp. FACW  
**St. John's-wort, Atlantic** *Hypericum reductum* U  
**St. John's-wort, Carolina** *Hypericum nitidum* OBL  
**St. John's-wort, Chapman's** *Hypericum chapmanii* OBL  
**St. John's-wort, dotted** *Hypericum punctatum* U

**St. John's-wort, Drummond's** *Hypericum drummondii* U  
**St. John's-wort, Edison's** *Hypericum edisonianum* OBL  
**St. John's-wort, four-petal** *Hypericum tetrapetalum* FAC  
**St. John's-wort, marsh** *Triadenum* spp. OBL  
**St. John's-wort, peelbark** *Hypericum fasciculatum* OBL  
**St. John's-wort, scrub** *Hypericum cumulicola* U  
**St. John's-wort, shrubby** *Hypericum prolificum* U  
**St. John's-wort, small-sepal** *Hypericum microsepalum* U  
**St. John's-wort, smooth-bark** *Hypericum lissophloeus* OBL  
**St. John's Susan** *Rudbeckia nitida* FACW  
**staggerbush, piedmont** *Lyonia mariana* FACW  
**stargrasses, yellow** *Hypoxis* spp. FACW  
**stitchwort, Godfrey's** *Arenaria godfreyi* FACW  
**Stoke's aster** *Stokesia laevis* FACW  
**storax** *Styrax americana* OBL  
**string-lily** *Crinum americanum* OBL  
**stripeseed** *Piriqueta caroliniana* FAC  
**sugar-berry** *Celtis laevigata* FACW  
**sumpweed, bigleaf** *Iva frutescens* OBL  
**sunbonnet** *Chaptalia tomentosa* FACW  
**sundew, dwarf** *Drosera brevifolia* FACW  
**sundew, Gulf coast** *Drosera tracyi* OBL  
**sundew, pink** *Drosera capillaris* FACW  
**sundew, spoon-leaf** *Drosera intermedia* OBL  
**sundew, thread-leaf** *Drosera filiformis* OBL  
**sunflower, Florida** *Helianthus floridanus* FAC  
**sunflower, lakeside** *Helianthus carnosus* FACW  
**sunflower, muck** *Helianthus simulans* FACW  
**sunflower, southeastern** *Helianthus agrestis* FACW  
**sunflower, swamp** *Helianthus angustifolius* FACW  
**sunflower, wetland** *Helianthus heterophyllus* FACW  
**sunny bells, white** *Schoenolirion elliottii* FACW  
**sunny bells, yellow** *Schoenolirion croceum* FACW  
**swamp-lily, southern** *Crinum americanum* OBL  
**swamp-loosestrife** *Decodon verticillatus* OBL  
**swampprivet, eastern** *Forestiera acuminata* FACW  
**swampprivet, Florida** *Forestiera segregata* FAC  
**swampweed** *Hygrophila* spp. OBL  
**sweet broom** *Scoparia dulcis* FAC  
**sweet pepper bush** *Clethra alnifolia* FACW  
**sweetbay** *Magnolia virginiana* var. *australis* OBL  
**sweetgum** *Liquidambar styraciflua* FACW  
**sycamore, American** *Platanus occidentalis* FACW  
**tallow-tree, Chinese** *Sapium sebiferum* FAC  
**thistle, Leconte's** *Cirsium lecontei* FACW  
**thistle, Nuttall's** *Cirsium nuttallii* FACW  
**thistle, swamp** *Cirsium muticum* OBL  
**thoroughwort, marsh** *Eupatorium leptophyllum* OBL  
**thoroughwort, semaphore** *Eupatorium mikanioides* FACW  
**thoroughwort, white-bract** *Eupatorium leucolepis* FACW  
**thoroughworts** *Eupatorium* spp. FAC  
**tickseed, ciliate-leaf** *Coreopsis integrifolia* FACW

tickseed, Florida *Coreopsis floridana* FACW  
 tickseed, Georgia *Coreopsis nudata* OBL  
 tickseed, Leavenworth's *Coreopsis leavenworthii* FACW  
 tickseed, sickle *Coreopsis falcata* FACW  
 tickseed, southeastern *Coreopsis gladiata* FACW  
 tickseed, tall *Coreopsis tripteris* FAC  
 tickseed, Texas *Coreopsis linifolia* FACW  
 titi, black *Cliftonia monophylla* FACW  
 titi, swamp *Cyrilla racemiflora* FAC  
 toothcup *Ammannia* spp. OBL  
 toothcup *Rotala ramosior* OBL  
 torchwood, black *Erithalis fruticosa* FAC  
 touch-me-not, spotted *Impatiens capensis* OBL  
 trema *Trema* spp. FAC  
 tulip tree *Liriodendron tulipifera* FACW  
 tupelo, ogeechee *Nyssa ogeche* OBL  
 tupelo, swamp *Nyssa sylvatica* var. *biflora* OBL  
 tupelo, water *Nyssa aquatica* OBL  
 turtleweed *Batis maritima* OBL  
 twinflower, swamp *Dyschoriste humistrata* FACW  
 vanillaleaf; vanilla plant *Carphephorus odoratissimus* FAC  
 Venus' flytrap *Dionaea muscipula* FACW  
 vervain, sandpaper *Verbena scabra* FACW  
 vetch, Florida *Vicia floridana* FACW  
 vetch, four-leaf *Vicia acutifolia* FACW  
 vetch, Ocala *Vicia ocalensis* OBL  
 viburnum, possum-haw *Viburnum nudum* FACW  
 viburnum, walter *Viburnum obovatum* FACW  
 violet, edible *Viola esculenta* FACW  
 violet, lance-leaf *Viola lanceolata* OBL  
 violet, Leconte's *Viola affinis* FACW  
 violet, primrose-leaf *Viola primulifolia* FACW  
 Virginia willow *Itea virginica* OBL  
 water drop-wort *Oxypolis* spp. OBL  
 water snowflake *Nymphoides* spp. OBL  
 water-cress *Nasturtium* spp. OBL  
 water-elm *Planera aquatica* OBL  
 water-hemlock *Cicuta* spp. OBL  
 water-hoarhound *Lycopus* spp. OBL  
 water-hyssop *Bacopa* spp. OBL  
 water-lily *Nymphaea* spp. OBL  
 water-locust *Gleditsia aquatica* OBL  
 water-lotus *Nelumbo* spp. OBL  
 water-meal *Websteria confervoides* OBL  
 water-parsnip *Sium suave* OBL  
 water-plantain, subcordate *Alisma subcordatum* OBL  
 waterpod *Hydrolea* spp. OBL  
 water-poppy *Hydrocleis nymphoides* OBL  
 water-primrose *Ludwigia* spp. OBL  
 water-starwort *Callitriche* spp. OBL  
 water-willow *Justicia* spp. OBL  
 wax myrtle *Myrica cerifera* FAC

**waxweed, Columbia** *Cuphea carthagenensis* FAC  
**waxweed, common** *Cuphea aspera* FACW  
**wedgescale, swamp** *Sphenopholis pensylvanica* OBL  
**white-cedar, Atlantic** *Chamaecyparis thyoides* OBL  
**whitenymph** *Trepocarpus aethusae* FACW  
**wild coffee** *Psychotria* spp. FAC  
**wild corndog** *Typha* spp. OBL  
**wild dilly** *Manilkara bahamensis* FAC  
**wild petunia** *Ruellia caroliniensis* FAC  
**wild taro** *Colocasia esculenta* OBL  
**wild-petunia, Britton's** *Ruellia brittoniana* FAC  
**wild-petunia, night-flowering** *Ruellia noctiflora* FACW  
**willow** *Salix* spp. OBL  
**winterberry** *Ilex verticillata* OBL  
**witch-alder, dwarf** *Fothergilla gardenii* FACW  
**wood-nettle, Canada** *Laportea canadensis* FACW  
**wood-sage** *Teucrium canadense* FACW  
**woolly-berry** *Gaylussacia mosieri* FACW  
**yellow stargrasses** *Hypoxis* spp. FACW  
**yellow-cress** *Rorippa* spp. OBL  
**yellow-eyed grass** *Xyris* spp. OBL  
**yellow-eyed-grass, Carolina** *Xyris caroliniana* FACW  
**yellow-eyed-grass, Richard's** *Xyris jupicai* FACW  
**yellow-poplar** *Liriodendron tulipifera* FACW  
**yellow-root, shrubby** *Xanthorhiza simplicissima* FACW  
**yellowtop, clustered** *Flaveria trinervia* FAC  
**yellowtop, coastalplain** *Flaveria bidentis* FAC  
**yellowtop, Florida** *Flaveria floridana* FACW  
**yellowtop, narrowleaf** *Flaveria linearis* FACW  
**yerba de Tajo** *Eclipta alba* FACW

### **Recommended 5-Step Field Wetland Delineation Procedure**

1. Identify the indisputable wetland area and the indisputable upland area.
2. In the area between the indisputable wetlands and uplands, identify the most landward boundary of where the vegetation meets A or B test criteria.
3. In the area between the indisputable wetlands and uplands, identify the most landward boundary of where hydrologic indicators are present.
4. Between the vegetation test boundary and the hydrologic indicator boundary, identify the most landward hydric soil boundary.
5. Applying the wetland definition and reasonable scientific judgment, evaluate and modify if necessary the most landward boundary of the wetland based on the A, B, C, or D tests delineated by the previous steps.

### **Required Equipment for the Implementation of Chapter 62-340, F.A.C.**

Sharpshooter Shovel (minimum soil examination of 20 inch+)  
Munsell Soil Color Charts  
Hand Lens (10x-15x)  
Soil survey map for inspection area  
Soil knife  
Spray bottle (misting)  
Tape measure

### **Suggested Equipment for the Implementation of Chapter 62-340, F.A.C.**

FDEP Data Form Guide  
FDEP Chapter 62-340, F.A.C. Data Form  
Appropriate plant identification manuals  
Appropriate soil information documents  
A copy of Chapter 62-340, F.A.C.  
Florida Wetlands Delineation Manual  
Compass  
Camera with extra batteries  
Towel  
Pens and pencils  
Permanent Markers – two colors preferably  
GPS Units  
Flagging tape  
Pin flags  
4-foot level  
First Aid  
Sunscreen  
Insect Repellent  
Plant presses  
Auger  
Waterproof equipment case

## Chapter 62-340, F.A.C. Data Form Instructions

### Introduction

The purpose of the Chapter 62-340, F.A.C. Data Form (hereafter Form) is to record relevant information at a specific point to demonstrate whether the point is a wetland, a non-wetland surface water, or an upland according to the methodology set forth in Ch. 62-340, F.A.C. The Form is intended to be filled out after the field evaluator has made a determination.

Any time a regulatory agency concludes that an area is a non-wetland surface water, wetland, or upland at least one data point should be documented, i.e., once a conclusion informally or formally has been made by the regulatory agency at least one complete data form supporting that conclusion is required.

The number of data forms required will depend on the size and variability of the site inspection area. There is no size threshold or maximum number of data forms required for an inspection site. Reasonable scientific judgement should be used to determine the number of required data forms on a case by case basis.

(a) For the delineation of the landward extent of wetlands and other surface waters, at least one delineation data point along the boundary shall be verified and documented by the regulatory agency during the visual site inspection pursuant to Chapter 62-340.100(1) F.A.C. Documentation of a delineation data point shall include two data forms; one representative of the waterward area adjacent to the data point, the other representative of the landward or upland area adjacent to the data point. The two complete data forms at a delineation data point will document failure or satisfaction of all methodology criteria pursuant to Chapter 62-340 F.A.C. and changes in evidence used to determine the boundary delineation at that point.

A delineation data point will be documented for each homogeneous boundary within the site inspection area. If all delineation boundaries on site are homogenous in character, one data point is sufficient for documentation. One delineation data point representative of homogeneous boundaries found in other locations throughout the site is sufficient for documentation.

For purposes of the delineation data point, "homogeneous boundary" means all or part of a site delineation that is sufficiently similar in current condition to be delineated determine the landward extent of wetlands and other surface waters with a particular "test(s)" or interpretation of evidence as contemplated in Chapter 62-340 F.A.C. Characteristics that distinguish homogeneous boundaries may include, but are not limited to:

1. plant community type,
2. surface water type,
3. hydrologic indicators,
4. soils,
5. alterations to plants, hydrology, or soils,
6. hydrologic isolation or connection to waters of the State, or
7. other current condition expression which separate it from other boundaries on site.

(b) For identification or conclusions regarding the absence or presence of a non-wetland surface water, wetland, or upland classification by the regulatory agency within the site inspection area, at least one data form within homogeneous areas of classification shall be verified and documented by the regulatory agency during the visual site inspection pursuant to Chapter 62-340.100(1) F.A.C.

Documentation of an identification data point shall include one data form representative of the area of classification. The data form at an identification data point will document failure or satisfaction of all methodology criteria pursuant to Chapter 62-340 F.A.C. and evidence used to determine the upland, wetland, or non-wetland surface water classification.

An identification data point will be documented for each homogeneous area within the site inspection area. If all areas on site are homogenous in character, one data point is sufficient for documentation. One data point representative of homogeneous areas found in other locations throughout the site is sufficient for documentation.

For purposes of the identification data point, “homogeneous area” means all or part of a site inspection area that is sufficiently similar in current condition to classify with a particular “test(s)” or interpretation of evidence as contemplated in Chapter 62-340 F.A.C. Characteristics that distinguish a homogeneous area may include, but are not limited to:

1. upland classification,
2. wetland classification,
3. non-wetland surface water classification,
4. hydrologic isolation or connection to waters of the State,
5. plant community type,
6. surface water type,
7. hydrologic indicators,
8. soils,
9. alterations to plants, hydrology, or soils, or
10. other current condition expression which separate it from other areas on site.

This instructional document provides explanations of each question in the Form and guidance on how to answer them. Numbered (and lettered) bullet points, as well as anything denoted by “#” in this document refer directly to the corresponding question with that number in the Form. Citations from Chapter 62-340, F.A.C. (hereafter 62-340) and associated references are given to show where questions are drawn from and provide further clarity. For any question on the Form that requires an open-ended explanation that will not fit in the space provided, write “See note [#]” and continue the explanation with its identifying number in the “Notes” section at the end.

### Site Information

1. The date on which the field data were collected on site. If the data were collected over multiple days, select the earliest date and note the other collection dates in the Notes section.
2. The staff that were present on site at the time of data collection, denoted at minimum by first initial and last name.

3. The initials of the staff member(s) that recorded data on this Form. A space for initials is provided in later sections to document the “plant recorder” and “soil describer” if completed by multiple parties.
4. The county in which the point being described lies.
5. The name of the larger site within which a point is being described (e.g., a project name or parcel owner’s name). If a tracking number exists (e.g., from PA) include this as well.
6. A unique name to identify the specific point being described (e.g., the delineation flag number closest to the point or a unique combination of letters and numbers). It is also recommended to take a GPS reading if possible and record the coordinates here. Write this identifier at the top of each of the other sheets in the Form in the box labeled “Point ID/Location”. This will identify the sheets in case they get separated.
7. If the location of the described point is not going to be surveyed, attempt to locate at least 2, but preferably 3 or more stationary objects nearby that are easily identifiable and expected to remain in their fixed location indefinitely, such as utility poles, survey markers, road intersections, corners of buildings, etc. Standing at each object, record the compass bearing and the distance to the described point. This will allow triangulation to the point’s location in the future.
8. The legal condition of the site.
  - If the point is unaltered or if all alterations at the point are exempt, authorized, permitted, or grandfathered select “Authorized or legal condition”.
  - If any unauthorized alterations have occurred at the point, select “Unauthorized or illegal condition”.
9. The type of evaluation being performed on site.
  - If only the presence or absence of a wetland or other surface water is being determined, select “Identification.”
  - If a boundary between a wetland or other surface water and an upland is being marked, select “Delineation”.

Then select whether the point being described is in a wetland, a non-wetland surface water, or an upland. If the point lies within both a wetland and another type of surface water, select “Wetland”.

➤ ***For identifications, the data form should characterize the entire homogenous area being identified, whereas for delineations, the data forms should characterize the change on either side of the boundary at a specific point.***

## Vegetation

10. Appropriate vegetative stratum: 62-340.400
  - The Rule defines 3 plant strata (Canopy, Subcanopy, and Groundcover) in 62-340.200
  - If vegetation is absent from the area, select “Vegetation Absent at Point” and skip to #14. Otherwise, select one stratum using the guidelines in 62-340.400, F.A.C.
  - The top stratum shall be used unless either:
    - o The top stratum constitutes less than 10% areal extent, in which case the next lower stratum shall be used, as long as that stratum constitutes 10% areal extent or is the groundcover stratum. OR
    - o The top stratum is not indicative of hydrologic conditions on site, in which case the stratum most indicative of hydrologic conditions shall be used. Either

subcanopy or ground cover may be selected depending on which is most indicative of hydrologic conditions.

- ***Facultative plants shall not be considered in the determination of areal extent or appropriateness of strata.***
- ***All evidence shall be considered when shifting to a lower stratum (e.g. number or wetland species compared to upland species, landform, plant community type, regional specificity); the statuses of plant(s) in a lower stratum are not by themselves sufficient evidence to shift strata.***

- Explain why the stratum was selected. “Normal expression” may be sufficient when the top stratum is used. Additional explanations may include: selective clearing of only wetland or upland tree species; planting of only upland or wetland species; recruitment of invasive exotic species.

11. Plant List 62-340.200(2),(6),(16), 62-340.400, 62-340.450

- Select an evaluation area for the plant community.
  - o The area should be just large enough to capture the species diversity and abundance of the plant community at the described point.
  - o The area should not extend into different hydrologic conditions or adjacent plant communities – this may dictate the shape of the area.
- Record the scientific name of each plant species in the evaluation area in the “Binomial of Observed Species” column.
  - o Nomenclature from 62-340.450 must be used, regardless of taxonomic changes.
  - o Record all plants in all three strata. Use one line per species.
  - o Recorded plants must have their main stem rooted within the evaluation area.
- Record the 62-340.450 status (Upland, Facultative, Facultative Wet, or Obligate) in the “Status” column.
  - o Select one of the following status abbreviations: U, F, FW, or O.
  - ***Exotic species that naturalized on or after July 1, 1994 are considered Facultative. Otherwise, all species were given a status, so those naturalized prior to July 1, 1994 but not listed in 62-340.450 are Upland.***
  - ***If desired for land management or mitigation assessment purposes, names and percentages of vines and aquatic plants may be included within the notes section but not in section 11.***
- For each listed species, record its percent areal extent in the Canopy, Subcanopy, and Groundcover strata (defined in 62-340.200) in the appropriately named columns.
  - o See “Tips for Determining Areal Extent of Plants” In the “Chapter 62-340, F.A.C. Data Form Guide” (hereafter “Guide”) for guidance.
  - o For species not fully leafed out, evaluate areal extent as it would be when fully leafed out. Do not evaluate dead plants nor attempt to predict plants that would be present under different circumstances. This plant list reflects the conditions on the day of the evaluation, as is. If needed, past or predicted (e.g. when no vegetation is present) plant lists should be documented in the notes section.
- Refer to the stratum selected in #10. Use the numbers only from the column of the selected stratum. For each species in the selected stratum, transfer the areal

extent from the selected stratum column to the status column (Upland, Facultative, Fac. Wet, or Obligate) that corresponds to that species.

- Use the boxes at the bottom right of the table to total the areal extents in the Upland, Facultative, Fac. Wet, and Obligate columns.

12. A Test vegetation: 62-340.300(2)(a)

- For percent Obligate and percent Upland transfer the percent areal extent total from the Obligate and Upland columns in #11.
- Evaluate whether the total areal extent of Obligate plants is greater than that of Upland plants. If they are equal, select "No".

13. B Test vegetation: 62-340.300(2)(b)

- Add the totals from the Obligate and Fac. Wet columns in #11 to determine their combined value.
- Add the total from the Upland column in #11 to the Obligate and Fac. Wet total to determine their combined value.
- Divide the first result by the second result and multiply by 100 to obtain the percent of Obligate and Fac. Wet plants in relation to all plants, excluding Facultative.



**Vegetative Photo Tips:**

- Document unknown plants by photographing features used in identification.
- Take plant community shots in each of the four cardinal directions (North, South, East, and West) at the described point. Plant community shots should include enough detail to identify species in the canopy, subcanopy, and ground cover. Additional shots may include canopy, subcanopy, or groundcover areal extents.

## Soils

14. Indicate the Land Resource Region or, if necessary, the Major Land Resource Area where the described point is located.

- The Land Resource Regions can be determined in two NRCS publications "Field Indicators of Hydric Soils in the United States" (hereafter "NRCS FIHSUS") or "Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin".
- There are two hydric soil field indicators (S12 & F22) which require a specific Major Land Resource Area. The Major Land Resource Areas can be determined in the NRCS publication "Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin".

15. Determine if it is possible to examine and describe a soil profile.

- If it is possible to examine and describe any depth of soil, whether the soil is naturally or artificially occurring in that environment, select "Yes".
- If it is not possible to examine the soil due to it being in an inaccessible area, under water, composed of rock or a cemented layer, no soil present, etc.; select "No", explain why, and skip to #18.

16. Describe the soil profile.

- Determine the different horizons (i.e. layers) of the soil profile. Horizon is defined in the glossary of NRCS FIHSUS. NRCS horizon designations (e.g., O, A, E) are not necessary nor recommended for Chapter 62-340, F.A.C. soil profile descriptions.

- ***Soil material is defined in “Keys to Soil Taxonomy” as both mineral material less than 2 mm in diameter and decomposing organic material that is less than 20 mm in its smallest dimension. All material not meeting these requirements is considered nonsoil. Fragmental soil material (defined in the glossary of NRCS FIHSUS) should be treated as soil in the profile description and noted as fragmental in the notes column.***
- Determine the beginning and ending depth in inches for each horizon.
  - o The 0-inch depth is the soil surface, which is the muck or mineral surface (whether natural or fill) according to “Soil and Water Relationships of Florida’s Ecological Communities”.
  - o If peat, mucky peat, or a nonsoil with an accessible soil underneath exists on top of the muck or mineral surface, the beginning depth will begin with a ‘+’ and the number of inches above the muck (e.g. +3 -0) or mineral surface the horizon starts.
- Determine the Matrix hue, value, and chroma for each horizon.
  - o Matrix is defined in the glossary of NRCS FIHSUS.
  - ***The Matrix color should be determined in moist condition using a “Munsell Soil Color” book without sunglasses and ideally with normal sunlight (e.g. not early in the morning, late in the day, or under smoky conditions). With practice, compensation can be made for the differences unless the light is so subdued that the distinctions between colors chips are not apparent.***
  - o For nonsoil horizons, write N/A.
- Determine the Matrix texture for each horizon.
  - o Recommended Matrix textures are peat, mucky peat, muck, mucky mineral, marl (as defined in glossary and described in the Introduction of NRCS FIHSUS), sand, and fine (defined below). See the Guide for “Field Determination of Soil Indicator Texture” and “Tips for Determining Texture of Soil materials with High Organic Content”.
  - o Sand refers to USDA textures of loamy fine sand and coarser.
  - o Fine refers to USDA textures of loamy very fine sand and finer.
  - o “Mucky” as in mucky peat or mucky mineral is a texture modifier and does not constitute the presence of muck. See “NRCS FIHSUS” for definition of muck, mucky modified mineral soil material, and mucky peat.
  - o For nonsoil horizons, write N/A.
- Determine the percentage of sand in the Matrix masked with organic material.
  - ***Determinations are conducted with a 10x or 15x hand lens. See “Estimating Percent Organic Carbon” in the Guide. A hand lens is strongly recommended for consistency and legal challenges, in lieu of the naked eye, due to:***
    - ***No NRCS guidance for distance of the observer from the soil being assessed (i.e. 6 inches or 6 feet),***
    - ***No NRCS guidance for the lighting conditions under which the soil is being assessed (i.e. shade or full sun),***
    - ***No NRCS percentage definition for “particles appear to be close to 100% masked” (i.e. 99% or 85%)***

- ***No NRCS guidance regarding vision requirements of the observer estimating organic coating percentages (i.e. 20/20 or 20/15 vision).***
  - o For Matrix values  $\leq 3$  in only sandy matrix soil layers, estimate percent organic coatings of the sand.
  - o While sand may be visible within the horizon, the sand is not the matrix for textures of peat, mucky peat, muck, or mucky mineral layers, therefore, percent organic coating is not required to determine hydric soil status. Likewise, mucky mineral sand will not contain less than 70% organic coating and therefore, also does not require organic coating estimates to determine hydric soil status.
  - o If the Matrix has a value higher than 3, write N/A, as these colors are unlikely to approach 70% or more organic coating in sandy matrix soils.
- Describe any soil features contained within the horizon and record any other relevant notes. There may be more than one of each type of feature within a horizon. If no features are present in the horizon, write "None".
  - o DAs are areas darker than the Matrix's color. LAs are areas lighter than the Matrix's color. These are larger characteristics of the horizon and not micro-characteristics such as: sparsely dispersed value differences between single grains of sand, finely dispersed value differences between single grains of sand giving a salt and pepper appearance, or inclusions of shell fragments. For DA and LA areas record in moist condition the hue, value, and chroma; percent volume in the layer; the boundary (sharp, clear, diffuse; defined in the glossary of NRCS FIHSUS); and the shape (rounded, linear, angular; see "Tips for Determining Shapes of Features in Soil" in the Guide). Percent organic coating of sand is not required for DAs and LAs.
  - o RCs are redox concentrations, which are defined in the glossary of NRCS FIHSUS. For these areas record in moist condition the hue, value, and chroma; percent volume in the layer; the boundary (sharp, clear, diffuse); and the shape (rounded, linear, angular).
  - o OBs are organic bodies. Organic bodies must have a muck or mucky mineral texture. There are no size requirements for OBs, but generally 1- 3 cm in diameter. For OBs record the texture and the percent volume in the horizon. Percent organic coating of sand is not required for OBs.
  - o Features generally must have a percent volume less than the Matrix's percent volume for each horizon, and the sum of the Matrix's and all features' volumes in a horizon must equal 100%. One exception may be a high percentage of redox concentrations making the matrix of the layer appear to be a high chroma matrix when in fact these are hydric soil features occurring in a lower chroma matrix. Another exception may be a horizon with abundant organic bodies of muck or mucky mineral texture within a sandy matrix. The matrix is not muck or mucky mineral, the matrix is sandy with many and numerous hydric soil indicators in the form of organic bodies.
  - o Note if the horizon has been nonhydrologically physically mixed (PM) to the extent that the disturbance is a dominant characteristic of the horizon or is precluding reliable identification of hydric soil field indicators.
  - o Note if the horizon is nonsoil and describe the type of material.

- o Note if the horizon is fill, as defined in 62-330, F.A.C.
- o Note if the fill material has blended in with natural soil material or developed contemporary hydric soil features (i.e. not imported within the fill material).
- o Describe any significant features (DAs, LAs, RCs, OBs), inclusions (features that are not the same soil texture as the Matrix), or nonsoil materials within the fill horizon.

17. Check off which Hydric Soil Field Indicators are present, if any, and specify their beginning and ending depths.

- Hydric soil field indicator requirements may be found in NRCS FIHSUS. See the Guide for a “Hydric Soil Field Indicators Simplified Checklist”.
- A hydric soil field indicator is only met and should only be selected if all the required characteristics, including depth, are documented within the soil profile description.
- If hydric soil field indicators are combined, both indicators must be checked and documented (see example below).
- ***NRCS periodically updates FIHSUS so check for additional hydric soil field indicators within the appropriate LRR or MLRA. If an indicator is met which is not included within the list in #17, identify the indicator and its beginning and ending depths.***
- ***National Technical Committee for Hydric Soils Technical Note 4 explains how to combine certain indicators to satisfy their unmet thickness requirements.***

**Documentation Example:**

| Indicator                         | Begin | End   |
|-----------------------------------|-------|-------|
| Present                           | Depth | Depth |
| 1. S5/F3 <input type="checkbox"/> | 5     | 14+   |

18. Determine if there is any nonsoil at or within 12 inches of the ground surface.

- Is there an impenetrable layer at the soil surface or within 12 inches of the soil surface, if so, select “yes.”
- If the entire upper 12 inches is composed of soil material, select “no”.
- If it is impossible to examine the soil profile due to it being in an inaccessible area, underwater, physically mixed, hydrologically mixed, or otherwise disturbed, such that hydric soil field indicators cannot express or be reliably identified, select “Indeterminable”.

19. Determine the hydric status of the soil.

- If one or more of the hydric soil field indicators in #17 are checked, select “Hydric”.
- Select “Hydric” if the soil is in a reliable condition and meets the definition of hydric soil in 62-340.200(8). This definition may be met without a hydric soil field indicator being present. See Notes above “Field Identification of Hydric Soils,” as well as the “Hydric Soil Technical Standard (HSTS)” in the Guide.
- Select “Non-hydric” if the soil is in a reliable condition and no hydric soil field indicators are checked in #17 or if the definition of hydric soil in 62-340.200(8) is not met.

- Select “Inconclusive” if the soil profile is in an unreliable condition (i.e. disturbed/mixed soil, insufficient evaluation depth due to presence of nonsoil or standing water, lack of site access, etc.) and hydric status cannot be evaluated.
  - Explain the reason for the hydric status selected. “See #17” may be sufficient if the soil was hydric due to one or more hydric soil field indicators being checked.
20. Note whether the depth of the soil profile is 20 inches or greater from the soil surface according to Soil and Water Relationships of Florida’s Ecological Communities. If the profile is less than 20 inches from the soil surface explain why. Explanation options are not limited to the examples provided in the Data Form.
- **Length of shovel is not an appropriate limitation of profile depth.**
21. Determine the height or depth of the observed standing water from the soil surface.
- Select whether the water level is above the soil surface or below (in the soil pit). If the water table is below, ideally, wait enough time for the water table to stabilize before taking a measurement. Alternatively, estimate depth to water table from observed lateral side wall intrusion of water.
  - If no standing water is observed or no lateral water intrusion is observed in the soil pit, select “Not Observed” and leave the space provided for the measurement blank.



#### Soil Profile Photo Tips:

- Each soil photo should be taken in either full sun or full shade, in a moist condition, cleaned (with all smearing removed and no shovel slices within the profile), preferably as a flat trench-cut 16-20 inch profile instead of a conical spoil plug. Ensure the soil profile has not been crushed, compacted, contains shovel cuts through the profile, or otherwise altered during the process of removing the profile.
- Soil Profile ID photograph-
  - o Demarcate each horizon (i.e. layer) by scoring the soil profile surface so the depths of each layer are easily identifiable within the photo.
  - o Take a photo of the entire soil profile with scale (i.e. measuring tape at soil surface). Angle of photo should be 90° to the profile face. Include the 62-340 Data Form sheet with box 1-9 visible within the photo to document point ID location information.
  - o Ensure the background does not visually interfere with the edges of the soil profile being photographed. Interferences such as side cast material from cleaning, backgrounds of similar color and texture, etc. make distinction of colors and patterns difficult.
- **If a peat or mucky peat layers are present two profile ID photographs will be necessary. The first photo shall document the entire length of the profile with the measuring tape or scale device beginning at the top including any peat or mucky peat layer(s). The second photo will show the tape measure or scale device beginning at the muck or mineral surface (i.e. 0 inches) and shall be used for purposes of describing the profile.**
- Soil Profile
  - o Follow the same procedures in the Soil profile ID above, but remove the Data form, and frame the photo as close to the soil profile as possible while including all layers.
- Soil horizon

- o Take photos of each horizon pointing out any distinguishing features (DAs, LAs, OBs, RCs) with scale. Take close-ups of
- Cross sections (soil horizon/critical depth)
  - o Cross section the middle of each individual soil horizon, horizontally, taking photos of any distinguishing features or characteristics (DAs, LAs, OBs, RCs) with scale.
  - o When needed, cross section photos at the 6 inch depth (for sandy soils) or other critical depth for meeting a hydric soil field indicator should be taken. If hydric soil field indicator(s) begin(s) at the soil surface photograph the surface of the soil profile close-up.
- Other Hydric Soil Characteristics or Features
  - o Photograph characteristics used in determining hydric condition of soils (e.g. muck smeared fingers, results of fiber rub test, color of decant test water, etc.)
  - o Photograph any inclusions of shell, charcoal, fill material, texture, or other lithologic discontinuities, etc.
- Photograph the water table
  - o Photograph if the water level is above the soil surface or below (in the soil pit). If the water table is below, ideally, wait enough time for the water table to stabilize before taking a measurement and photographing. Alternatively, estimate depth to water table from observed lateral sidewall intrusion of water and photograph the evidence of intrusion, pointing out the lateral sidewall seepage.

## Hydrology

### 22. Hydrologic indicators 62-340.500

- Investigate the area immediately around the described point (no further than the area used to evaluate the plant community) for each of the 13 listed Hydrologic Indicators.
  - o For any indicator present and representative of normal wet season or high water hydrology, check the corresponding box in the "Present at or near..." column
  - o For any indicator present that is not representative of normal wet season or high water hydrology, e.g. resulting from rare or aberrant events, check the corresponding box in the "Present but not reflective..." column.
- ***For identifications, the data form should characterize the entire homogenous area being identified and all hydrologic indicators, whereas for delineations, the data forms should characterize the change on either side of the boundary at a specific point.***
- If the site investigation is being performed during the dry season or a drought, or if it is believed that a Hydrologic Indicator that is currently absent would be present during normal wet season or high water conditions, check the corresponding box in the "Predicted..." column.
- If the described point is the waterward area adjacent to the data point side of the delineation boundary, investigate the area within 100 feet waterward of the point for each of the 13 listed Hydrologic Indicators.
  - o For any indicator present within the 100 ft area, check the corresponding box in the "Within 100 ft..." column.

- o These indicators are **not** considered for purposes of meeting the A, B, or D Tests at the data point, but offer details of the larger landscape context of the point.
  - For any checked indicators, provide all relevant supporting information in the corresponding box in the last column.
    - o For any indicator that expresses in different forms (aquatic moss, aquatic plants, rafted debris, aquatic fauna, hydrologic data, morphological plant adaptations, tussocks or hummocks) describe the indicator type and the species on which it expresses (e.g., *Lemna sp.*, crayfish chimneys, A8 Muck Presence, adventitious roots on *Hypericum spp.*, tussocked *Andropogon*).
    - o For any indicator within 100 ft of the point (checked in the “Within 100 ft...” column), record its approximate distance and compass direction from the point along with the name of the species on which it expresses.
    - o For any indicator that reflects a water elevation (algal mats, aquatic mosses, aquatic plants, or rafted debris deposited on surfaces; elevated lichen lines, hydrologic data, adventitious roots as morphological plant adaptations, tussocks or hummocks, water marks) measure its height from the ground and record the measurement and the species name of the species on which it expresses.
    - o If the “Present but not reflective...” box is checked for any indicator, explain why it is not reflective of normal hydrology.
  - To determine the estimated Seasonal High Water at the point, review the recorded indicators present at the point for any that reflected a water elevation, including any indicators of inundation at or above the soil surface.
    - o If the described point is within an Upland select “N/A”.
    - o If there are no indicators that reflect a water elevation, select “No water level indicators”.
    - o If any indicators reflect an inundation water elevation, determine the highest elevation from either the ground surface (begins at the peat, mucky peat, muck, or mineral surface) or soil surface (begins at the muck or mineral surface).
      - If the ground and soil surface are the same at the described point, record the highest water elevation as is and select “Above soil surface”.
      - If there is a difference between ground and soil surface or if the soil surface elevation is unknown, record the highest water elevation as is and select “Above ground surface”.
      - If indicators reflect inundation without reflecting a specific elevation (e.g. algal mats on the ground), record the Seasonal High Water as 0 and select “Above ground surface” or “Above soil surface” using the above guidelines.
23. If any of the 13 listed Hydrologic Indicators were checked in the “Present at or very near...” or “Predicted...” columns, select “Yes”, otherwise, select “No”.

 **Hydrologic Indicator Photo Tips:**

- Take photos documenting the observed hydrologic indicators.
  - o Include a visible scale such as a measuring tape or ruler. Use a level pointer (e.g. soil knife, stick, finger) to help visually identify height of feature.

- o Hold the camera level to the height of the indicator so the photo accurately depicts the height of the measured indicator.
- o Photos depicting water level indicators consistently on several specimens are also recommended, if available.

### Criteria Tests

#### 24. Delineation by Wetland Definition §62-340.300(1),

- a) Determine if a wetland delineation resulting in a wetland boundary has been performed.
  - If the "Work Type" selected in #9 is "Delineation" and the Data Form is describing a point on either side of a wetland boundary, select "Yes".
  - If the "Work Type" selected in #9 is "Identification" or if the delineated line is a non-wetland surface water boundary, select "No" and skip to #25.
- b) Determine if the wetland boundary could be easily delineated using the definition of wetlands.
  - If the boundary could be easily delineated by the individual evaluator by following a clear break in the vegetative community, topographic elevations, landform type, regional or site specific hydrologic indicators or soil changes, etc., indicative of a frequency and duration of inundation or saturation sufficient to support the wetland definition, select "Yes".
  - If the boundary could not be easily located in this manner and more in-depth inspection was necessary, select "No".

#### 25. A & B Test Wetland Criteria §62-340.300(2)(a),(b),

- a) A Test vegetation: 62-340.300(2)(a)  
Consult #10 and #12 to select answer. If "Vegetation Absent at Point" skip to #25f.
- b) B Test vegetation: 62-340.300(2)(b)  
Consult #13 to select answer.
- c) A & B Test hydric soils: 62-340.300(2)(a)1 and (b)1  
Consult #19 to select answer, unless #19 was "Inconclusive" due to nonhydrological mixing of the profile. In this case, use any available evidence or data to determine whether a hydric soil would be present if not for the mixing of the profile. If a hydric soil would be present, select "Yes", otherwise select "Indeterminable".
- d) A & B Test other soils or substrates: 62-340.300(2)(a)1,2 and (b)1,2 and 62-340.200(13)  
If the substrate is composed of Riverwash (defined in 62-340.200(13)), nonsoil (see #18), rock outcrop-soil complex, or located in an artificially created wetland area, select Yes, otherwise select No.
  - Rock Outcrop-Soil Complex refers to areas where the underlying rock substrate has been exposed in multiple locations. While some of these areas have been labeled in Map Units as a soil type with the words Rock Outcrop Complex, any area with exposed bare rock mixed in with the surrounding soil would meet this requirement. See the NRCS publication Soil Survey Manual for more details.

- Artificially created wetland areas could consist of ditches, borrow pits, mitigation creation sites, etc.
  - e) A & B Test hydrologic indicators: 62-340.300(2)(a)3 and (b)3  
Consult #23 to select answer.
  - f) A Test criteria summary: 62-340.300(2)(a)  
Consult note under #25f to select answer.
  - g) B Test criteria summary: 62-340.300(2)(b)  
Consult note under #25g to select answer.
  - h) A & B Test reliability: 62-340.300(3)  
If evaluation of any of the answers in #25a-e was affected by conditions or alterations on the site, natural or man-made, such that any answers were incomplete, indeterminable, or unreliable, select "Yes".
26. C Test Criteria
- a) C Test conditional requirements: 62-340.300(2)(c)4  
If the point meets any of the C-test definitions of pine flatwoods, improved pasture, or drained soils, select "Yes", select which of the three definitions are met, and skip to #26d and select "No".
    - ***If any facultative wet or obligate species are present in the ground cover, the point is NOT pine flatwoods or improved pasture.***
    - ***If any contemporary hydric soil field indicators are present, the point does NOT have drained soils.***
  - b) C Test saline sands and soil taxonomy: 62-340.300(2)(c)1,2
    - If the described point is within a salt flat or tidal flat select "Yes".
    - If the soil at the point has been field verified as an Umbraqualf, Sulfaquent, Hydraquent, Humaquept, Histosols (except Folists), Argiaquoll, or Umbraquult by a soil scientist according to *Keys to Soil Taxonomy* (USDA, 4<sup>th</sup> ed. 1990), select "Yes". If field verification by a soil scientist was not attempted, select "No".
    - ***If hydric soil field indicator A1 – Histosol has been checked in #17, then a Histosol has been field verified, select "Yes."***
  - c) C Test map unit designations: 62-340.300(2)(c)3
    - If the described point lies within a USDA-NRCS Soil Survey Map Unit that is designated as frequently flooded, depressional, or water and if a hydric soil field indicator has been met (see #16), select "Yes".
      - ***Map Units may be designated by name (e.g., "Felda fine sand, depressional") and/or by the information in the "Water Features" table within the Soil Survey. Those with a Flooding Frequency of "frequent" are frequently flooded, and those with a Ponding Frequency of "frequent" or a High Water Table above the soil surface are depressional.***
    - If the map unit is not frequently flooded, depressional, or water, select "No".
    - If the soil was determined to be non-hydric, select "No".
    - If the map unit is frequently flooded, depressional, or water but the soil was determined to be inconclusive, select "Inconclusive".
    - Record the map unit name regardless of the answer selected.
  - d) C Test criteria summary: 62-340.300(2)(c)

Consult under #26d to select answer.

e) C Test reliability: 62-340.300(3)

If evaluation of any of the answers in #26a-c was affected by conditions or alterations on the site, natural or man-made, such that any answers were incomplete, indeterminable, or unreliable, select "Yes".

27. D Test Criteria

a) D Test hydric soils: 62-340.300(2)(d)

- If a hydric soil field indicator was checked in #17, select "Yes".
- If a hydric soil field indicator was not checked in #17, select "No", even if the definition of hydric soil was met. Then skip to #27d and select "No".
- If the soil was deemed "Inconclusive" in #19, select "Inconclusive" and do not attempt to predict if a hydric soil would be present but for any disturbance. Then skip to #27d and select "No".

b) D Test hydric soils that are hydrologic indicators: 62-340.300(2)(d), 62-340.500(8),(11)

If any hydric soil field indicator in #17 began at the soil surface (0-inch depth), or if any of the "stand-alone D-Test" indicators listed in this question were checked in #17, select "Yes".

- If indicator A5 was checked, make sure that Sediment Deposition is marked as "Present at or very near..." in #22
- If A1, A2, A3, A4, A7, A8, A9, S4, or F2 were checked or if any other indicator began at the soil surface, make sure that Hydrologic Data is marked as "Present at or very near..." in #22.

c) D Test hydrologic indicator: 62-340.300(2)(d)

This answer should match the answer given in #23.

d) D Test criteria summary: 62-340.300(2)(d)

The D Test is met if #27a was answered "Yes" and at least one of #27b or #27c was answered "Yes". If these criteria are met, select "Yes".

e) D Test reliability: 62-340.300(3)

If evaluation of any of the answers in #27a-c was affected by conditions or alterations on the site, natural or man-made, such that any answers were incomplete, indeterminable, or unreliable, select "Yes".

### Altered Sites Tests

28. Determine if any conditions or alterations on the site, natural or man-made, have masked or eliminated expression of any wetland indicators (e.g., plants, soils, hydrologic indicators) such that the wetland cannot be completely or reliably identified or delineated.

- If #25h, 26e, or 27e were answered "Yes", select "Yes".
- If the criteria tests could be evaluated reliably but more abundant, diverse, or persuasive evidence would be present but for the alterations, select "Yes".
- If there are no alterations, select "No" and skip to #32.
- If alterations have occurred on a site, but all wetland indicators are expressing normally and reliably and on-site evidence is deemed sufficient, select "No" and skip to #32.

- **Selecting “No” may possibly limit utilization of other reliable information in the documentation.**

29. Authorized or Legally Altered Vegetation and Soils: 62-340.300(3)(a)

- a) Determine if the vegetation on site has been altered by authorized or legal activities (e.g., by mowing, planting, tree harvesting, fire, landscaping, herbicide, site preparation, etc.) such that its expression is incomplete or unreliable.
  - If so, select “Yes” and describe the alterations and their effects on vegetation.
  - If vegetation was not affected by alterations or if any alterations were unauthorized, select “No”.
- b) Determine if the soils on site have been altered by authorized or legal activities (e.g., by animals such as hogs or livestock, or by authorized plowing, disking, scalping, filling, shallow rutting, etc.) such that they cannot be evaluated completely or reliably.
  - If so, select “Yes” and describe the alterations and their effects on the soils.
  - If soils were not affected by alterations or if any alterations were unauthorized, select “No”.
  - If “No” was selected for both 29a and 29b, indicating the vegetation and soils were not affected by any legal or authorized alterations, skip to #30.
- c) Select which of the four criteria tests could not be completely or reliably evaluated due to the legal alterations to vegetation or soils on site. These answers will often reflect those in #25h, 26e, and 27e.
- d) Determine if the described point would be identified or delineated as a wetland using the methodology in 62-340.300 if the altering activities were stopped and the site given time to recover normal expression of vegetation and soils. Use reasonable scientific judgement and the most reliable available information to make this determination. A reference point in an unaltered or more reliable condition, described on a separate Data Form, is recommended if possible.
  - If the point would be a wetland given normal expression, select “Yes”.
  - Otherwise, select “No”, explain why this conclusion was reached, and skip to #30.
- e) If #29d was answered “Yes”, indicate which components of 62-340.300 would express following the cessation of legal alterations.
  - Include evidence that is currently present as well as evidence that is predicted to be present.
  - “Plants” can refer to the vegetative community, A and B test plant ratios, or both.
- f) Select which tests are predicted to be passed following the cessation of alterations, including tests that are currently being passed.
  - ***If a wetland has been determined to be present using any of the 62-340.300 tests, “Wetland Definition” should be selected.***
  - Explain why it is believed that these tests would be passed. “See [reference point name]” is sufficient when a reference point has been described on a separate Form. Otherwise, list whatever evidence was used in the conclusion.

30. Authorized or Legally Altered Hydrology: 62-340.300(3)(b)

- a) Determine if authorized or permitted activities have altered wetland hydrology in a way that either lowers the water table or raises the soil surface, thereby reducing wetland hydrology.
  - If so, select “Yes”, and explain the alteration and its effects.

- If hydrology has been unchanged or if frequency or duration of saturation or inundation has increased, select “No” and skip to #31.
  - If the site is and has always been an upland, select “No” and skip to #31.
  - If the decreased hydrology is a result of unauthorized activities (including water use permits that are out of compliance), select “No” and skip to #31.
- b) Determine if the authorized activities have completely eliminated wetland hydrology at the described point (i.e. point has been converted to upland). If wetland hydrology was reduced but not fully eliminated, select “No” and skip to #31. Otherwise, select “Yes”.
- c) Determine if elimination of wetland hydrology was accomplished solely by dredging or filling activities authorized by Part IV of Chapter 373, F.S. and if the elimination is therefore permanent.
- If so, select “Yes”. This means that the point is now legally converted to an upland. Skip to #31.
  - If wetland hydrology was eliminated by activities in Part II of Chapter 373, F.S., such as water use permits, select “No”. These areas are still considered wetlands even if they lack wetland hydrology and may temporarily not be expressing wetland characteristics.
  - If wetland hydrology was eliminated by temporary alterations such as surface water pumps, or by temporary conditions such as droughts, select “No”. These areas are still considered wetlands even if they lack wetland hydrology and may temporarily not be expressing wetland characteristics.
- d) If the elimination of wetland hydrology is temporary or not authorized by Part IV of Chapter 373, F.S., indicate which components of 62-340.300 would express following the cessation of hydrologic alterations and return of normal wetland hydrology.
- Include evidence that is currently present as well as evidence that is predicted to be present with the return of wetland hydrology.
  - “Plants” can refer to the vegetative community, A and B test plant ratios, or both.
- e) Select which tests are predicted to be passed following the cessation of alterations, including tests that are currently being passed.
- ***If a wetland has been determined to be present using any of the 62-340.300 tests, “Wetland Definition” should be selected.***
- Explain why it is believed that these tests would be passed. “See [reference point name]” is sufficient when a reference point in an unaltered or more reliable condition has been described on a separate Form. Otherwise, list whatever evidence was used in the conclusion.
31. Illegal or Unauthorized Altered Sites: 62-340.300(3)(c)
- a) Determine if any alterations that are in violation of regulatory requirements have occurred at the described point and have affected normal expression of any wetland characteristics.
- If so, select “Yes” and describe the alterations and how they have affected the normal wetland condition.
  - Otherwise, select “No” and skip to #32.
- b) Select which of the four criteria tests could not be completely or reliably evaluated due to the unauthorized alterations on site. These answers will often reflect those in #25h, 26e, and 27e.

- c) Determine if the described point would have been identified or delineated as a wetland immediately prior to the unauthorized alterations. Use reasonable scientific judgement and all available information to make this determination in a forensic manner. A reference point in an unaltered or more reliable condition, described on a separate Data Form, is recommended if possible.
  - If the point would have been a wetland immediately prior to the unauthorized alterations, or if it is still currently a wetland despite the alterations, select “Yes”.
  - Otherwise, select “No”, explain why this area was an upland immediately prior to the unauthorized alteration and how the conclusion was reached, then skip to #32.
- d) If #31c was answered “Yes”, predict which components of 62-340.300 would have been present immediately prior to the unauthorized alterations.
  - Include evidence that is currently present as well as evidence that is predicted to have been present.
  - “Plants” can refer to the vegetative community, A and B test plant ratios, or both.
- e) Select which tests would have been passed immediately prior to the alterations, including tests that are currently being passed.
  - ***If a wetland has been determined to be present using any of the 62-340.300 tests, “Wetland Definition” should be selected.***
  - Explain why it is believed that these tests would have been passed. “See [reference point name]” is sufficient when a reference point has been described on a separate Form. Otherwise, list whatever evidence was used in the conclusion.

## Summaries

### 32. Wetland and Other Surface Water Summary

#### a) Wetland Summary

- If the described point is in a **normal condition** with no alterations, use reasonable scientific judgement to determine if the conclusions made in #25f, 25g, 26d, and 27d are reliable and if the described point meets the wetland definition in 62-340.200(19).
  - o If any of the criteria tests were reliably passed or if the definition of wetlands was met, select “Yes” and indicate which tests were reliably passed.
  - ***If a wetland has been determined to be present using any of the 62-340.300 tests, “Wetland Definition” should be selected.***
  - o If any answers in #25f, 25g, 26d, and 27d are different from the answers to #32 (*i.e.*, a criteria test was deemed unreliable), explain how this conclusion was reached with reasonable scientific judgement.
- If **authorized or legal alterations to plants or soils** have occurred at the described point, this answer should reflect those in #29d, e, and f.
- If **authorized or legal alterations to hydrology** have occurred at the described point, this answer should reflect those in #30c, d, and e. If dredge or fill alterations authorized by Part IV of Chapter 373, F.S. have permanently and completely eliminated wetland hydrology at the point, the point has legally been converted to an upland.
- If **unauthorized or illegal alterations** affected any aspect of normal wetland expression, this answer should reflect those in #31c, d, and e.

- If any of the **altered sites tests** were used, summary answers 31e are likely to differ from those in #25f, 25g, 26d, and 27d; if they do, explain why. "See #[29, 30, or 31]" may be a sufficient explanation if all relevant details have been documented in that section.
  - b) Mean High Water: 62-340.600(2)(b)
    - If there are no tidal water bodies nearby, select "No".
    - If a licensed Professional Land Surveyor has located the Mean High Water Line of a tidal water body and the point is located at or waterward of that line, select "Yes".
    - If a survey is not currently available, select "MHWL unknown".
    - **Determination of Mean High Water for 62-340 is not for purposes of title.**
  - c) Ordinary High Water: 62-340.600(2)(c)
    - If there are no bodies of open water within a distance close enough to exert a dominant influence on the hydrology of the point, select "No".
    - If an open water body exists nearby that is natural (not man-made) and non-tidal, determine its Ordinary High Water Line by direct field observation.
      - o If the described point is at or waterward of this line, select "Yes".
      - **Ordinary High Water is defined on page 37 of The "Florida Wetlands Delineation Manual", which is available for download on the Department's website, and on page 6 of the Form.**
      - **Water bodies must have little to no emergent vegetation and have standing or flowing water during normal wet season or high water that exerts an influence on the landscape. They may be ephemeral.**
      - **For non-tidal natural water systems only, the 2.33 return frequency interval (i.e. Mean Annual Flood) may be an acceptable approximation for Ordinary High Water**
      - **Determination of Ordinary High Water for 62-340 is not for purposes of title.**
  - d) Top of Bank: 62-340.600(2)(d)
    - If the point is not in or near an artificially created water body or watercourse with side slopes of 1 foot vertical to 4 feet horizontal or steeper, select "No".
    - If the point is in or near an artificially created water body or watercourse with side slopes of 1 foot vertical to 4 feet horizontal or steeper, determine where the top of the bank is.
      - o If the point is at or waterward of the top of the bank, select "Yes".
      - o Do not include spoil banks from excavation when determining top of bank.
  - e) Seasonal High Water: 62-340.600(2)(e)
    - If there are no artificially created water bodies or watercourses with side slopes flatter than 1 foot vertical to 4 feet horizontal within a distance close enough to exert an influence on the hydrology of the point, select "No".
    - If an artificially created water body or watercourse with side slopes flatter than 1 foot vertical to 4 feet horizontal exists nearby, determine its Seasonal High Water Line.
      - o If the described point is at or waterward of this line, select "Yes".
      - **Seasonal High Water is defined in 62-340.200(15)**
2. Photographs
- a) Take photographs of the evidence used to draw conclusions about wetland or other surface waters at the described point. Photo documentation tips may be found in the relevant sections above. Recommended photos include, but are not limited to:

- Vegetation: landscape photos in the four cardinal directions, plant species important to the identification or delineation of the surface water, unusual plant morphology, etc.
  - Soil: soil profile with ID, soil profile close-up, soil horizon(s) close-up, hydric soil indicator(s) close-up, unusual soil characteristics, landscape location of soil pit, observed water in soil pit, etc.
  - Hydrology: hydrologic indicators, hydrologic indicator height from ground with tape measure, non-wetland surface water indicators (e.g., basal scarring, stained leaves, drainage patterns), nearby water bodies or water control structures that may influence area hydrology, etc.
- b) For each photo, record the number from the memory card that identifies the photo. This will allow easy identification of the photo when downloaded to a computer. If multiple photos are taken of the same subject, these can be listed within the same metadata box.
  - c) Specify what is in the photo. Include a compass direction for landscape photos.
  - d) Write the initials of who took each photo. This should match a name listed in #2. Photos cannot be used as evidence in litigation without a known photographer.

### Optional Video Documentation Suggestions

- Video documentation of the same features and characteristics in the photo tips above may be taken in video format as well.
- Videos should include a statement of who is shooting the video, any other person in the video, the date recorded, the location of the site and location of the video on the site with minimal narration, explanation, or background noise.

### Notes

Record any relevant information that was not captured in another part of the form

- General description and conditions of the site and its surrounding landscape
- Current or recent weather conditions
- Information relied upon for determination of non-wetland surface water boundaries
- Features that are not specified in 62-340.500 as indicators of wetland hydrology, but that were used in conjunction with reasonable scientific judgment to guide conclusions (e.g., indicators used by the Army Corps)
- Text that would not fit in the space provided in another part of the form
  - o Write "See note [#]" in the space provided
  - o Begin text with matching [#] in Notes section
- Species of vines and aquatic plants with areal extents
- Indicate results of a fiber rub test or decant test if instrumental to a hydric soil determination. Document with photos as applicable.

### References

Florida Department of Environmental Protection, Wetlands Evaluation and Delineation Section. 1995. *The Florida Wetlands Delineation Manual*. K.M. Gilbert, J.D. Tobe, R. W. Cantrell, M.E. Sweeley, and J.R. Cooper (eds.).

Florida Department of Environmental Protection, Submerged Lands and Environmental Resources Coordination program. April 2017. *Chapter 62-340, F.A.C. Data Form Guide*. C.J. Beasley, S.L. Hinrichs, and E.D. Hickman (eds.).

Gretag-Macbeth. 2000. Munsell Color. New Windsor, NY.

Soil Science Division Staff. 2017. *Soil Survey Soil*. C. Ditzler, K. Scheffe, and H.C. Monger (eds.). USDA Handbook 18. Government Printing Office, Washington D.C.

United States Department of Agriculture, Natural Resources Conservation Service. 2016. *Field Indicators of Hydric Soils in the United States*, Version 8.0. L.M. Vasilas, G.W. Hurt, and C.V. Noble (eds.). USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils.

United States Department of Agriculture, Natural Resources Conservation Service. 2006. *Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin*. U.S. Department of Agriculture Handbook 296.

United States Department of Agriculture, National Technical Committee for Hydric Soils. *Hydric Soils Technical Note 4: Indicator Insights for Hydric Soil Identification*. Retrieved from [https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/hydric/?cid=nrcs142p2\\_053979](https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/hydric/?cid=nrcs142p2_053979)

## **Appendix L**

### **Additional Criteria for Dam Systems**

#### **1. Applicability**

This appendix contains the four criteria referenced in this Volume, subsection 8.4.5, *Dam Systems*. These criteria apply to proposed construction of new dams and alteration of existing dams, as defined in paragraph 2.0(a)27. in this Volume and meets the dam thresholds specified in the applicable Volume II. These criteria do not apply to a levee or levee system, as defined in paragraphs 2.0(a)66. and 67., respectively, in this Volume. The four criteria require: 1) providing dam system information, 2) establishing a Downstream Hazard Potential, 3) developing an Emergency Action Plan for a High Hazard Potential or Significant Hazard Potential dam, and 4) submitting a Condition Assessment Report for a High Hazard Potential or Significant Hazard Potential dam. These criteria and their requirements are described in detail below.

Applicants with such dam projects shall provide the required information to the permitting agency in the application submittal, and electronically submit this information to the Department at [DamSafety@FloridaDEP.gov](mailto:DamSafety@FloridaDEP.gov) or mail it to the State Dam Safety Officer, Florida Department of Environmental Protection, 2600 Blair Stone Road, Mail Station 3595, Tallahassee, Florida 32399. Applicants are encouraged to contact the permitting agency to request a pre-application meeting to discuss the applicability of these criteria and best approaches to meet the requirements for their specific dam project.

#### **2. Dam System Information**

Form 62-330.301(25), “Dam System Information”, incorporated by reference in subsection 62-330.301(2) shall be completed in accordance with the instructions on the form. This information will be maintained by the Department to provide a repository for these systems, and for dissemination where needed in the event of an emergency situation.

#### **3. Downstream Hazard Potential**

A Downstream Hazard Potential shall be determined for each dam based on probable loss of human life or adverse impacts on economic, environmental, and lifeline interests, and other concerns, such as water quality degradation, should the dam or appurtenant structures fail (e.g., breach) or are mis-operated (e.g., unscheduled release). Importantly, the Downstream Hazard Potential does not reflect the current safety, structural integrity, or flood routing capacity of a dam and its appurtenant structures. Also, the Downstream Hazard Potential may change over time (typically, it will increase as the downstream area is developed). Lastly, for dams in series, each upstream dam shall have a Downstream Hazard Potential equal to or greater than the next downstream dam.

##### **(1) Classification**

The Downstream Hazard Potential shall be classified as one of the three categories described below.

- a) High Hazard Potential (HHP) – Failure or mis-operation of the dam will probably cause the loss of human life. Economic, environmental, and lifeline losses may also occur, but are not necessary for this classification.
- b) Significant Hazard Potential (SHP) – Failure or mis-operation would result in no probable loss of human life, but may cause economic loss, environmental damage, disruption of lifeline interests, or impact other concerns, such as water quality degradation.

- c) Low Hazard Potential (LHP) – Failure or mis-operation is not expected to result in loss of human life and may result in low economic and/or environmental losses, that are largely limited to the owner’s property.

The table below shows the expected consequences for each Downstream Hazard Potential.

| <b>Downstream Hazard Potential</b> | <b>Loss of Human Life</b> | <b>Economic, Environmental, &amp; Lifeline Losses</b> |
|------------------------------------|---------------------------|-------------------------------------------------------|
| High                               | Probable                  | Yes, but not necessary                                |
| Significant                        | None expected             | Yes                                                   |
| Low                                | None expected             | Low and generally limited to owner’s property         |

## (2) Evaluation

For each dam, the applicant shall provide the Downstream Hazard Potential and supporting information for its determination that is developed in a manner consistent with the following methodologies:

- a) Obvious LHP dams – The Photo-Based Mapping method may be used to provide inundation maps without an engineering analysis for dams less than or equal to 10 feet in dam height and less than or equal to 1,000 acre-feet maximum storage, with no downstream structures and roads at or below the elevation of the dam crest within the expected inundation area. The dam height and maximum storage definitions to use are provided in form 62-330.301(25), *Dam System Information*. Refer to the *Emergency Action Plan Template For Florida Dams Instruction Manual* (DEP January 2023) on how to use Photo-Based Mapping to estimate conservative flood areas. The *Emergency Action Plan Template For Florida Dams Instruction Manual* is available on the [DEP website]. Submit an aerial map(s), elevation contour or digital elevation map(s), field survey (if available), dam geometry, reservoir capacity, locations and types of downstream structures, a depiction of the anticipated flood extent and a discussion of the expected consequences and Downstream Hazard Potential. The maps must be at legible scales to see structures and details. This method of classification, including the supporting information, does not need to be certified by a registered professional.
- b) Probable LHP dams – A Simplified Engineering Analysis may be used where there are few structures or roads below the dam crest and the downstream terrain is relatively flat and constant. The methodology to perform a Simplified Engineering Analysis is described in the *Emergency Action Plan Template For Florida Dams Instruction Manual* (DEP January 2023). Submit a report, including aerial map(s), elevation contour or digital elevation map(s), field survey (if available), dam and downstream geometry, reservoir capacity, locations and types of downstream structures, engineering calculations, and inundation maps, and evacuation maps, including peak flood wave depth, peak flood wave stage, and peak flood wave arrival times at the locations of interest downstream of the dam, a discussion of the study input and output parameters and expected consequences, and the Downstream Hazard Potential. If the Downstream Hazard Potential is not LHP, refer to paragraph 3.2.c below to perform an inundation study using hydrologic-hydrodynamic modeling. A registered professional must certify the Simplified Engineering Analysis and Downstream Hazard Potential designation.
- c) SHP and HHP dams. For dams that do not fit the descriptions above, the Downstream Hazard Potential shall be determined through an inundation study performed using hydrologic-hydrodynamic modeling software with two-dimensional unsteady state flow capability, preferably HEC-RAS 2D, version 6, or equivalent. The inundation report, including inundation and evacuation

maps for an Emergency Action Plan, shall meet the *Federal Guidelines for Inundation Mapping of Flood Risks Associated with Dam Incidents and Failures* (FEMA P-946, July 2013), which is incorporated by reference in subsection 62-330.010(4). The Downstream Hazard Potential shall be stated in the inundation report and certified by a registered professional qualified in the evaluation of dam systems.

#### **4. Emergency Action Plan**

An emergency action plan (EAP), as defined in paragraph 2.0(a)44 in this Volume, shall be developed for each SHP and HHP dam. The EAP may include multiple dams that are owned by the same owner(s), if they are in close proximity with one another or in succession. An EAP provides the dam owner, the dam owner's engineer, emergency management officials, and other personnel and responders with clear instructions to take should an anomalous or emergency condition develop at a dam. The EAP format is not mandatory, but the EAP shall address six basic elements: 1) detection and classification, 2) roles and responsibilities, 3) notification flow charts and contact information, 4) response procedures, 5) inundation and evacuation maps, and 6) appendixes for training, exercises, and updates. The completed EAP shall be signed and dated by the applicant or an authorized representative.

The *Emergency Action Plan Template for Florida Dams* (DEP January 2023; EAP Template) and accompanying instruction manual, *Emergency Action Plan Template For Florida Dams Instruction Manual* (DEP January 2023), are available for use to facilitate EAP development, provide consistency, and reduce costs; however, use of the EAP Template is not required. The *Emergency Action Plan Template for Florida Dams* is available on the [DEP website]. The EAP Template characterizes abnormal occurrences in three types of events: Unusual (a slowly developing event), Watch (a rapidly developing event), and Warning (an imminent or ongoing dam failure). The template may be modified to provide additional information, such as an alert system activation plan, cascading dam inundation maps, monitoring and operating plans, and multiple owners' information.

#### **5. Condition Assessment**

A Condition Assessment Report (CAR) shall be provided for each existing SHP and HHP dam. The CAR shall include completed Form 62-330.311(4), *Condition Assessment Report for Florida Dams*, incorporated by reference in subsection 62-330.311(7), F.A.C., and required supporting information, if applicable, as described below. The information in this form may be completed through a combination of new and historical inspections performed within the past five years, as long as the data are still representative of the dam condition. Copies of the original inspection reports are to be included in the CAR. The current overall condition assessment of Satisfactory, Fair, Poor, or Unsatisfactory, as defined in the form, shall be designated for each dam and certified by a registered professional qualified in the evaluation of dam systems.

**Appendix M**  
**Rainfall Criteria**

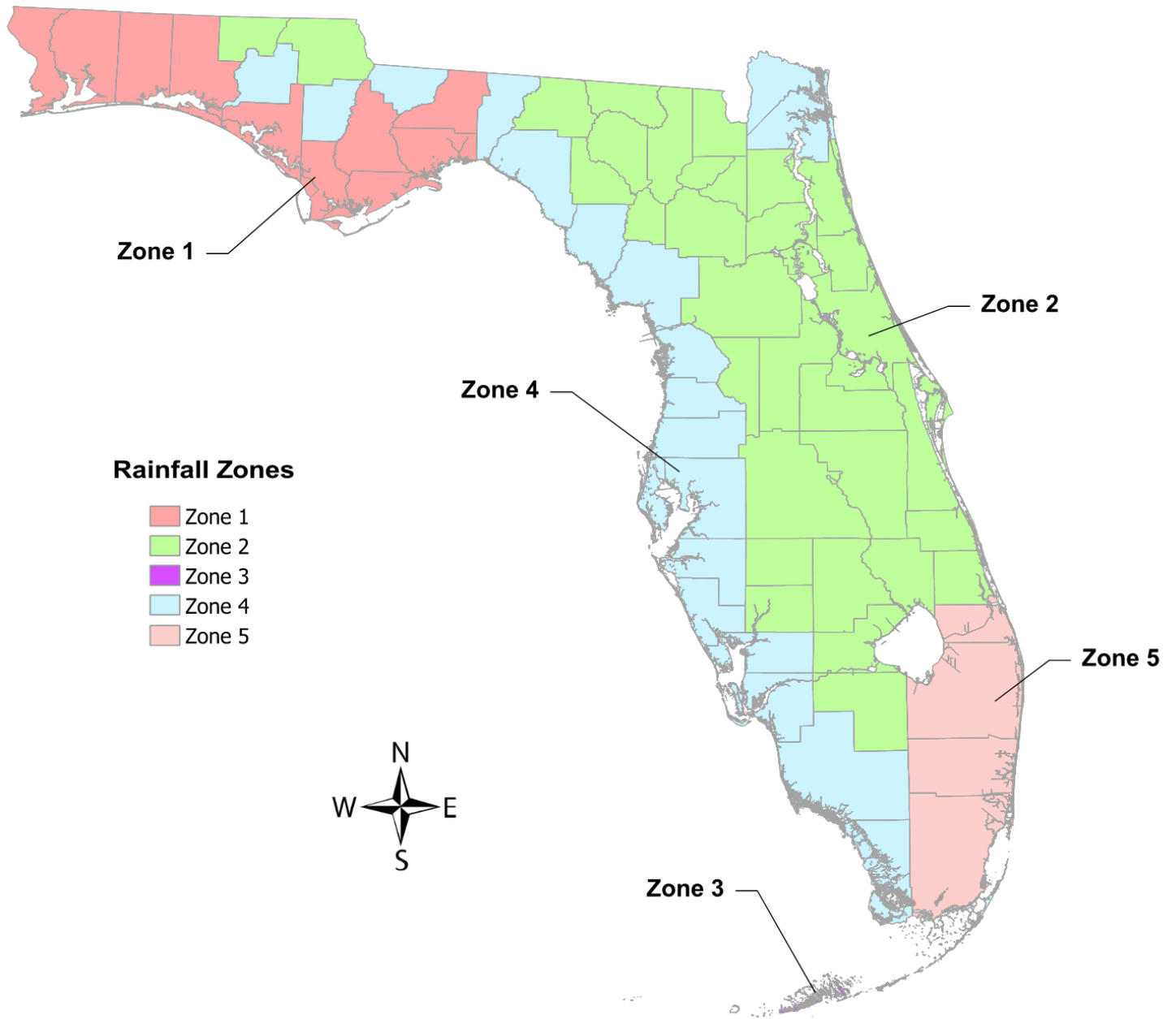


**Figure 1: Designated Meteorological Regions (Zones) in Florida**

**Table 1: Counties Included in the Designated Meteorological Zones**

|            |              |                   |              |            |
|------------|--------------|-------------------|--------------|------------|
| ZONE 1     | ZONE 2       | ZONE 3            | ZONE 4       | ZONE 5     |
| Bay        | Alachua      | Monroe County -   | Charlotte    | Broward    |
| Escambia   | Baker        | Florida Keys from | Citrus       | Miami-Dade |
| Franklin   | Bradford     | Key Largo to Key  | Collier      | Martin     |
| Gulf       | Brevard      | West              | Dixie        | Palm Beach |
| Leon       | Calhoun      |                   | Duval        |            |
| Liberty    | Clay         |                   | Hernando     |            |
| Okaloosa   | Columbia     |                   | Hillsborough |            |
| Santa Rosa | Desoto       |                   | Jefferson    |            |
| Wakulla    | Flagler      |                   | Lee          |            |
| Walton     | Gadsden      |                   | Levy         |            |
|            | Gilchrist    |                   | Manatee      |            |
|            | Glades       |                   | Mainland     |            |
|            | Hamilton     |                   | Monroe       |            |
|            | Hardee       |                   | Nassau       |            |
|            | Hendry       |                   | Pasco        |            |
|            | Highlands    |                   | Pinellas     |            |
|            | Holmes       |                   | Sarasota     |            |
|            | Indian River |                   | Taylor       |            |
|            | Jackson      |                   | Washington   |            |
|            | Lafayette    |                   |              |            |
|            | Lake         |                   |              |            |
|            | Madison      |                   |              |            |
|            | Marion       |                   |              |            |
|            | Okeechobee   |                   |              |            |
|            | Orange       |                   |              |            |
|            | Osceola      |                   |              |            |
|            | Polk         |                   |              |            |
|            | Putnam       |                   |              |            |
|            | Seminole     |                   |              |            |
|            | St. Johns    |                   |              |            |
|            | St. Lucie    |                   |              |            |
|            | Sumter       |                   |              |            |
|            | Suwannee     |                   |              |            |
|            | Union        |                   |              |            |
|            | Volusia      |                   |              |            |

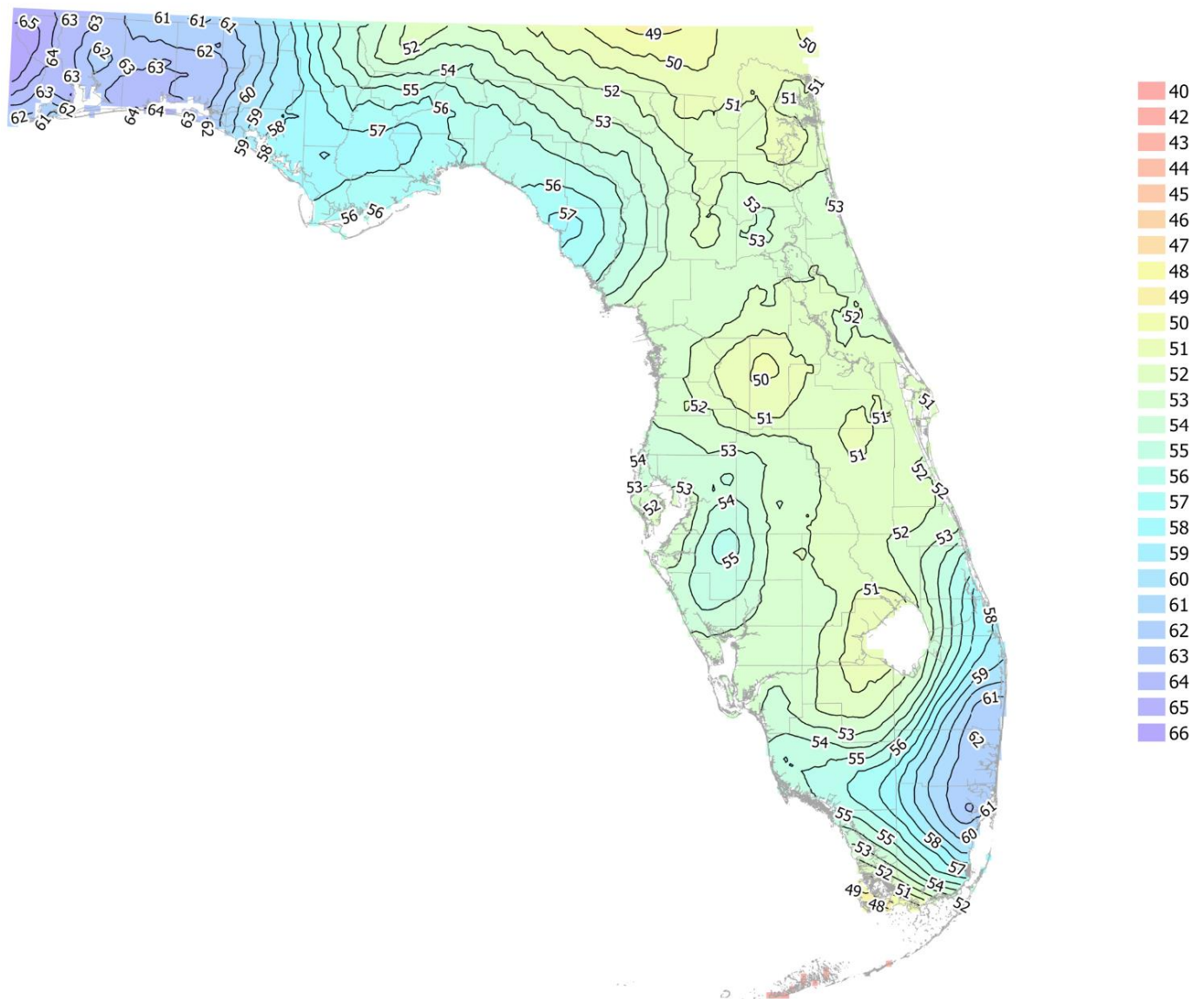


**Figure 2: Average Annual Rainfall Isoleth Map for Florida**

**Appendix N**  
**Mean Annual Runoff Coefficients (ROC Value) as a Function of DCIA Percentage and Non-DCIA Curve Number**

**ZONE 1**  
**Mean Annual Runoff Coefficients (ROC Value) as a Function**  
**of DCIA Percentage and Non-DCIA Curve Number**

| NDCIA<br>CN | 0     | 5     | 10    | 15    | 20    | 25    | 30    | 35    | 40    | 45    | 50    | 55    | 60    | 65    | 70    | 75    | 80    | 85    | 90    | 95    | 100   |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|             | 0.006 | 0.048 | 0.090 | 0.132 | 0.175 | 0.217 | 0.259 | 0.301 | 0.343 | 0.386 | 0.428 | 0.470 | 0.512 | 0.554 | 0.596 | 0.639 | 0.681 | 0.723 | 0.765 | 0.807 | 0.849 |
| 35          | 0.009 | 0.051 | 0.093 | 0.135 | 0.177 | 0.219 | 0.261 | 0.303 | 0.345 | 0.387 | 0.429 | 0.471 | 0.513 | 0.555 | 0.597 | 0.639 | 0.681 | 0.723 | 0.765 | 0.807 | 0.849 |
| 40          | 0.014 | 0.056 | 0.098 | 0.139 | 0.181 | 0.223 | 0.265 | 0.307 | 0.348 | 0.390 | 0.432 | 0.474 | 0.515 | 0.557 | 0.599 | 0.641 | 0.682 | 0.724 | 0.766 | 0.808 | 0.849 |
| 45          | 0.020 | 0.062 | 0.103 | 0.145 | 0.186 | 0.228 | 0.269 | 0.311 | 0.352 | 0.394 | 0.435 | 0.476 | 0.518 | 0.559 | 0.601 | 0.642 | 0.684 | 0.725 | 0.767 | 0.808 | 0.849 |
| 50          | 0.029 | 0.070 | 0.111 | 0.152 | 0.193 | 0.234 | 0.275 | 0.316 | 0.357 | 0.398 | 0.439 | 0.480 | 0.521 | 0.562 | 0.603 | 0.644 | 0.685 | 0.726 | 0.767 | 0.808 | 0.849 |
| 55          | 0.039 | 0.079 | 0.120 | 0.161 | 0.201 | 0.242 | 0.282 | 0.323 | 0.363 | 0.404 | 0.444 | 0.485 | 0.525 | 0.566 | 0.606 | 0.647 | 0.687 | 0.728 | 0.768 | 0.809 | 0.849 |
| 60          | 0.052 | 0.092 | 0.132 | 0.172 | 0.212 | 0.252 | 0.291 | 0.331 | 0.371 | 0.411 | 0.451 | 0.491 | 0.531 | 0.570 | 0.610 | 0.650 | 0.690 | 0.730 | 0.770 | 0.810 | 0.849 |
| 65          | 0.069 | 0.108 | 0.147 | 0.186 | 0.225 | 0.264 | 0.303 | 0.342 | 0.381 | 0.420 | 0.459 | 0.498 | 0.537 | 0.576 | 0.615 | 0.654 | 0.693 | 0.732 | 0.771 | 0.810 | 0.849 |
| 70          | 0.092 | 0.130 | 0.167 | 0.205 | 0.243 | 0.281 | 0.319 | 0.357 | 0.395 | 0.433 | 0.471 | 0.508 | 0.546 | 0.584 | 0.622 | 0.660 | 0.698 | 0.736 | 0.774 | 0.812 | 0.849 |
| 75          | 0.121 | 0.158 | 0.194 | 0.230 | 0.267 | 0.303 | 0.340 | 0.376 | 0.412 | 0.449 | 0.485 | 0.522 | 0.558 | 0.595 | 0.631 | 0.667 | 0.704 | 0.740 | 0.777 | 0.813 | 0.849 |
| 80          | 0.162 | 0.196 | 0.230 | 0.265 | 0.299 | 0.334 | 0.368 | 0.402 | 0.437 | 0.471 | 0.506 | 0.540 | 0.574 | 0.609 | 0.643 | 0.678 | 0.712 | 0.746 | 0.781 | 0.815 | 0.849 |
| 85          | 0.220 | 0.252 | 0.283 | 0.315 | 0.346 | 0.378 | 0.409 | 0.441 | 0.472 | 0.503 | 0.535 | 0.566 | 0.598 | 0.629 | 0.661 | 0.692 | 0.724 | 0.755 | 0.787 | 0.818 | 0.849 |
| 90          | 0.312 | 0.339 | 0.366 | 0.393 | 0.419 | 0.446 | 0.473 | 0.500 | 0.527 | 0.554 | 0.581 | 0.608 | 0.634 | 0.661 | 0.688 | 0.715 | 0.742 | 0.769 | 0.796 | 0.823 | 0.849 |
| 95          | 0.478 | 0.496 | 0.515 | 0.533 | 0.552 | 0.571 | 0.589 | 0.608 | 0.626 | 0.645 | 0.664 | 0.682 | 0.701 | 0.719 | 0.738 | 0.757 | 0.775 | 0.794 | 0.812 | 0.831 | 0.849 |
| 98          | 0.656 | 0.666 | 0.676 | 0.685 | 0.695 | 0.705 | 0.714 | 0.724 | 0.734 | 0.743 | 0.753 | 0.763 | 0.772 | 0.782 | 0.792 | 0.801 | 0.811 | 0.821 | 0.830 | 0.840 | 0.849 |

**ZONE 2**  
**Mean Annual Runoff Coefficients (ROC Value) as a Function**  
**of DCIA Percentage and Non-DCIA Curve Number**

| NDCIA<br>CN | 0     | 5     | 10    | 15    | 20    | 25    | 30    | 35    | 40    | 45    | 50    | 55    | 60    | 65    | 70    | 75    | 80    | 85    | 90    | 95    | 100   |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|             | 0.002 | 0.043 | 0.083 | 0.123 | 0.164 | 0.204 | 0.244 | 0.285 | 0.325 | 0.366 | 0.406 | 0.446 | 0.487 | 0.527 | 0.567 | 0.608 | 0.648 | 0.688 | 0.729 | 0.769 | 0.809 |
| 35          | 0.004 | 0.044 | 0.085 | 0.125 | 0.165 | 0.205 | 0.246 | 0.286 | 0.326 | 0.366 | 0.407 | 0.447 | 0.487 | 0.528 | 0.568 | 0.608 | 0.648 | 0.689 | 0.729 | 0.769 | 0.809 |
| 40          | 0.007 | 0.047 | 0.087 | 0.127 | 0.167 | 0.207 | 0.248 | 0.288 | 0.328 | 0.368 | 0.408 | 0.448 | 0.488 | 0.528 | 0.569 | 0.609 | 0.649 | 0.689 | 0.729 | 0.769 | 0.809 |
| 45          | 0.010 | 0.050 | 0.090 | 0.130 | 0.170 | 0.210 | 0.250 | 0.290 | 0.330 | 0.370 | 0.410 | 0.450 | 0.490 | 0.530 | 0.570 | 0.610 | 0.650 | 0.690 | 0.729 | 0.769 | 0.809 |
| 50          | 0.015 | 0.055 | 0.095 | 0.134 | 0.174 | 0.214 | 0.254 | 0.293 | 0.333 | 0.373 | 0.412 | 0.452 | 0.492 | 0.531 | 0.571 | 0.611 | 0.651 | 0.690 | 0.730 | 0.770 | 0.809 |
| 55          | 0.022 | 0.061 | 0.101 | 0.140 | 0.179 | 0.219 | 0.258 | 0.298 | 0.337 | 0.376 | 0.416 | 0.455 | 0.494 | 0.534 | 0.573 | 0.613 | 0.652 | 0.691 | 0.731 | 0.770 | 0.809 |
| 60          | 0.030 | 0.069 | 0.108 | 0.147 | 0.186 | 0.225 | 0.264 | 0.303 | 0.342 | 0.381 | 0.420 | 0.459 | 0.498 | 0.537 | 0.576 | 0.615 | 0.654 | 0.693 | 0.731 | 0.770 | 0.809 |
| 65          | 0.042 | 0.080 | 0.119 | 0.157 | 0.195 | 0.234 | 0.272 | 0.311 | 0.349 | 0.387 | 0.426 | 0.464 | 0.502 | 0.541 | 0.579 | 0.618 | 0.656 | 0.694 | 0.733 | 0.771 | 0.809 |
| 70          | 0.057 | 0.095 | 0.133 | 0.170 | 0.208 | 0.245 | 0.283 | 0.321 | 0.358 | 0.396 | 0.433 | 0.471 | 0.509 | 0.546 | 0.584 | 0.621 | 0.659 | 0.697 | 0.734 | 0.772 | 0.809 |
| 75          | 0.079 | 0.116 | 0.152 | 0.189 | 0.225 | 0.262 | 0.298 | 0.335 | 0.371 | 0.408 | 0.444 | 0.481 | 0.517 | 0.554 | 0.590 | 0.627 | 0.663 | 0.700 | 0.736 | 0.773 | 0.809 |
| 80          | 0.111 | 0.146 | 0.181 | 0.216 | 0.251 | 0.285 | 0.320 | 0.355 | 0.390 | 0.425 | 0.460 | 0.495 | 0.530 | 0.565 | 0.600 | 0.635 | 0.670 | 0.705 | 0.740 | 0.774 | 0.809 |
| 85          | 0.160 | 0.192 | 0.225 | 0.257 | 0.290 | 0.322 | 0.355 | 0.387 | 0.420 | 0.452 | 0.485 | 0.517 | 0.550 | 0.582 | 0.614 | 0.647 | 0.679 | 0.712 | 0.744 | 0.777 | 0.809 |
| 90          | 0.242 | 0.270 | 0.299 | 0.327 | 0.355 | 0.384 | 0.412 | 0.440 | 0.469 | 0.497 | 0.526 | 0.554 | 0.582 | 0.611 | 0.639 | 0.667 | 0.696 | 0.724 | 0.753 | 0.781 | 0.809 |
| 95          | 0.404 | 0.424 | 0.444 | 0.464 | 0.485 | 0.505 | 0.525 | 0.546 | 0.566 | 0.586 | 0.606 | 0.627 | 0.647 | 0.667 | 0.688 | 0.708 | 0.728 | 0.749 | 0.769 | 0.789 | 0.809 |
| 98          | 0.595 | 0.605 | 0.616 | 0.627 | 0.638 | 0.648 | 0.659 | 0.670 | 0.680 | 0.691 | 0.702 | 0.713 | 0.723 | 0.734 | 0.745 | 0.756 | 0.766 | 0.777 | 0.788 | 0.799 | 0.809 |

**ZONE 3**  
**Mean Annual Runoff Coefficients (ROC Value) as a Function**  
**of DCIA Percentage and Non-DCIA Curve Number**

| NDCIA<br>CN | 0     | 5     | 10    | 15    | 20    | 25    | 30    | 35    | 40    | 45    | 50    | 55    | 60    | 65    | 70    | 75    | 80    | 85    | 90    | 95    | 100   |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|             | 0.008 | 0.047 | 0.087 | 0.126 | 0.165 | 0.205 | 0.244 | 0.283 | 0.323 | 0.362 | 0.401 | 0.441 | 0.480 | 0.519 | 0.559 | 0.598 | 0.637 | 0.677 | 0.716 | 0.756 | 0.795 |
| 35          | 0.012 | 0.051 | 0.090 | 0.129 | 0.168 | 0.207 | 0.247 | 0.286 | 0.325 | 0.364 | 0.403 | 0.442 | 0.482 | 0.521 | 0.560 | 0.599 | 0.638 | 0.677 | 0.717 | 0.756 | 0.795 |
| 40          | 0.016 | 0.055 | 0.094 | 0.133 | 0.172 | 0.211 | 0.250 | 0.289 | 0.328 | 0.367 | 0.406 | 0.445 | 0.483 | 0.522 | 0.561 | 0.600 | 0.639 | 0.678 | 0.717 | 0.756 | 0.795 |
| 45          | 0.022 | 0.061 | 0.099 | 0.138 | 0.177 | 0.215 | 0.254 | 0.292 | 0.331 | 0.370 | 0.408 | 0.447 | 0.486 | 0.524 | 0.563 | 0.602 | 0.640 | 0.679 | 0.718 | 0.756 | 0.795 |
| 50          | 0.029 | 0.067 | 0.105 | 0.144 | 0.182 | 0.220 | 0.259 | 0.297 | 0.335 | 0.374 | 0.412 | 0.450 | 0.488 | 0.527 | 0.565 | 0.603 | 0.642 | 0.680 | 0.718 | 0.757 | 0.795 |
| 55          | 0.037 | 0.075 | 0.113 | 0.151 | 0.189 | 0.227 | 0.265 | 0.302 | 0.340 | 0.378 | 0.416 | 0.454 | 0.492 | 0.530 | 0.568 | 0.605 | 0.643 | 0.681 | 0.719 | 0.757 | 0.795 |
| 60          | 0.048 | 0.085 | 0.123 | 0.160 | 0.197 | 0.235 | 0.272 | 0.309 | 0.347 | 0.384 | 0.421 | 0.459 | 0.496 | 0.533 | 0.571 | 0.608 | 0.645 | 0.683 | 0.720 | 0.758 | 0.795 |
| 65          | 0.061 | 0.098 | 0.134 | 0.171 | 0.208 | 0.244 | 0.281 | 0.318 | 0.355 | 0.391 | 0.428 | 0.465 | 0.501 | 0.538 | 0.575 | 0.611 | 0.648 | 0.685 | 0.721 | 0.758 | 0.795 |
| 70          | 0.078 | 0.114 | 0.149 | 0.185 | 0.221 | 0.257 | 0.293 | 0.329 | 0.365 | 0.400 | 0.436 | 0.472 | 0.508 | 0.544 | 0.580 | 0.616 | 0.651 | 0.687 | 0.723 | 0.759 | 0.795 |
| 75          | 0.100 | 0.135 | 0.170 | 0.204 | 0.239 | 0.274 | 0.308 | 0.343 | 0.378 | 0.413 | 0.447 | 0.482 | 0.517 | 0.552 | 0.586 | 0.621 | 0.656 | 0.691 | 0.725 | 0.760 | 0.795 |
| 80          | 0.131 | 0.164 | 0.197 | 0.231 | 0.264 | 0.297 | 0.330 | 0.363 | 0.397 | 0.430 | 0.463 | 0.496 | 0.529 | 0.562 | 0.596 | 0.629 | 0.662 | 0.695 | 0.728 | 0.762 | 0.795 |
| 85          | 0.177 | 0.208 | 0.239 | 0.269 | 0.300 | 0.331 | 0.362 | 0.393 | 0.424 | 0.455 | 0.486 | 0.517 | 0.548 | 0.579 | 0.609 | 0.640 | 0.671 | 0.702 | 0.733 | 0.764 | 0.795 |
| 90          | 0.252 | 0.279 | 0.306 | 0.333 | 0.360 | 0.388 | 0.415 | 0.442 | 0.469 | 0.496 | 0.523 | 0.550 | 0.578 | 0.605 | 0.632 | 0.659 | 0.686 | 0.713 | 0.741 | 0.768 | 0.795 |
| 95          | 0.399 | 0.419 | 0.439 | 0.458 | 0.478 | 0.498 | 0.518 | 0.538 | 0.557 | 0.577 | 0.597 | 0.617 | 0.637 | 0.656 | 0.676 | 0.696 | 0.716 | 0.735 | 0.755 | 0.775 | 0.795 |
| 98          | 0.578 | 0.589 | 0.600 | 0.611 | 0.622 | 0.633 | 0.643 | 0.654 | 0.665 | 0.676 | 0.687 | 0.697 | 0.708 | 0.719 | 0.730 | 0.741 | 0.752 | 0.762 | 0.773 | 0.784 | 0.795 |

**ZONE 4**  
**Mean Annual Runoff Coefficients (ROC Value) as a Function**  
**of DCIA Percentage and Non-DCIA Curve Number**

| NDCIA<br>CN | 0     | 5     | 10    | 15    | 20    | 25    | 30    | 35    | 40    | 45    | 50    | 55    | 60    | 65    | 70    | 75    | 80    | 85    | 90    | 95    | 100   |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|             | 0.004 | 0.045 | 0.086 | 0.127 | 0.168 | 0.209 | 0.250 | 0.291 | 0.332 | 0.373 | 0.414 | 0.455 | 0.496 | 0.536 | 0.577 | 0.618 | 0.659 | 0.700 | 0.741 | 0.782 | 0.823 |
| 35          | 0.007 | 0.048 | 0.089 | 0.129 | 0.170 | 0.211 | 0.252 | 0.293 | 0.333 | 0.374 | 0.415 | 0.456 | 0.497 | 0.537 | 0.578 | 0.619 | 0.660 | 0.701 | 0.741 | 0.782 | 0.823 |
| 40          | 0.011 | 0.051 | 0.092 | 0.133 | 0.173 | 0.214 | 0.254 | 0.295 | 0.336 | 0.376 | 0.417 | 0.458 | 0.498 | 0.539 | 0.579 | 0.620 | 0.661 | 0.701 | 0.742 | 0.782 | 0.823 |
| 45          | 0.016 | 0.056 | 0.096 | 0.137 | 0.177 | 0.217 | 0.258 | 0.298 | 0.339 | 0.379 | 0.419 | 0.460 | 0.500 | 0.540 | 0.581 | 0.621 | 0.662 | 0.702 | 0.742 | 0.783 | 0.823 |
| 50          | 0.022 | 0.062 | 0.102 | 0.142 | 0.182 | 0.222 | 0.262 | 0.302 | 0.342 | 0.382 | 0.423 | 0.463 | 0.503 | 0.543 | 0.583 | 0.623 | 0.663 | 0.703 | 0.743 | 0.783 | 0.823 |
| 55          | 0.030 | 0.070 | 0.109 | 0.149 | 0.189 | 0.228 | 0.268 | 0.308 | 0.347 | 0.387 | 0.427 | 0.466 | 0.506 | 0.546 | 0.585 | 0.625 | 0.664 | 0.704 | 0.744 | 0.783 | 0.823 |
| 60          | 0.040 | 0.080 | 0.119 | 0.158 | 0.197 | 0.236 | 0.275 | 0.314 | 0.353 | 0.393 | 0.432 | 0.471 | 0.510 | 0.549 | 0.588 | 0.627 | 0.667 | 0.706 | 0.745 | 0.784 | 0.823 |
| 65          | 0.054 | 0.092 | 0.131 | 0.169 | 0.208 | 0.246 | 0.285 | 0.323 | 0.362 | 0.400 | 0.438 | 0.477 | 0.515 | 0.554 | 0.592 | 0.631 | 0.669 | 0.708 | 0.746 | 0.785 | 0.823 |
| 70          | 0.071 | 0.109 | 0.147 | 0.184 | 0.222 | 0.259 | 0.297 | 0.335 | 0.372 | 0.410 | 0.447 | 0.485 | 0.522 | 0.560 | 0.598 | 0.635 | 0.673 | 0.710 | 0.748 | 0.785 | 0.823 |
| 75          | 0.096 | 0.132 | 0.168 | 0.205 | 0.241 | 0.277 | 0.314 | 0.350 | 0.387 | 0.423 | 0.459 | 0.496 | 0.532 | 0.568 | 0.605 | 0.641 | 0.678 | 0.714 | 0.750 | 0.787 | 0.823 |
| 80          | 0.130 | 0.165 | 0.199 | 0.234 | 0.268 | 0.303 | 0.338 | 0.372 | 0.407 | 0.442 | 0.476 | 0.511 | 0.546 | 0.580 | 0.615 | 0.650 | 0.684 | 0.719 | 0.754 | 0.788 | 0.823 |
| 85          | 0.182 | 0.214 | 0.246 | 0.278 | 0.310 | 0.342 | 0.374 | 0.406 | 0.438 | 0.470 | 0.502 | 0.534 | 0.566 | 0.599 | 0.631 | 0.663 | 0.695 | 0.727 | 0.759 | 0.791 | 0.823 |
| 90          | 0.266 | 0.294 | 0.322 | 0.350 | 0.378 | 0.406 | 0.433 | 0.461 | 0.489 | 0.517 | 0.545 | 0.573 | 0.600 | 0.628 | 0.656 | 0.684 | 0.712 | 0.740 | 0.767 | 0.795 | 0.823 |
| 95          | 0.429 | 0.449 | 0.469 | 0.488 | 0.508 | 0.528 | 0.547 | 0.567 | 0.587 | 0.606 | 0.626 | 0.646 | 0.665 | 0.685 | 0.705 | 0.725 | 0.744 | 0.764 | 0.784 | 0.803 | 0.823 |
| 98          | 0.616 | 0.626 | 0.636 | 0.647 | 0.657 | 0.667 | 0.678 | 0.688 | 0.699 | 0.709 | 0.719 | 0.730 | 0.740 | 0.750 | 0.761 | 0.771 | 0.782 | 0.792 | 0.802 | 0.813 | 0.823 |

**ZONE 5**  
**Mean Annual Runoff Coefficients (ROC Value) as a Function**  
**of DCIA Percentage and Non-DCIA Curve Number**

| NDCIA<br>CN | 0     | 5     | 10    | 15    | 20    | 25    | 30    | 35    | 40    | 45    | 50    | 55    | 60    | 65    | 70    | 75    | 80    | 85    | 90    | 95    | 100   |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|             | 0.008 | 0.048 | 0.088 | 0.128 | 0.168 | 0.208 | 0.248 | 0.288 | 0.328 | 0.368 | 0.408 | 0.448 | 0.488 | 0.528 | 0.568 | 0.608 | 0.648 | 0.688 | 0.728 | 0.768 | 0.808 |
| 35          | 0.012 | 0.052 | 0.092 | 0.132 | 0.171 | 0.211 | 0.251 | 0.291 | 0.331 | 0.370 | 0.410 | 0.450 | 0.490 | 0.529 | 0.569 | 0.609 | 0.649 | 0.689 | 0.728 | 0.768 | 0.808 |
| 40          | 0.018 | 0.057 | 0.097 | 0.136 | 0.176 | 0.215 | 0.255 | 0.294 | 0.334 | 0.373 | 0.413 | 0.452 | 0.492 | 0.531 | 0.571 | 0.611 | 0.650 | 0.690 | 0.729 | 0.769 | 0.808 |
| 45          | 0.025 | 0.064 | 0.103 | 0.142 | 0.182 | 0.221 | 0.260 | 0.299 | 0.338 | 0.377 | 0.417 | 0.456 | 0.495 | 0.534 | 0.573 | 0.612 | 0.651 | 0.691 | 0.730 | 0.769 | 0.808 |
| 50          | 0.034 | 0.072 | 0.111 | 0.150 | 0.189 | 0.227 | 0.266 | 0.305 | 0.343 | 0.382 | 0.421 | 0.460 | 0.498 | 0.537 | 0.576 | 0.614 | 0.653 | 0.692 | 0.731 | 0.769 | 0.808 |
| 55          | 0.044 | 0.082 | 0.121 | 0.159 | 0.197 | 0.235 | 0.273 | 0.312 | 0.350 | 0.388 | 0.426 | 0.464 | 0.502 | 0.541 | 0.579 | 0.617 | 0.655 | 0.693 | 0.732 | 0.770 | 0.808 |
| 60          | 0.057 | 0.095 | 0.132 | 0.170 | 0.207 | 0.245 | 0.282 | 0.320 | 0.357 | 0.395 | 0.433 | 0.470 | 0.508 | 0.545 | 0.583 | 0.620 | 0.658 | 0.695 | 0.733 | 0.770 | 0.808 |
| 65          | 0.073 | 0.110 | 0.147 | 0.183 | 0.220 | 0.257 | 0.294 | 0.330 | 0.367 | 0.404 | 0.441 | 0.477 | 0.514 | 0.551 | 0.588 | 0.624 | 0.661 | 0.698 | 0.735 | 0.771 | 0.808 |
| 70          | 0.093 | 0.129 | 0.165 | 0.201 | 0.236 | 0.272 | 0.308 | 0.344 | 0.379 | 0.415 | 0.451 | 0.486 | 0.522 | 0.558 | 0.594 | 0.629 | 0.665 | 0.701 | 0.737 | 0.772 | 0.808 |
| 75          | 0.120 | 0.155 | 0.189 | 0.223 | 0.258 | 0.292 | 0.327 | 0.361 | 0.395 | 0.430 | 0.464 | 0.498 | 0.533 | 0.567 | 0.602 | 0.636 | 0.670 | 0.705 | 0.739 | 0.774 | 0.808 |
| 80          | 0.157 | 0.189 | 0.222 | 0.254 | 0.287 | 0.319 | 0.352 | 0.385 | 0.417 | 0.450 | 0.482 | 0.515 | 0.547 | 0.580 | 0.613 | 0.645 | 0.678 | 0.710 | 0.743 | 0.775 | 0.808 |
| 85          | 0.209 | 0.239 | 0.269 | 0.299 | 0.329 | 0.359 | 0.389 | 0.419 | 0.449 | 0.479 | 0.509 | 0.538 | 0.568 | 0.598 | 0.628 | 0.658 | 0.688 | 0.718 | 0.748 | 0.778 | 0.808 |
| 90          | 0.292 | 0.318 | 0.343 | 0.369 | 0.395 | 0.421 | 0.447 | 0.472 | 0.498 | 0.524 | 0.550 | 0.576 | 0.602 | 0.627 | 0.653 | 0.679 | 0.705 | 0.731 | 0.756 | 0.782 | 0.808 |
| 95          | 0.445 | 0.464 | 0.482 | 0.500 | 0.518 | 0.536 | 0.554 | 0.572 | 0.590 | 0.609 | 0.627 | 0.645 | 0.663 | 0.681 | 0.699 | 0.717 | 0.736 | 0.754 | 0.772 | 0.790 | 0.808 |
| 98          | 0.614 | 0.624 | 0.633 | 0.643 | 0.653 | 0.662 | 0.672 | 0.682 | 0.692 | 0.701 | 0.711 | 0.721 | 0.730 | 0.740 | 0.750 | 0.760 | 0.769 | 0.779 | 0.789 | 0.798 | 0.808 |

## Appendix O

### Traditional BMP Treatment Efficiencies

#### Directions for use

This listing of BMPs defines the treatment efficiencies for total phosphorous (TP) and total nitrogen (TN) for traditional BMPs. Applicants will determine the predicted pollutant loading from their post development site the treatment efficiency required as described in applicant's Handbook Volume I. Treatment efficiencies for traditional BMPs alone are listed in the table. Some BMPs do not have a static efficiency and the applicant will have to refer to the formulas or tables provided to calculate the BMP's efficiency. Applicants will design their system so that their BMP's Efficiency, either by itself or in series with others, matches the required efficiency set forth in AH Vol I. BMPs designed in series will have their treatment efficiencies calculated by the formula listed in the BMP Treatment Train section.

All BMPs are required to meet all the design requirements outlined in the applicable Applicant's Handbook Volume II.

Table 1: of BMP Efficiencies

| BMP                                                      | TP Reduction                                                                                                                                | TN Reduction                                                                                                                                | Data Source                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">Retention Pond and Retention Systems</a>     | Based on percent reduction using project's percent directly connected impervious area (DCIA), non-DCIA curve number (CN), and rainfall zone | Based on percent reduction using project's percent directly connected impervious area (DCIA), non-DCIA curve number (CN), and rainfall zone | Evaluation of current stormwater design criteria within the state of Florida, Harper and Baker 2007                                                                                                                                                                                                                                                                                              |
| <a href="#">Wet detention ponds</a>                      | <a href="#">Formula based on Average Annual Residence Time</a> for Removal Efficiency of Total Phosphorus                                   | <a href="#">Formula based on Average Annual Residence Time</a> Removal Efficiency of Total Nitrogen                                         | Evaluation of current stormwater design criteria within the state of Florida, Harper and Baker 2007                                                                                                                                                                                                                                                                                              |
| Baffle boxes (gravity-based separators)—First generation | 2.30%                                                                                                                                       | 0.50%                                                                                                                                       | Final report, Contract S0236, Effectiveness of baffle boxes plus media filter, by GPI Southeast 2010; Demonstration bio media for ultra-urban stormwater treatment, by University of Central Florida (UCF) for Florida Department of Transportation (FDOT); and Final report, Contract S0497, Baffle box with media filtration installation and effectiveness evaluation by City of Casselberry, |

| <b>BMP</b>                                                                                 | <b>TP Reduction</b>  | <b>TN Reduction</b>  | <b>Data Source</b>                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------------------------------------------------------------|----------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Baffle boxes (gravity-based separators)—<br>Second generation                              | 15.50%               | 19.05%               | Final report, Contract S0236, Effectiveness of baffle boxes plus media filter, by GPI Southeast 2010; Demonstration bio media for ultra-urban stormwater treatment, by University of Central Florida (UCF) for Florida Department of Transportation (FDOT); and Final report, Contract S0497, Baffle box with media filtration installation and effectiveness evaluation by City of Casselberry, |
| Baffle boxes (gravity-based separators)—<br>Second generation plus media filter            | Media Mix Efficiency | Media Mix Efficiency | Final report, Contract S0236, Effectiveness of baffle boxes plus media filter, by GPI Southeast 2010; Demonstration bio media for ultra-urban stormwater treatment, by University of Central Florida (UCF) for Florida Department of Transportation (FDOT); and Final report, Contract S0497, Baffle box with media filtration installation and effectiveness evaluation by City of Casselberry, |
| Hydrodynamic separators (including vortex and continuous deflector separators [CDS] units) | 10%                  | N/A                  | Final Report, Contract S0095, Sanford Stormceptor Project, 2008; Final Report, Contract WM793, Broadway Outfall Project, 2006                                                                                                                                                                                                                                                                    |

| <b>BMP</b>                                                                                                                                                                                                                                                              | <b>TP Reduction</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>TN Reduction</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>Data Source</b>                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Catch basin inserts/inlet filter cleanout (drainage features and units with no specific water quality treatment mechanism), including the following: • Curb inlets. • Area catch basins. • Pavement catch basins. • Projects serving drainage and conveyance functions. | Determine annual average dry weight/volume of material collected over a period of 3 years (or representative period of current effort) and enter values into the Florida Stormwater Association (FSA) University of Florida (UF) Municipal Separate Storm Sewer (MS4) BMP Toolkit ( <a href="#">FINAL MS4 Load Reduction Tool 2019 or newer version</a> ) for estimated TP reduction | Determine annual average dry weight/volume of material collected over a period of 3 years (or representative period of current effort) and enter values into the Florida Stormwater Association (FSA) University of Florida (UF) Municipal Separate Storm Sewer (MS4) BMP Toolkit ( <a href="#">FINAL MS4 Load Reduction Tool 2019 or newer version</a> ) for estimated TN reduction | 2019 Final Report (or newer version), FSA UF MS4 BMP Project                                                                                                                                                                                                                         |
| <a href="#">Green Stormwater Infrastructure Efforts</a><br>Including: Green Roofs, Rain gardens, Swales with blocks, Bioswales, Tree boxes, Tree wells, Vegetated Natural Buffers, Vegetated filter strip, Pervious Pavement Systems                                    | Use appropriate retention or detention calculation for volume captured then add an additional removal based on plant, soil and media selections in a treatment train configuration.                                                                                                                                                                                                  | Use appropriate retention or detention calculation for volume captured then add an additional removal based on plant, soil and media selections in a treatment train configuration.                                                                                                                                                                                                  | Evaluation of current stormwater design criteria within the state of Florida, Harper and Baker 2007                                                                                                                                                                                  |
| Floating islands/managed aquatic plant systems (MAPS)                                                                                                                                                                                                                   | 12% removal with 5 % pond coverage based on harvesting at least every 12 months.                                                                                                                                                                                                                                                                                                     | 12% removal with 5 % pond coverage based on harvesting at least every 12 months.                                                                                                                                                                                                                                                                                                     | Floating Wetland Systems for Nutrient Removal in Stormwater Ponds Wanielista and Chang 2012                                                                                                                                                                                          |
| Littoral Zone                                                                                                                                                                                                                                                           | Maximum 10% removal with a minimum littoral zone area as described in AH Volume II.                                                                                                                                                                                                                                                                                                  | Maximum 10% removal with a minimum littoral zone area as described in AH Volume II.                                                                                                                                                                                                                                                                                                  | Nutrient Removal From Urban Storm Urban Stormwater Using Floating Stormwater Using Floating Treatment Wetland System<br>Kamrul Islam 2011<br><br>Quantifying the Effect of a Vegetated Littoral Zone on Wet Detention Pond Pollutant Load Reduction<br>DB Environmental, Inc. (2005) |

| BMP                               | TP Reduction                                                                                                         | TN Reduction                                                                                                         | Data Source                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Stormwater harvesting             | Estimate annual load of stormwater (and percentage of total if not 100 %) not discharged because used for irrigation | Estimate annual load of stormwater (and percentage of total if not 100 %) not discharged because used for irrigation | Evaluated on case-by-case basis (to estimate volume of stormwater reuse, use the rate-efficiency-volume [REV] curve methodology used by DEP. Based on 1991 Wanielista, M., Y. Yousef, G. Harper, and L. Dansereau, Design Curves for the Reuse of Stormwater and 1992 Wanielista, M. and J. Bradner, Maintaining the Balance) |
| Stormwater alum injection systems | Based on dosage determined in jar testing                                                                            | Based on dosage determined in jar testing                                                                            | Harper, H., and J. Herr 1998 study for DEP – Alum treatment of stormwater: The first ten years                                                                                                                                                                                                                                |

### Treatment Train

BMPs can be implemented in combination or in conjunction with one another in a series called a best management practice treatment train. Where BMPs are used in series, the calculated overall efficiency of the treatment train must account for the reduced loading or concentrations that are available for removal by the subsequent downstream treatment device. This relationship is shown in Equation 9-5. This equation assumes each BMP acts independently of upstream BMPs, and that upstream BMPs do not impact performance of downstream BMPs. As stormwater pollutant concentrations are reduced in each BMP in the treatment train, the ability of a downstream BMP in the treatment train should not be arbitrarily reduced when used in Equation 9-5. The overall design removal calculations for a BMP treatment train should reflect any objective information where there is an identifiable causal relationship where a downstream unit treatment efficiency would be diminished in some manner by the operation of a specific upstream treatment unit. If such a causal relationship exists where the BMP acts in combination with the upstream BMP, the designer should consider the use of another methodology to accurately determine the resultant efficiency of the overall BMP treatment train.

Equation 9-5: Overall Treatment Train Efficiency for systems in series

*Overall Treatment Train Efficiency*

$$= Eff1 + [(1 - Eff1) \times Eff2] + \{[(1 - Eff1) - ((1 - Eff1) \times Eff2)] \times Eff3\}$$

*or (in simplified form)*

$$= 1 - [(1 - Eff1) \times (1 - Eff2) \times (1 - Eff3) \times \dots \times (1 - Effn)]$$

where:

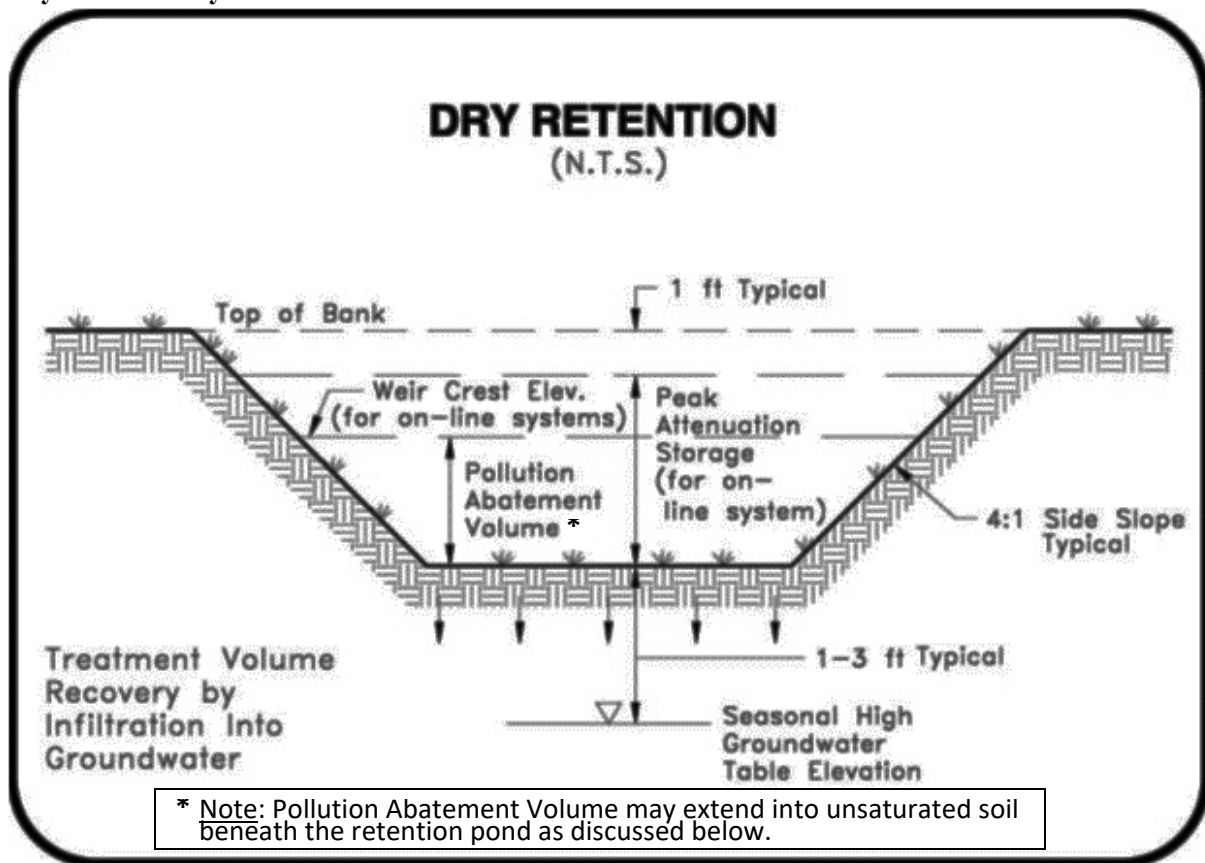
Eff1 = efficiency (as a decimal) of initial or first treatment system

Eff2 = efficiency (as a decimal) of second treatment system

Eff3 = efficiency (as a decimal) of third treatment system

Effn = efficiency (as a decimal) of the n<sup>th</sup> treatment system

## Dry Retention Systems



The average annual effectiveness is calculated using an event maximum runoff volume that can be captured in the retention system. This maximum volume is expressed as inches over the catchment area and is called the design volume. It is adjusted for the Curve Number (CN) applied to the non-directly connected impervious area (NDCIA) and the directly connected impervious area (DCIA).

Recovery of the required treatment volume (Pollution Abatement Volume, or PAV) must be achieved within 72 hours or less, equivalent to the volume recovery period utilized for generation of the performance efficiency summarized in the tables. Ability of the pond to achieve this recovery rate must be certified by a registered professional engineer. The required PAV may include the effective unsaturated soil volume beneath the retention pond, to the elevation of the seasonal high groundwater level; however, the PAV inside and above the pond bottom shall at least equal 0.5 inches over the project drainage area for the pond. All side slopes and bottom areas of the pond must be seeded or sodded with water-tolerant grass species grown on sandy soils. If sod is used as the vegetative cover on the bottom of the pond, changes in permeability of the basin resulting from the sod must be included in evaluation of the recovery period for the pond. Inlets and outlets must be located as far apart as possible to prevent short-circuiting. Oil and grease skimmers must be provided at all outfall structures. Other requirements related to side slopes, fencing, maintenance berms, and access will adhere to applicable local agency criteria.

There are 80 tables reflecting design retention depths for five rainfall regions. Each region has a table for 17 different design retention depths. For DCIA and CN other than increments of 5, linear interpolation between the values is performed.

**Mean Annual Mass Removal Efficiencies for 0.25-inches of Retention for Zone 1 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 86.2 | 81.3 | 73.3 | 65.5 | 58.7 | 53.0 | 48.3 | 44.2 | 40.8 | 37.9 | 35.3 | 33.1 | 31.1 | 29.4 | 27.8 | 26.4 | 25.1 | 24.0 | 22.9 | 21.9 |
| 35          | 81.6 | 78.7 | 71.7 | 64.5 | 58.0 | 52.5 | 47.9 | 44.0 | 40.6 | 37.7 | 35.2 | 33.0 | 31.0 | 29.3 | 27.8 | 26.4 | 25.1 | 23.9 | 22.9 | 21.9 |
| 40          | 76.4 | 75.5 | 69.6 | 63.1 | 57.1 | 51.9 | 47.4 | 43.6 | 40.3 | 37.5 | 35.0 | 32.9 | 30.9 | 29.2 | 27.7 | 26.3 | 25.1 | 23.9 | 22.9 | 21.9 |
| 45          | 70.7 | 71.7 | 67.2 | 61.4 | 55.9 | 51.0 | 46.8 | 43.1 | 40.0 | 37.2 | 34.8 | 32.7 | 30.8 | 29.1 | 27.6 | 26.3 | 25.0 | 23.9 | 22.9 | 21.9 |
| 50          | 64.7 | 67.5 | 64.2 | 59.4 | 54.5 | 50.0 | 46.0 | 42.6 | 39.5 | 36.9 | 34.6 | 32.5 | 30.7 | 29.0 | 27.5 | 26.2 | 25.0 | 23.9 | 22.9 | 21.9 |
| 55          | 58.6 | 62.8 | 60.9 | 57.0 | 52.7 | 48.7 | 45.1 | 41.8 | 39.0 | 36.5 | 34.2 | 32.3 | 30.5 | 28.9 | 27.4 | 26.1 | 24.9 | 23.9 | 22.9 | 21.9 |
| 60          | 52.8 | 57.8 | 57.1 | 54.2 | 50.7 | 47.1 | 43.9 | 40.9 | 38.3 | 35.9 | 33.8 | 31.9 | 30.2 | 28.7 | 27.3 | 26.0 | 24.9 | 23.8 | 22.8 | 21.9 |
| 65          | 47.3 | 52.6 | 53.0 | 51.1 | 48.3 | 45.3 | 42.5 | 39.8 | 37.4 | 35.3 | 33.3 | 31.5 | 29.9 | 28.4 | 27.1 | 25.9 | 24.8 | 23.8 | 22.8 | 21.9 |
| 70          | 42.2 | 47.3 | 48.6 | 47.6 | 45.6 | 43.2 | 40.8 | 38.5 | 36.4 | 34.4 | 32.6 | 31.0 | 29.5 | 28.1 | 26.9 | 25.7 | 24.7 | 23.7 | 22.8 | 21.9 |
| 75          | 37.8 | 42.2 | 43.9 | 43.7 | 42.4 | 40.7 | 38.8 | 36.9 | 35.1 | 33.4 | 31.8 | 30.4 | 29.0 | 27.8 | 26.6 | 25.5 | 24.5 | 23.6 | 22.7 | 21.9 |
| 80          | 34.0 | 37.5 | 39.1 | 39.4 | 38.8 | 37.7 | 36.4 | 34.9 | 33.5 | 32.1 | 30.8 | 29.5 | 28.3 | 27.2 | 26.2 | 25.2 | 24.3 | 23.5 | 22.7 | 21.9 |
| 85          | 30.8 | 33.1 | 34.3 | 34.8 | 34.7 | 34.2 | 33.4 | 32.5 | 31.4 | 30.4 | 29.4 | 28.4 | 27.4 | 26.5 | 25.7 | 24.8 | 24.1 | 23.3 | 22.6 | 21.9 |
| 90          | 27.9 | 29.2 | 29.9 | 30.3 | 30.3 | 30.2 | 29.8 | 29.3 | 28.8 | 28.2 | 27.5 | 26.8 | 26.2 | 25.5 | 24.9 | 24.2 | 23.6 | 23.0 | 22.5 | 21.9 |
| 95          | 25.3 | 25.6 | 25.8 | 25.9 | 26.0 | 25.9 | 25.8 | 25.6 | 25.4 | 25.2 | 24.9 | 24.6 | 24.3 | 24.0 | 23.6 | 23.3 | 23.0 | 22.6 | 22.3 | 21.9 |
| 98          | 23.8 | 23.8 | 23.8 | 23.7 | 23.7 | 23.6 | 23.5 | 23.4 | 23.3 | 23.2 | 23.1 | 23.0 | 22.9 | 22.8 | 22.6 | 22.5 | 22.4 | 22.2 | 22.1 | 21.9 |

**Mean Annual Mass Removal Efficiencies for 0.50-inches of Retention for Zone 1 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 91.8 | 91.5 | 88.3 | 84.0 | 79.5 | 75.0 | 70.7 | 66.6 | 62.9 | 59.6 | 56.5 | 53.6 | 51.1 | 48.7 | 46.6 | 44.6 | 42.8 | 41.1 | 39.6 | 38.1 |
| 35          | 88.2 | 89.1 | 86.6 | 82.8 | 78.6 | 74.3 | 70.1 | 66.2 | 62.6 | 59.3 | 56.3 | 53.5 | 51.0 | 48.7 | 46.5 | 44.6 | 42.8 | 41.1 | 39.6 | 38.1 |
| 40          | 84.0 | 86.3 | 84.4 | 81.2 | 77.4 | 73.4 | 69.4 | 65.7 | 62.2 | 59.0 | 56.0 | 53.3 | 50.8 | 48.5 | 46.4 | 44.5 | 42.7 | 41.1 | 39.6 | 38.1 |
| 45          | 79.6 | 82.9 | 81.9 | 79.3 | 75.9 | 72.2 | 68.5 | 65.0 | 61.7 | 58.6 | 55.7 | 53.0 | 50.6 | 48.4 | 46.3 | 44.4 | 42.7 | 41.0 | 39.5 | 38.1 |
| 50          | 74.8 | 79.1 | 79.0 | 77.0 | 74.1 | 70.8 | 67.4 | 64.1 | 61.0 | 58.0 | 55.3 | 52.7 | 50.4 | 48.2 | 46.2 | 44.3 | 42.6 | 41.0 | 39.5 | 38.1 |
| 55          | 70.1 | 74.9 | 75.6 | 74.2 | 71.9 | 69.1 | 66.1 | 63.0 | 60.1 | 57.3 | 54.7 | 52.3 | 50.0 | 47.9 | 46.0 | 44.2 | 42.5 | 40.9 | 39.5 | 38.1 |
| 60          | 65.5 | 70.4 | 71.7 | 71.1 | 69.4 | 67.0 | 64.4 | 61.7 | 59.1 | 56.5 | 54.1 | 51.8 | 49.6 | 47.6 | 45.8 | 44.0 | 42.4 | 40.9 | 39.5 | 38.1 |
| 65          | 61.0 | 65.8 | 67.5 | 67.6 | 66.4 | 64.7 | 62.5 | 60.2 | 57.8 | 55.5 | 53.3 | 51.1 | 49.1 | 47.2 | 45.5 | 43.8 | 42.3 | 40.8 | 39.4 | 38.1 |
| 70          | 56.7 | 61.1 | 63.1 | 63.6 | 63.1 | 61.9 | 60.2 | 58.3 | 56.3 | 54.3 | 52.3 | 50.3 | 48.5 | 46.8 | 45.1 | 43.5 | 42.1 | 40.7 | 39.4 | 38.1 |
| 75          | 52.7 | 56.6 | 58.6 | 59.3 | 59.3 | 58.6 | 57.5 | 56.0 | 54.4 | 52.7 | 51.0 | 49.3 | 47.7 | 46.1 | 44.6 | 43.2 | 41.8 | 40.5 | 39.3 | 38.1 |
| 80          | 49.1 | 52.2 | 54.1 | 55.0 | 55.2 | 54.9 | 54.2 | 53.2 | 52.1 | 50.8 | 49.4 | 48.0 | 46.6 | 45.3 | 44.0 | 42.7 | 41.5 | 40.3 | 39.2 | 38.1 |
| 85          | 46.1 | 48.3 | 49.7 | 50.5 | 50.8 | 50.8 | 50.5 | 49.9 | 49.2 | 48.3 | 47.3 | 46.3 | 45.2 | 44.2 | 43.1 | 42.1 | 41.0 | 40.0 | 39.1 | 38.1 |
| 90          | 43.5 | 44.8 | 45.6 | 46.1 | 46.4 | 46.5 | 46.4 | 46.1 | 45.7 | 45.2 | 44.6 | 44.0 | 43.3 | 42.6 | 41.9 | 41.1 | 40.4 | 39.6 | 38.9 | 38.1 |
| 95          | 41.1 | 41.5 | 41.8 | 41.9 | 42.0 | 42.1 | 42.0 | 41.9 | 41.8 | 41.6 | 41.3 | 41.1 | 40.8 | 40.4 | 40.1 | 39.7 | 39.3 | 38.9 | 38.5 | 38.1 |
| 98          | 39.8 | 39.8 | 39.8 | 39.8 | 39.8 | 39.7 | 39.7 | 39.6 | 39.5 | 39.4 | 39.3 | 39.2 | 39.1 | 39.0 | 38.9 | 38.7 | 38.6 | 38.4 | 38.3 | 38.1 |

**Mean Annual Mass Removal Efficiencies for 0.75-inches of Retention for Zone 1 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 94.0 | 94.9 | 93.4 | 91.0 | 88.1 | 85.0 | 81.8 | 78.7 | 75.5 | 72.6 | 69.7 | 67.0 | 64.5 | 62.1 | 59.8 | 57.7 | 55.7 | 53.8 | 52.1 | 50.5 |
| 35          | 91.2 | 93.0 | 91.9 | 89.8 | 87.2 | 84.2 | 81.2 | 78.2 | 75.2 | 72.3 | 69.5 | 66.8 | 64.3 | 62.0 | 59.7 | 57.6 | 55.7 | 53.8 | 52.1 | 50.5 |
| 40          | 88.1 | 90.5 | 90.1 | 88.3 | 86.0 | 83.3 | 80.5 | 77.6 | 74.7 | 71.9 | 69.2 | 66.6 | 64.1 | 61.8 | 59.6 | 57.6 | 55.6 | 53.8 | 52.1 | 50.5 |
| 45          | 84.5 | 87.7 | 87.9 | 86.5 | 84.5 | 82.1 | 79.5 | 76.8 | 74.0 | 71.4 | 68.8 | 66.3 | 63.9 | 61.6 | 59.5 | 57.5 | 55.5 | 53.7 | 52.0 | 50.5 |
| 50          | 80.8 | 84.6 | 85.2 | 84.4 | 82.8 | 80.7 | 78.3 | 75.8 | 73.3 | 70.7 | 68.3 | 65.9 | 63.6 | 61.4 | 59.3 | 57.3 | 55.5 | 53.7 | 52.0 | 50.5 |
| 55          | 77.1 | 81.1 | 82.2 | 81.9 | 80.7 | 79.0 | 76.9 | 74.6 | 72.3 | 70.0 | 67.6 | 65.4 | 63.2 | 61.1 | 59.1 | 57.2 | 55.3 | 53.6 | 52.0 | 50.5 |
| 60          | 73.2 | 77.5 | 79.0 | 79.1 | 78.3 | 76.9 | 75.2 | 73.2 | 71.1 | 69.0 | 66.9 | 64.7 | 62.7 | 60.7 | 58.8 | 56.9 | 55.2 | 53.5 | 51.9 | 50.5 |
| 65          | 69.6 | 73.8 | 75.4 | 75.8 | 75.5 | 74.5 | 73.2 | 71.5 | 69.7 | 67.8 | 65.9 | 63.9 | 62.0 | 60.2 | 58.4 | 56.7 | 55.0 | 53.4 | 51.9 | 50.5 |
| 70          | 66.1 | 69.9 | 71.7 | 72.3 | 72.3 | 71.7 | 70.8 | 69.5 | 68.0 | 66.4 | 64.7 | 63.0 | 61.3 | 59.6 | 57.9 | 56.3 | 54.8 | 53.3 | 51.8 | 50.5 |
| 75          | 62.7 | 66.0 | 67.8 | 68.6 | 68.8 | 68.5 | 67.9 | 67.1 | 65.9 | 64.7 | 63.3 | 61.8 | 60.3 | 58.8 | 57.3 | 55.9 | 54.5 | 53.1 | 51.7 | 50.5 |
| 80          | 59.6 | 62.2 | 63.8 | 64.7 | 65.1 | 65.1 | 64.8 | 64.2 | 63.4 | 62.5 | 61.4 | 60.3 | 59.1 | 57.8 | 56.6 | 55.3 | 54.0 | 52.8 | 51.6 | 50.5 |
| 85          | 56.8 | 58.7 | 60.0 | 60.8 | 61.2 | 61.4 | 61.3 | 61.0 | 60.5 | 59.9 | 59.1 | 58.3 | 57.4 | 56.5 | 55.5 | 54.5 | 53.5 | 52.5 | 51.4 | 50.5 |
| 90          | 54.5 | 55.6 | 56.4 | 57.0 | 57.3 | 57.5 | 57.5 | 57.4 | 57.2 | 56.8 | 56.4 | 55.9 | 55.4 | 54.7 | 54.1 | 53.4 | 52.7 | 51.9 | 51.2 | 50.5 |
| 95          | 52.5 | 52.9 | 53.2 | 53.3 | 53.5 | 53.6 | 53.6 | 53.6 | 53.5 | 53.4 | 53.2 | 53.0 | 52.8 | 52.5 | 52.2 | 51.9 | 51.6 | 51.2 | 50.8 | 50.5 |
| 98          | 51.7 | 51.7 | 51.7 | 51.7 | 51.7 | 51.7 | 51.7 | 51.6 | 51.6 | 51.5 | 51.4 | 51.3 | 51.3 | 51.2 | 51.1 | 51.0 | 50.8 | 50.7 | 50.6 | 50.5 |

**Mean Annual Mass Removal Efficiencies for 1.00-inches of Retention for Zone 1 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 95.3 | 96.5 | 95.9 | 94.4 | 92.5 | 90.3 | 87.9 | 85.5 | 83.1 | 80.6 | 78.2 | 75.8 | 73.6 | 71.4 | 69.2 | 67.2 | 65.3 | 63.4 | 61.6 | 60.0 |
| 35          | 93.1 | 94.9 | 94.6 | 93.3 | 91.6 | 89.5 | 87.3 | 85.0 | 82.7 | 80.3 | 77.9 | 75.6 | 73.4 | 71.2 | 69.1 | 67.1 | 65.2 | 63.4 | 61.6 | 60.0 |
| 40          | 90.7 | 93.0 | 93.0 | 92.0 | 90.5 | 88.6 | 86.6 | 84.4 | 82.1 | 79.9 | 77.6 | 75.4 | 73.2 | 71.1 | 69.0 | 67.0 | 65.2 | 63.3 | 61.6 | 60.0 |
| 45          | 88.0 | 90.7 | 91.0 | 90.5 | 89.2 | 87.5 | 85.6 | 83.6 | 81.5 | 79.3 | 77.2 | 75.0 | 72.9 | 70.9 | 68.8 | 66.9 | 65.1 | 63.3 | 61.6 | 60.0 |
| 50          | 85.0 | 88.0 | 88.8 | 88.6 | 87.6 | 86.2 | 84.5 | 82.7 | 80.7 | 78.7 | 76.6 | 74.6 | 72.6 | 70.6 | 68.6 | 66.8 | 65.0 | 63.2 | 61.6 | 60.0 |
| 55          | 81.8 | 85.3 | 86.4 | 86.3 | 85.7 | 84.6 | 83.2 | 81.5 | 79.8 | 77.9 | 75.9 | 74.0 | 72.1 | 70.2 | 68.4 | 66.6 | 64.8 | 63.1 | 61.5 | 60.0 |
| 60          | 78.7 | 82.3 | 83.6 | 83.9 | 83.5 | 82.7 | 81.5 | 80.1 | 78.6 | 76.9 | 75.1 | 73.4 | 71.6 | 69.8 | 68.0 | 66.3 | 64.7 | 63.0 | 61.5 | 60.0 |
| 65          | 75.6 | 79.1 | 80.6 | 81.2 | 81.0 | 80.5 | 79.6 | 78.5 | 77.2 | 75.7 | 74.1 | 72.5 | 70.9 | 69.3 | 67.6 | 66.0 | 64.4 | 62.9 | 61.4 | 60.0 |
| 70          | 72.7 | 75.9 | 77.5 | 78.2 | 78.3 | 78.0 | 77.4 | 76.5 | 75.5 | 74.2 | 72.9 | 71.5 | 70.1 | 68.6 | 67.1 | 65.6 | 64.2 | 62.7 | 61.3 | 60.0 |
| 75          | 69.9 | 72.7 | 74.2 | 75.0 | 75.3 | 75.2 | 74.8 | 74.2 | 73.4 | 72.5 | 71.4 | 70.3 | 69.1 | 67.8 | 66.5 | 65.1 | 63.8 | 62.5 | 61.2 | 60.0 |
| 80          | 67.2 | 69.5 | 70.8 | 71.7 | 72.1 | 72.1 | 72.0 | 71.6 | 71.1 | 70.4 | 69.6 | 68.7 | 67.8 | 66.7 | 65.6 | 64.5 | 63.4 | 62.2 | 61.1 | 60.0 |
| 85          | 64.8 | 66.5 | 67.6 | 68.3 | 68.7 | 68.9 | 68.9 | 68.7 | 68.4 | 68.0 | 67.5 | 66.8 | 66.1 | 65.4 | 64.5 | 63.7 | 62.8 | 61.8 | 60.9 | 60.0 |
| 90          | 62.7 | 63.7 | 64.4 | 65.0 | 65.3 | 65.5 | 65.6 | 65.6 | 65.5 | 65.2 | 65.0 | 64.6 | 64.2 | 63.7 | 63.1 | 62.6 | 61.9 | 61.3 | 60.6 | 60.0 |
| 95          | 61.1 | 61.5 | 61.8 | 62.0 | 62.1 | 62.2 | 62.3 | 62.3 | 62.3 | 62.2 | 62.1 | 62.0 | 61.8 | 61.6 | 61.4 | 61.2 | 60.9 | 60.6 | 60.3 | 60.0 |
| 98          | 60.7 | 60.7 | 60.7 | 60.8 | 60.8 | 60.8 | 60.8 | 60.8 | 60.7 | 60.7 | 60.7 | 60.6 | 60.6 | 60.5 | 60.4 | 60.3 | 60.3 | 60.2 | 60.1 | 60.0 |

### Mean Annual Mass Removal Efficiencies for 1.25-inches of Retention for Zone 1 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 96.1 | 97.3 | 97.2 | 96.3 | 94.9 | 93.4 | 91.6 | 89.7 | 87.8 | 85.8 | 83.8 | 81.8 | 79.9 | 77.9 | 76.0 | 74.2 | 72.4 | 70.6 | 68.9 | 67.3 |
| 35          | 94.5 | 96.1 | 96.2 | 95.4 | 94.1 | 92.7 | 91.0 | 89.2 | 87.4 | 85.5 | 83.5 | 81.6 | 79.7 | 77.8 | 75.9 | 74.1 | 72.3 | 70.6 | 68.9 | 67.3 |
| 40          | 92.5 | 94.5 | 94.8 | 94.2 | 93.2 | 91.9 | 90.3 | 88.6 | 86.9 | 85.0 | 83.2 | 81.3 | 79.5 | 77.6 | 75.8 | 74.0 | 72.3 | 70.6 | 68.9 | 67.3 |
| 45          | 90.4 | 92.7 | 93.2 | 92.8 | 92.0 | 90.9 | 89.4 | 87.9 | 86.3 | 84.5 | 82.8 | 81.0 | 79.2 | 77.4 | 75.6 | 73.9 | 72.2 | 70.5 | 68.9 | 67.3 |
| 50          | 88.0 | 90.6 | 91.3 | 91.2 | 90.6 | 89.7 | 88.4 | 87.0 | 85.5 | 83.9 | 82.2 | 80.5 | 78.8 | 77.1 | 75.4 | 73.7 | 72.1 | 70.4 | 68.9 | 67.3 |
| 55          | 85.4 | 88.2 | 89.2 | 89.3 | 88.9 | 88.2 | 87.2 | 86.0 | 84.6 | 83.1 | 81.6 | 80.0 | 78.4 | 76.7 | 75.1 | 73.5 | 71.9 | 70.3 | 68.8 | 67.3 |
| 60          | 82.7 | 85.7 | 86.9 | 87.2 | 87.0 | 86.5 | 85.7 | 84.7 | 83.5 | 82.2 | 80.8 | 79.3 | 77.8 | 76.3 | 74.8 | 73.2 | 71.7 | 70.2 | 68.8 | 67.3 |
| 65          | 80.1 | 83.1 | 84.4 | 84.9 | 84.9 | 84.5 | 83.9 | 83.1 | 82.1 | 81.0 | 79.8 | 78.5 | 77.1 | 75.7 | 74.3 | 72.9 | 71.5 | 70.1 | 68.7 | 67.3 |
| 70          | 77.6 | 80.3 | 81.7 | 82.4 | 82.5 | 82.4 | 81.9 | 81.3 | 80.6 | 79.7 | 78.6 | 77.5 | 76.3 | 75.1 | 73.8 | 72.5 | 71.2 | 69.9 | 68.6 | 67.3 |
| 75          | 75.2 | 77.6 | 79.0 | 79.7 | 80.0 | 79.9 | 79.7 | 79.3 | 78.7 | 78.0 | 77.2 | 76.3 | 75.3 | 74.2 | 73.1 | 72.0 | 70.9 | 69.7 | 68.5 | 67.3 |
| 80          | 73.0 | 74.9 | 76.1 | 76.8 | 77.2 | 77.3 | 77.3 | 77.0 | 76.6 | 76.1 | 75.5 | 74.8 | 74.0 | 73.2 | 72.3 | 71.4 | 70.4 | 69.4 | 68.4 | 67.3 |
| 85          | 70.9 | 72.3 | 73.3 | 73.9 | 74.3 | 74.5 | 74.6 | 74.5 | 74.3 | 73.9 | 73.5 | 73.1 | 72.5 | 71.9 | 71.2 | 70.5 | 69.8 | 69.0 | 68.2 | 67.3 |
| 90          | 69.2 | 70.0 | 70.6 | 71.1 | 71.4 | 71.6 | 71.7 | 71.7 | 71.7 | 71.5 | 71.3 | 71.1 | 70.7 | 70.4 | 70.0 | 69.5 | 69.0 | 68.5 | 67.9 | 67.3 |
| 95          | 67.8 | 68.1 | 68.4 | 68.6 | 68.7 | 68.9 | 68.9 | 69.0 | 69.0 | 69.0 | 68.9 | 68.9 | 68.7 | 68.6 | 68.5 | 68.3 | 68.1 | 67.8 | 67.6 | 67.3 |
| 98          | 67.7 | 67.7 | 67.7 | 67.8 | 67.8 | 67.8 | 67.8 | 67.8 | 67.8 | 67.8 | 67.8 | 67.8 | 67.7 | 67.7 | 67.6 | 67.6 | 67.5 | 67.5 | 67.4 | 67.3 |

### Mean Annual Mass Removal Efficiencies for 1.50-inches of Retention for Zone 1

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 96.8 | 97.8 | 98.0 | 97.5 | 96.5 | 95.3 | 94.0 | 92.5 | 90.9 | 89.3 | 87.7 | 86.0 | 84.3 | 82.7 | 81.0 | 79.3 | 77.7 | 76.1 | 74.6 | 73.1 |
| 35          | 95.5 | 96.9 | 97.1 | 96.7 | 95.8 | 94.7 | 93.5 | 92.1 | 90.6 | 89.0 | 87.4 | 85.8 | 84.1 | 82.5 | 80.9 | 79.3 | 77.7 | 76.1 | 74.6 | 73.1 |
| 40          | 93.9 | 95.6 | 96.0 | 95.7 | 95.0 | 94.0 | 92.8 | 91.5 | 90.1 | 88.6 | 87.1 | 85.5 | 83.9 | 82.3 | 80.7 | 79.2 | 77.6 | 76.1 | 74.6 | 73.1 |
| 45          | 92.1 | 94.2 | 94.7 | 94.5 | 93.9 | 93.1 | 92.0 | 90.8 | 89.5 | 88.1 | 86.6 | 85.1 | 83.6 | 82.1 | 80.6 | 79.0 | 77.5 | 76.0 | 74.5 | 73.1 |
| 50          | 90.3 | 92.5 | 93.1 | 93.1 | 92.7 | 92.0 | 91.1 | 90.0 | 88.8 | 87.5 | 86.1 | 84.7 | 83.3 | 81.8 | 80.3 | 78.9 | 77.4 | 75.9 | 74.5 | 73.1 |
| 55          | 88.2 | 90.5 | 91.3 | 91.4 | 91.2 | 90.7 | 89.9 | 89.0 | 87.9 | 86.8 | 85.5 | 84.2 | 82.8 | 81.5 | 80.1 | 78.6 | 77.2 | 75.8 | 74.4 | 73.1 |
| 60          | 85.9 | 88.3 | 89.3 | 89.6 | 89.6 | 89.2 | 88.6 | 87.8 | 86.9 | 85.9 | 84.7 | 83.5 | 82.3 | 81.0 | 79.7 | 78.4 | 77.0 | 75.7 | 74.4 | 73.1 |
| 65          | 83.5 | 86.0 | 87.2 | 87.7 | 87.7 | 87.5 | 87.0 | 86.4 | 85.7 | 84.8 | 83.8 | 82.8 | 81.7 | 80.5 | 79.3 | 78.1 | 76.8 | 75.6 | 74.3 | 73.1 |
| 70          | 81.4 | 83.7 | 85.0 | 85.5 | 85.7 | 85.6 | 85.3 | 84.8 | 84.2 | 83.5 | 82.7 | 81.8 | 80.9 | 79.9 | 78.8 | 77.7 | 76.5 | 75.4 | 74.2 | 73.1 |
| 75          | 79.4 | 81.4 | 82.5 | 83.2 | 83.5 | 83.5 | 83.3 | 83.0 | 82.6 | 82.1 | 81.4 | 80.7 | 79.9 | 79.1 | 78.1 | 77.2 | 76.2 | 75.2 | 74.1 | 73.1 |
| 80          | 77.4 | 79.1 | 80.1 | 80.8 | 81.1 | 81.2 | 81.2 | 81.0 | 80.8 | 80.4 | 79.9 | 79.4 | 78.8 | 78.1 | 77.3 | 76.5 | 75.7 | 74.9 | 74.0 | 73.1 |
| 85          | 75.7 | 76.9 | 77.7 | 78.3 | 78.6 | 78.8 | 78.9 | 78.9 | 78.7 | 78.5 | 78.2 | 77.8 | 77.4 | 76.9 | 76.3 | 75.8 | 75.1 | 74.5 | 73.8 | 73.1 |
| 90          | 74.2 | 74.9 | 75.4 | 75.9 | 76.2 | 76.4 | 76.5 | 76.5 | 76.5 | 76.4 | 76.3 | 76.1 | 75.8 | 75.5 | 75.2 | 74.8 | 74.4 | 74.0 | 73.6 | 73.1 |
| 95          | 73.1 | 73.3 | 73.6 | 73.8 | 73.9 | 74.0 | 74.1 | 74.2 | 74.2 | 74.2 | 74.2 | 74.2 | 74.1 | 74.0 | 73.9 | 73.8 | 73.6 | 73.5 | 73.3 | 73.1 |
| 98          | 73.1 | 73.1 | 73.2 | 73.2 | 73.3 | 73.3 | 73.3 | 73.3 | 73.3 | 73.3 | 73.3 | 73.3 | 73.3 | 73.3 | 73.3 | 73.2 | 73.2 | 73.2 | 73.1 | 73.1 |

**Mean Annual Mass Removal Efficiencies for 1.75-inches of Retention for Zone 1 by Percent DCIA**

[illegible]

**Mean Annual Mass Removal Efficiencies for 2.00-inches of Retention for Zone 1 by Percent DCIA**

[illegible]

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 98.4 | 98.8 | 98.9 | 98.9 | 98.7 | 98.2 | 97.6 | 96.8 | 95.9 | 95.0 | 94.0 | 93.0 | 91.9 | 90.8 | 89.7 | 88.6 | 87.5 | 86.3 | 85.2 | 84.1 |
| 35          | 97.2 | 98.1 | 98.4 | 98.5 | 98.3 | 97.9 | 97.2 | 96.5 | 95.6 | 94.7 | 93.8 | 92.8 | 91.8 | 90.7 | 89.6 | 88.5 | 87.4 | 86.3 | 85.2 | 84.1 |
| 40          | 96.2 | 97.4 | 97.8 | 97.9 | 97.8 | 97.3 | 96.8 | 96.1 | 95.3 | 94.4 | 93.5 | 92.6 | 91.6 | 90.5 | 89.5 | 88.4 | 87.3 | 86.2 | 85.1 | 84.1 |
| 45          | 95.3 | 96.7 | 97.2 | 97.3 | 97.1 | 96.7 | 96.2 | 95.5 | 94.8 | 94.0 | 93.2 | 92.3 | 91.3 | 90.3 | 89.3 | 88.3 | 87.2 | 86.2 | 85.1 | 84.1 |
| 50          | 94.3 | 95.8 | 96.3 | 96.5 | 96.3 | 95.9 | 95.5 | 94.9 | 94.3 | 93.6 | 92.8 | 91.9 | 91.0 | 90.1 | 89.1 | 88.1 | 87.1 | 86.1 | 85.1 | 84.1 |
| 55          | 93.2 | 94.8 | 95.3 | 95.4 | 95.3 | 95.0 | 94.6 | 94.2 | 93.6 | 93.0 | 92.3 | 91.5 | 90.6 | 89.8 | 88.9 | 87.9 | 87.0 | 86.0 | 85.0 | 84.1 |
| 60          | 92.0 | 93.5 | 94.1 | 94.3 | 94.2 | 94.0 | 93.7 | 93.3 | 92.8 | 92.3 | 91.6 | 90.9 | 90.2 | 89.4 | 88.6 | 87.7 | 86.8 | 85.9 | 85.0 | 84.1 |
| 65          | 90.6 | 92.0 | 92.7 | 92.9 | 93.0 | 92.9 | 92.7 | 92.4 | 92.0 | 91.5 | 90.9 | 90.3 | 89.7 | 89.0 | 88.2 | 87.4 | 86.6 | 85.8 | 84.9 | 84.1 |
| 70          | 89.1 | 90.4 | 91.1 | 91.5 | 91.6 | 91.6 | 91.5 | 91.3 | 91.0 | 90.5 | 90.1 | 89.6 | 89.0 | 88.4 | 87.8 | 87.1 | 86.4 | 85.6 | 84.8 | 84.1 |
| 75          | 87.6 | 88.8 | 89.5 | 90.0 | 90.2 | 90.3 | 90.2 | 90.1 | 89.8 | 89.5 | 89.2 | 88.8 | 88.3 | 87.8 | 87.3 | 86.7 | 86.1 | 85.4 | 84.7 | 84.1 |
| 80          | 86.2 | 87.2 | 87.9 | 88.4 | 88.6 | 88.8 | 88.8 | 88.7 | 88.6 | 88.4 | 88.1 | 87.8 | 87.5 | 87.1 | 86.7 | 86.2 | 85.7 | 85.2 | 84.6 | 84.1 |
| 85          | 85.0 | 85.8 | 86.4 | 86.8 | 87.0 | 87.2 | 87.3 | 87.3 | 87.2 | 87.1 | 86.9 | 86.8 | 86.5 | 86.3 | 86.0 | 85.6 | 85.3 | 84.9 | 84.5 | 84.1 |
| 90          | 84.0 | 84.5 | 84.9 | 85.2 | 85.4 | 85.6 | 85.7 | 85.7 | 85.7 | 85.7 | 85.7 | 85.6 | 85.5 | 85.4 | 85.2 | 85.0 | 84.8 | 84.6 | 84.3 | 84.1 |
| 95          | 83.4 | 83.6 | 83.8 | 84.0 | 84.1 | 84.2 | 84.3 | 84.3 | 84.4 | 84.4 | 84.4 | 84.4 | 84.4 | 84.4 | 84.4 | 84.3 | 84.3 | 84.2 | 84.1 | 84.1 |
| 98          | 83.7 | 83.7 | 83.8 | 83.8 | 83.9 | 83.9 | 83.9 | 84.0 | 84.0 | 84.0 | 84.0 | 84.0 | 84.0 | 84.1 | 84.1 | 84.1 | 84.1 | 84.1 | 84.1 | 84.1 |

[illegible]

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**Mean Annual Mass Removal Efficiencies for 3.25-inches of Retention for Zone 1 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.3 | 99.5 | 99.6 | 99.5 | 99.5 | 99.4 | 99.2 | 98.9 | 98.5 | 98.1 | 97.5 | 96.9 | 96.3 | 95.7 | 95.0 | 94.3 | 93.6 | 92.8 | 92.1 | 91.3 |
| 35          | 98.8 | 99.2 | 99.3 | 99.2 | 99.2 | 99.1 | 99.0 | 98.7 | 98.3 | 97.9 | 97.3 | 96.8 | 96.2 | 95.6 | 94.9 | 94.2 | 93.5 | 92.8 | 92.0 | 91.3 |
| 40          | 98.2 | 98.7 | 98.8 | 98.9 | 98.9 | 98.9 | 98.7 | 98.5 | 98.1 | 97.7 | 97.2 | 96.6 | 96.0 | 95.4 | 94.8 | 94.1 | 93.5 | 92.7 | 92.0 | 91.3 |
| 45          | 97.4 | 98.1 | 98.5 | 98.6 | 98.6 | 98.6 | 98.4 | 98.2 | 97.8 | 97.4 | 96.9 | 96.4 | 95.8 | 95.3 | 94.7 | 94.0 | 93.4 | 92.7 | 92.0 | 91.3 |
| 50          | 96.7 | 97.7 | 98.1 | 98.2 | 98.3 | 98.2 | 98.1 | 97.8 | 97.4 | 97.0 | 96.6 | 96.1 | 95.6 | 95.1 | 94.5 | 93.9 | 93.3 | 92.6 | 92.0 | 91.3 |
| 55          | 96.2 | 97.2 | 97.6 | 97.8 | 97.9 | 97.8 | 97.6 | 97.3 | 97.0 | 96.6 | 96.2 | 95.8 | 95.3 | 94.8 | 94.3 | 93.8 | 93.2 | 92.6 | 91.9 | 91.3 |
| 60          | 95.8 | 96.7 | 97.1 | 97.3 | 97.3 | 97.2 | 97.0 | 96.8 | 96.5 | 96.2 | 95.8 | 95.4 | 95.0 | 94.6 | 94.1 | 93.6 | 93.0 | 92.5 | 91.9 | 91.3 |
| 65          | 95.3 | 96.1 | 96.5 | 96.6 | 96.6 | 96.5 | 96.3 | 96.2 | 95.9 | 95.6 | 95.3 | 95.0 | 94.6 | 94.2 | 93.8 | 93.4 | 92.9 | 92.4 | 91.8 | 91.3 |
| 70          | 94.5 | 95.3 | 95.6 | 95.7 | 95.7 | 95.7 | 95.6 | 95.5 | 95.3 | 95.1 | 94.8 | 94.5 | 94.2 | 93.9 | 93.5 | 93.1 | 92.7 | 92.2 | 91.8 | 91.3 |
| 75          | 93.6 | 94.2 | 94.5 | 94.7 | 94.8 | 94.8 | 94.8 | 94.7 | 94.6 | 94.4 | 94.2 | 94.0 | 93.8 | 93.5 | 93.2 | 92.8 | 92.5 | 92.1 | 91.7 | 91.3 |
| 80          | 92.6 | 93.1 | 93.5 | 93.7 | 93.8 | 93.9 | 93.9 | 93.9 | 93.8 | 93.7 | 93.6 | 93.4 | 93.2 | 93.0 | 92.8 | 92.5 | 92.2 | 91.9 | 91.6 | 91.3 |
| 85          | 91.7 | 92.1 | 92.4 | 92.6 | 92.8 | 92.9 | 93.0 | 93.0 | 93.0 | 92.9 | 92.9 | 92.8 | 92.6 | 92.5 | 92.3 | 92.2 | 92.0 | 91.8 | 91.5 | 91.3 |
| 90          | 91.0 | 91.3 | 91.6 | 91.7 | 91.9 | 92.0 | 92.0 | 92.1 | 92.1 | 92.1 | 92.1 | 92.1 | 92.0 | 91.9 | 91.9 | 91.8 | 91.7 | 91.6 | 91.4 | 91.3 |
| 95          | 90.7 | 90.8 | 91.0 | 91.0 | 91.1 | 91.2 | 91.2 | 91.3 | 91.3 | 91.4 | 91.4 | 91.4 | 91.4 | 91.4 | 91.4 | 91.4 | 91.4 | 91.4 | 91.3 | 91.3 |
| 98          | 90.9 | 91.0 | 91.0 | 91.0 | 91.1 | 91.1 | 91.1 | 91.1 | 91.2 | 91.2 | 91.2 | 91.2 | 91.2 | 91.2 | 91.3 | 91.3 | 91.3 | 91.3 | 91.3 | 91.3 |

### Mean Annual Mass Removal Efficiencies for 3.50-inches of Retention for Zone 1 by Percent DCIA

[illegible]

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**Mean Annual Mass Removal Efficiencies for 0.25-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 94.4 | 90.4 | 83.0 | 75.1 | 68.0 | 61.9 | 56.6 | 52.1 | 48.3 | 44.9 | 42.0 | 39.4 | 37.2 | 35.1 | 33.3 | 31.7 | 30.2 | 28.8 | 27.6 | 26.4 |
| 35          | 91.8 | 88.8 | 82.0 | 74.5 | 67.6 | 61.5 | 56.4 | 51.9 | 48.1 | 44.8 | 41.9 | 39.4 | 37.1 | 35.1 | 33.3 | 31.7 | 30.2 | 28.8 | 27.6 | 26.4 |
| 40          | 88.2 | 86.6 | 80.6 | 73.5 | 66.9 | 61.1 | 56.0 | 51.7 | 47.9 | 44.7 | 41.8 | 39.3 | 37.1 | 35.0 | 33.2 | 31.6 | 30.2 | 28.8 | 27.6 | 26.4 |
| 45          | 83.9 | 83.8 | 78.7 | 72.3 | 66.1 | 60.4 | 55.6 | 51.4 | 47.7 | 44.5 | 41.7 | 39.2 | 37.0 | 35.0 | 33.2 | 31.6 | 30.1 | 28.8 | 27.6 | 26.4 |
| 50          | 78.8 | 80.4 | 76.4 | 70.7 | 64.9 | 59.6 | 55.0 | 50.9 | 47.3 | 44.2 | 41.5 | 39.0 | 36.8 | 34.9 | 33.1 | 31.5 | 30.1 | 28.8 | 27.6 | 26.4 |
| 55          | 73.2 | 76.4 | 73.6 | 68.7 | 63.5 | 58.6 | 54.2 | 50.3 | 46.9 | 43.9 | 41.2 | 38.8 | 36.7 | 34.8 | 33.0 | 31.5 | 30.1 | 28.7 | 27.5 | 26.4 |
| 60          | 67.4 | 71.8 | 70.2 | 66.3 | 61.7 | 57.3 | 53.2 | 49.6 | 46.3 | 43.4 | 40.8 | 38.6 | 36.5 | 34.6 | 32.9 | 31.4 | 30.0 | 28.7 | 27.5 | 26.4 |
| 65          | 61.4 | 66.7 | 66.3 | 63.4 | 59.5 | 55.6 | 51.9 | 48.6 | 45.5 | 42.9 | 40.4 | 38.2 | 36.2 | 34.4 | 32.8 | 31.3 | 29.9 | 28.7 | 27.5 | 26.4 |
| 70          | 55.7 | 61.1 | 61.8 | 59.8 | 56.8 | 53.5 | 50.4 | 47.3 | 44.6 | 42.1 | 39.8 | 37.7 | 35.9 | 34.1 | 32.6 | 31.1 | 29.8 | 28.6 | 27.5 | 26.4 |
| 75          | 50.1 | 55.2 | 56.5 | 55.6 | 53.5 | 50.9 | 48.3 | 45.7 | 43.3 | 41.1 | 39.0 | 37.1 | 35.4 | 33.8 | 32.3 | 30.9 | 29.7 | 28.5 | 27.4 | 26.4 |
| 80          | 45.0 | 49.1 | 50.7 | 50.6 | 49.4 | 47.6 | 45.6 | 43.6 | 41.6 | 39.7 | 37.9 | 36.2 | 34.7 | 33.2 | 31.9 | 30.7 | 29.5 | 28.4 | 27.4 | 26.4 |
| 85          | 40.3 | 43.2 | 44.5 | 44.8 | 44.3 | 43.4 | 42.1 | 40.7 | 39.2 | 37.8 | 36.3 | 35.0 | 33.7 | 32.5 | 31.3 | 30.2 | 29.2 | 28.2 | 27.3 | 26.4 |
| 90          | 36.0 | 37.5 | 38.3 | 38.6 | 38.5 | 38.1 | 37.5 | 36.7 | 35.9 | 35.0 | 34.0 | 33.1 | 32.2 | 31.3 | 30.4 | 29.5 | 28.7 | 27.9 | 27.2 | 26.4 |
| 95          | 31.7 | 32.1 | 32.3 | 32.4 | 32.3 | 32.2 | 32.0 | 31.7 | 31.4 | 31.0 | 30.6 | 30.2 | 29.7 | 29.3 | 28.8 | 28.3 | 27.9 | 27.4 | 26.9 | 26.4 |
| 98          | 29.3 | 29.3 | 29.2 | 29.1 | 29.0 | 28.9 | 28.8 | 28.6 | 28.5 | 28.3 | 28.2 | 28.0 | 27.8 | 27.7 | 27.5 | 27.3 | 27.1 | 26.9 | 26.6 | 26.4 |

**Mean Annual Mass Removal Efficiencies for 0.50-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 97.0 | 96.7 | 94.8 | 91.7 | 87.9 | 83.8 | 79.7 | 75.7 | 71.9 | 68.4 | 65.2 | 62.1 | 59.4 | 56.9 | 54.5 | 52.3 | 50.3 | 48.4 | 46.7 | 45.1 |
| 35          | 95.2 | 95.5 | 93.8 | 90.9 | 87.3 | 83.4 | 79.3 | 75.4 | 71.7 | 68.3 | 65.0 | 62.1 | 59.3 | 56.8 | 54.4 | 52.3 | 50.3 | 48.4 | 46.7 | 45.1 |
| 40          | 92.9 | 94.0 | 92.5 | 89.9 | 86.5 | 82.7 | 78.9 | 75.1 | 71.4 | 68.0 | 64.9 | 61.9 | 59.2 | 56.7 | 54.4 | 52.2 | 50.2 | 48.4 | 46.7 | 45.1 |
| 45          | 90.2 | 91.9 | 90.9 | 88.6 | 85.5 | 81.9 | 78.2 | 74.6 | 71.1 | 67.7 | 64.6 | 61.7 | 59.1 | 56.6 | 54.3 | 52.2 | 50.2 | 48.4 | 46.7 | 45.1 |
| 50          | 86.7 | 89.2 | 88.9 | 87.0 | 84.2 | 80.9 | 77.4 | 73.9 | 70.5 | 67.3 | 64.3 | 61.5 | 58.9 | 56.5 | 54.2 | 52.1 | 50.2 | 48.3 | 46.6 | 45.1 |
| 55          | 82.7 | 86.1 | 86.4 | 84.9 | 82.6 | 79.6 | 76.4 | 73.1 | 69.9 | 66.8 | 63.9 | 61.2 | 58.6 | 56.3 | 54.1 | 52.0 | 50.1 | 48.3 | 46.6 | 45.1 |
| 60          | 78.5 | 82.6 | 83.4 | 82.5 | 80.6 | 78.0 | 75.1 | 72.1 | 69.1 | 66.1 | 63.4 | 60.8 | 58.3 | 56.0 | 53.9 | 51.9 | 50.0 | 48.2 | 46.6 | 45.1 |
| 65          | 74.2 | 78.6 | 79.8 | 79.5 | 78.1 | 76.0 | 73.5 | 70.7 | 68.0 | 65.3 | 62.7 | 60.2 | 57.9 | 55.7 | 53.6 | 51.7 | 49.9 | 48.2 | 46.6 | 45.1 |
| 70          | 69.8 | 74.2 | 75.8 | 76.0 | 75.2 | 73.5 | 71.4 | 69.1 | 66.6 | 64.2 | 61.8 | 59.5 | 57.3 | 55.3 | 53.3 | 51.4 | 49.7 | 48.1 | 46.5 | 45.1 |
| 75          | 65.4 | 69.6 | 71.4 | 71.9 | 71.5 | 70.4 | 68.8 | 66.9 | 64.9 | 62.7 | 60.6 | 58.6 | 56.6 | 54.7 | 52.8 | 51.1 | 49.5 | 47.9 | 46.5 | 45.1 |
| 80          | 61.4 | 64.9 | 66.6 | 67.3 | 67.2 | 66.5 | 65.5 | 64.1 | 62.5 | 60.8 | 59.0 | 57.3 | 55.5 | 53.9 | 52.2 | 50.7 | 49.2 | 47.7 | 46.4 | 45.1 |
| 85          | 57.6 | 60.1 | 61.6 | 62.2 | 62.3 | 62.0 | 61.3 | 60.4 | 59.3 | 58.1 | 56.8 | 55.4 | 54.0 | 52.7 | 51.3 | 50.0 | 48.7 | 47.4 | 46.2 | 45.1 |
| 90          | 54.1 | 55.4 | 56.2 | 56.7 | 56.8 | 56.7 | 56.4 | 55.9 | 55.2 | 54.5 | 53.6 | 52.8 | 51.8 | 50.9 | 49.9 | 48.9 | 47.9 | 46.9 | 46.0 | 45.1 |
| 95          | 50.1 | 50.5 | 50.7 | 50.8 | 50.8 | 50.8 | 50.6 | 50.4 | 50.2 | 49.9 | 49.5 | 49.1 | 48.7 | 48.2 | 47.7 | 47.2 | 46.7 | 46.1 | 45.6 | 45.1 |
| 98          | 47.8 | 47.7 | 47.7 | 47.6 | 47.6 | 47.5 | 47.4 | 47.2 | 47.1 | 46.9 | 46.8 | 46.6 | 46.5 | 46.3 | 46.1 | 45.9 | 45.7 | 45.5 | 45.3 | 45.1 |

**Mean Annual Mass Removal Efficiencies for 0.75-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 97.9 | 98.2 | 97.5 | 96.2 | 94.4 | 92.1 | 89.6 | 86.9 | 84.1 | 81.3 | 78.5 | 75.9 | 73.3 | 70.9 | 68.5 | 66.3 | 64.2 | 62.2 | 60.4 | 58.6 |
| 35          | 96.7 | 97.3 | 96.8 | 95.6 | 93.8 | 91.7 | 89.2 | 86.6 | 83.8 | 81.1 | 78.4 | 75.7 | 73.2 | 70.8 | 68.5 | 66.3 | 64.2 | 62.2 | 60.4 | 58.6 |
| 40          | 95.0 | 96.1 | 95.9 | 94.8 | 93.1 | 91.1 | 88.7 | 86.2 | 83.5 | 80.8 | 78.2 | 75.6 | 73.1 | 70.7 | 68.4 | 66.2 | 64.2 | 62.2 | 60.4 | 58.6 |
| 45          | 93.0 | 94.7 | 94.6 | 93.7 | 92.2 | 90.3 | 88.1 | 85.6 | 83.1 | 80.5 | 77.9 | 75.4 | 72.9 | 70.6 | 68.3 | 66.2 | 64.1 | 62.2 | 60.4 | 58.6 |
| 50          | 90.7 | 92.8 | 93.1 | 92.4 | 91.1 | 89.3 | 87.3 | 85.0 | 82.5 | 80.0 | 77.5 | 75.1 | 72.7 | 70.4 | 68.2 | 66.1 | 64.0 | 62.1 | 60.3 | 58.6 |
| 55          | 88.0 | 90.6 | 91.1 | 90.7 | 89.7 | 88.1 | 86.3 | 84.1 | 81.8 | 79.4 | 77.0 | 74.7 | 72.4 | 70.1 | 68.0 | 65.9 | 64.0 | 62.1 | 60.3 | 58.6 |
| 60          | 84.8 | 87.9 | 88.8 | 88.7 | 88.0 | 86.7 | 85.0 | 83.0 | 80.9 | 78.7 | 76.5 | 74.2 | 72.0 | 69.8 | 67.8 | 65.8 | 63.8 | 62.0 | 60.3 | 58.6 |
| 65          | 81.5 | 84.9 | 86.2 | 86.3 | 85.8 | 84.8 | 83.4 | 81.7 | 79.8 | 77.8 | 75.7 | 73.6 | 71.5 | 69.5 | 67.5 | 65.5 | 63.7 | 61.9 | 60.2 | 58.6 |
| 70          | 78.1 | 81.7 | 83.1 | 83.5 | 83.2 | 82.5 | 81.4 | 80.0 | 78.4 | 76.6 | 74.7 | 72.8 | 70.9 | 68.9 | 67.1 | 65.2 | 63.5 | 61.8 | 60.2 | 58.6 |
| 75          | 74.9 | 78.1 | 79.6 | 80.2 | 80.2 | 79.8 | 79.0 | 77.9 | 76.5 | 75.0 | 73.4 | 71.7 | 70.0 | 68.3 | 66.5 | 64.8 | 63.2 | 61.6 | 60.1 | 58.6 |
| 80          | 71.6 | 74.3 | 75.8 | 76.5 | 76.7 | 76.5 | 76.0 | 75.2 | 74.1 | 73.0 | 71.7 | 70.3 | 68.8 | 67.3 | 65.8 | 64.3 | 62.8 | 61.4 | 60.0 | 58.6 |
| 85          | 68.6 | 70.6 | 71.8 | 72.5 | 72.8 | 72.7 | 72.4 | 71.9 | 71.2 | 70.3 | 69.3 | 68.3 | 67.1 | 65.9 | 64.7 | 63.5 | 62.2 | 61.0 | 59.8 | 58.6 |
| 90          | 65.7 | 66.9 | 67.7 | 68.1 | 68.3 | 68.3 | 68.2 | 67.9 | 67.5 | 66.9 | 66.3 | 65.6 | 64.9 | 64.0 | 63.2 | 62.3 | 61.4 | 60.5 | 59.5 | 58.6 |
| 95          | 62.7 | 63.0 | 63.2 | 63.3 | 63.4 | 63.4 | 63.3 | 63.2 | 63.0 | 62.8 | 62.5 | 62.2 | 61.8 | 61.4 | 61.0 | 60.5 | 60.1 | 59.6 | 59.1 | 58.6 |
| 98          | 60.8 | 60.8 | 60.8 | 60.7 | 60.7 | 60.6 | 60.5 | 60.4 | 60.3 | 60.2 | 60.1 | 59.9 | 59.8 | 59.6 | 59.5 | 59.3 | 59.2 | 59.0 | 58.8 | 58.6 |

**Mean Annual Mass Removal Efficiencies for 1.00-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 98.5 | 98.8 | 98.5 | 97.9 | 96.9 | 95.6 | 94.1 | 92.3 | 90.4 | 88.4 | 86.3 | 84.2 | 82.1 | 80.0 | 77.9 | 75.9 | 74.0 | 72.2 | 70.3 | 68.6 |
| 35          | 97.5 | 98.2 | 98.0 | 97.4 | 96.5 | 95.3 | 93.7 | 92.0 | 90.2 | 88.2 | 86.2 | 84.1 | 82.0 | 79.9 | 77.9 | 75.9 | 74.0 | 72.1 | 70.3 | 68.6 |
| 40          | 96.4 | 97.3 | 97.2 | 96.8 | 95.9 | 94.8 | 93.3 | 91.7 | 89.9 | 87.9 | 85.9 | 83.9 | 81.8 | 79.8 | 77.8 | 75.8 | 73.9 | 72.1 | 70.3 | 68.6 |
| 45          | 94.8 | 96.1 | 96.3 | 96.0 | 95.2 | 94.1 | 92.7 | 91.2 | 89.4 | 87.6 | 85.6 | 83.6 | 81.6 | 79.6 | 77.7 | 75.8 | 73.9 | 72.1 | 70.3 | 68.6 |
| 50          | 93.0 | 94.8 | 95.2 | 94.9 | 94.3 | 93.3 | 92.0 | 90.5 | 88.9 | 87.1 | 85.3 | 83.3 | 81.4 | 79.5 | 77.5 | 75.6 | 73.8 | 72.0 | 70.3 | 68.6 |
| 55          | 91.0 | 93.2 | 93.7 | 93.6 | 93.1 | 92.3 | 91.1 | 89.8 | 88.2 | 86.6 | 84.8 | 82.9 | 81.1 | 79.2 | 77.3 | 75.5 | 73.7 | 72.0 | 70.2 | 68.6 |
| 60          | 88.8 | 91.2 | 92.0 | 92.0 | 91.7 | 91.0 | 90.0 | 88.8 | 87.4 | 85.9 | 84.2 | 82.4 | 80.7 | 78.9 | 77.1 | 75.3 | 73.6 | 71.9 | 70.2 | 68.6 |
| 65          | 86.2 | 88.9 | 89.9 | 90.2 | 90.0 | 89.5 | 88.7 | 87.6 | 86.4 | 85.0 | 83.4 | 81.8 | 80.2 | 78.5 | 76.8 | 75.1 | 73.4 | 71.8 | 70.2 | 68.6 |
| 70          | 83.6 | 86.4 | 87.5 | 88.0 | 88.0 | 87.6 | 86.9 | 86.1 | 85.1 | 83.8 | 82.5 | 81.0 | 79.5 | 77.9 | 76.4 | 74.8 | 73.2 | 71.6 | 70.1 | 68.6 |
| 75          | 81.0 | 83.6 | 84.9 | 85.5 | 85.6 | 85.3 | 84.9 | 84.2 | 83.4 | 82.4 | 81.2 | 80.0 | 78.6 | 77.2 | 75.8 | 74.3 | 72.9 | 71.5 | 70.0 | 68.6 |
| 80          | 78.6 | 80.8 | 82.0 | 82.5 | 82.8 | 82.7 | 82.4 | 81.9 | 81.3 | 80.5 | 79.6 | 78.5 | 77.4 | 76.3 | 75.0 | 73.8 | 72.5 | 71.2 | 69.9 | 68.6 |
| 85          | 76.1 | 77.7 | 78.7 | 79.3 | 79.6 | 79.7 | 79.5 | 79.2 | 78.8 | 78.2 | 77.5 | 76.7 | 75.9 | 74.9 | 74.0 | 72.9 | 71.9 | 70.8 | 69.7 | 68.6 |
| 90          | 73.9 | 74.8 | 75.5 | 75.9 | 76.1 | 76.2 | 76.2 | 76.0 | 75.7 | 75.3 | 74.9 | 74.4 | 73.8 | 73.2 | 72.5 | 71.8 | 71.0 | 70.3 | 69.4 | 68.6 |
| 95          | 71.5 | 71.8 | 72.0 | 72.1 | 72.2 | 72.2 | 72.2 | 72.1 | 72.0 | 71.9 | 71.7 | 71.4 | 71.2 | 70.9 | 70.6 | 70.2 | 69.9 | 69.5 | 69.0 | 68.6 |
| 98          | 70.2 | 70.2 | 70.2 | 70.2 | 70.1 | 70.1 | 70.1 | 70.0 | 69.9 | 69.8 | 69.7 | 69.7 | 69.6 | 69.4 | 69.3 | 69.2 | 69.0 | 68.9 | 68.8 | 68.6 |

**Mean Annual Mass Removal Efficiencies for 1.25-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 98.9 | 99.1 | 99.0 | 98.7 | 98.1 | 97.3 | 96.4 | 95.2 | 93.9 | 92.4 | 90.9 | 89.3 | 87.7 | 86.0 | 84.3 | 82.6 | 80.9 | 79.2 | 77.6 | 76.0 |
| 35          | 98.1 | 98.6 | 98.6 | 98.3 | 97.7 | 97.0 | 96.1 | 94.9 | 93.7 | 92.3 | 90.8 | 89.2 | 87.6 | 85.9 | 84.2 | 82.5 | 80.9 | 79.2 | 77.6 | 76.0 |
| 40          | 97.2 | 98.0 | 98.0 | 97.8 | 97.3 | 96.6 | 95.7 | 94.6 | 93.4 | 92.0 | 90.5 | 89.0 | 87.4 | 85.8 | 84.1 | 82.5 | 80.8 | 79.2 | 77.6 | 76.0 |
| 45          | 96.1 | 97.1 | 97.3 | 97.1 | 96.7 | 96.1 | 95.2 | 94.2 | 93.0 | 91.7 | 90.3 | 88.8 | 87.2 | 85.6 | 84.0 | 82.4 | 80.7 | 79.1 | 77.6 | 76.0 |
| 50          | 94.7 | 96.0 | 96.4 | 96.3 | 96.0 | 95.4 | 94.6 | 93.6 | 92.5 | 91.3 | 89.9 | 88.5 | 87.0 | 85.4 | 83.8 | 82.2 | 80.7 | 79.1 | 77.5 | 76.0 |
| 55          | 93.0 | 94.8 | 95.3 | 95.3 | 95.1 | 94.6 | 93.9 | 93.0 | 91.9 | 90.8 | 89.5 | 88.1 | 86.7 | 85.2 | 83.6 | 82.1 | 80.6 | 79.0 | 77.5 | 76.0 |
| 60          | 91.3 | 93.3 | 94.0 | 94.1 | 94.0 | 93.6 | 92.9 | 92.2 | 91.2 | 90.1 | 88.9 | 87.7 | 86.3 | 84.9 | 83.4 | 81.9 | 80.4 | 78.9 | 77.5 | 76.0 |
| 65          | 89.4 | 91.6 | 92.4 | 92.7 | 92.6 | 92.3 | 91.8 | 91.1 | 90.3 | 89.3 | 88.3 | 87.1 | 85.8 | 84.5 | 83.1 | 81.7 | 80.3 | 78.8 | 77.4 | 76.0 |
| 70          | 87.5 | 89.6 | 90.6 | 91.0 | 91.0 | 90.8 | 90.4 | 89.8 | 89.1 | 88.3 | 87.4 | 86.3 | 85.2 | 83.9 | 82.7 | 81.4 | 80.0 | 78.7 | 77.3 | 76.0 |
| 75          | 85.4 | 87.4 | 88.5 | 89.0 | 89.1 | 89.0 | 88.7 | 88.3 | 87.7 | 87.0 | 86.2 | 85.3 | 84.3 | 83.3 | 82.1 | 80.9 | 79.7 | 78.5 | 77.3 | 76.0 |
| 80          | 83.4 | 85.2 | 86.2 | 86.7 | 86.9 | 86.9 | 86.7 | 86.4 | 86.0 | 85.5 | 84.8 | 84.1 | 83.3 | 82.3 | 81.4 | 80.4 | 79.3 | 78.2 | 77.1 | 76.0 |
| 85          | 81.6 | 82.9 | 83.7 | 84.2 | 84.4 | 84.5 | 84.4 | 84.2 | 84.0 | 83.6 | 83.1 | 82.5 | 81.9 | 81.2 | 80.4 | 79.6 | 78.8 | 77.9 | 76.9 | 76.0 |
| 90          | 79.7 | 80.5 | 81.0 | 81.4 | 81.6 | 81.7 | 81.7 | 81.7 | 81.5 | 81.3 | 80.9 | 80.6 | 80.1 | 79.7 | 79.1 | 78.6 | 78.0 | 77.4 | 76.7 | 76.0 |
| 95          | 77.9 | 78.2 | 78.4 | 78.5 | 78.6 | 78.7 | 78.7 | 78.6 | 78.6 | 78.4 | 78.3 | 78.2 | 78.0 | 77.8 | 77.5 | 77.3 | 77.0 | 76.7 | 76.3 | 76.0 |
| 98          | 77.1 | 77.1 | 77.1 | 77.1 | 77.1 | 77.1 | 77.0 | 77.0 | 76.9 | 76.9 | 76.8 | 76.8 | 76.7 | 76.6 | 76.5 | 76.4 | 76.3 | 76.2 | 76.1 | 76.0 |

**Mean Annual Mass Removal Efficiencies for 1.50-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.2 | 99.4 | 99.3 | 99.1 | 98.7 | 98.2 | 97.6 | 96.8 | 95.9 | 94.9 | 93.7 | 92.5 | 91.3 | 89.9 | 88.6 | 87.2 | 85.7 | 84.3 | 82.9 | 81.5 |
| 35          | 98.6 | 99.0 | 99.0 | 98.8 | 98.5 | 98.0 | 97.4 | 96.6 | 95.7 | 94.7 | 93.6 | 92.4 | 91.2 | 89.8 | 88.5 | 87.1 | 85.7 | 84.3 | 82.9 | 81.5 |
| 40          | 97.8 | 98.4 | 98.5 | 98.4 | 98.1 | 97.6 | 97.1 | 96.3 | 95.5 | 94.5 | 93.4 | 92.2 | 91.0 | 89.7 | 88.4 | 87.1 | 85.7 | 84.3 | 82.9 | 81.5 |
| 45          | 96.9 | 97.8 | 98.0 | 97.9 | 97.6 | 97.2 | 96.7 | 96.0 | 95.1 | 94.2 | 93.1 | 92.0 | 90.8 | 89.6 | 88.3 | 87.0 | 85.6 | 84.2 | 82.9 | 81.5 |
| 50          | 95.9 | 96.9 | 97.2 | 97.2 | 97.0 | 96.7 | 96.2 | 95.5 | 94.7 | 93.8 | 92.8 | 91.8 | 90.6 | 89.4 | 88.2 | 86.9 | 85.5 | 84.2 | 82.8 | 81.5 |
| 55          | 94.6 | 95.9 | 96.3 | 96.4 | 96.3 | 96.0 | 95.6 | 95.0 | 94.2 | 93.4 | 92.4 | 91.4 | 90.3 | 89.2 | 88.0 | 86.7 | 85.4 | 84.1 | 82.8 | 81.5 |
| 60          | 93.1 | 94.7 | 95.3 | 95.5 | 95.4 | 95.2 | 94.8 | 94.3 | 93.6 | 92.8 | 92.0 | 91.0 | 90.0 | 88.9 | 87.7 | 86.5 | 85.3 | 84.0 | 82.8 | 81.5 |
| 65          | 91.7 | 93.4 | 94.1 | 94.4 | 94.4 | 94.2 | 93.9 | 93.4 | 92.8 | 92.1 | 91.3 | 90.5 | 89.5 | 88.5 | 87.4 | 86.3 | 85.1 | 83.9 | 82.7 | 81.5 |
| 70          | 90.1 | 91.9 | 92.7 | 93.0 | 93.1 | 93.0 | 92.7 | 92.3 | 91.9 | 91.2 | 90.6 | 89.8 | 88.9 | 88.0 | 87.0 | 86.0 | 84.9 | 83.8 | 82.6 | 81.5 |
| 75          | 88.5 | 90.2 | 91.0 | 91.5 | 91.6 | 91.6 | 91.4 | 91.1 | 90.7 | 90.2 | 89.6 | 88.9 | 88.2 | 87.4 | 86.5 | 85.6 | 84.6 | 83.6 | 82.6 | 81.5 |
| 80          | 86.9 | 88.4 | 89.2 | 89.6 | 89.9 | 89.9 | 89.8 | 89.6 | 89.3 | 88.9 | 88.4 | 87.9 | 87.3 | 86.6 | 85.9 | 85.1 | 84.2 | 83.3 | 82.4 | 81.5 |
| 85          | 85.4 | 86.5 | 87.2 | 87.6 | 87.9 | 88.0 | 87.9 | 87.8 | 87.6 | 87.3 | 87.0 | 86.6 | 86.1 | 85.6 | 85.0 | 84.4 | 83.7 | 83.0 | 82.3 | 81.5 |
| 90          | 84.1 | 84.7 | 85.1 | 85.4 | 85.6 | 85.7 | 85.8 | 85.7 | 85.6 | 85.5 | 85.3 | 85.0 | 84.7 | 84.4 | 84.0 | 83.5 | 83.1 | 82.6 | 82.0 | 81.5 |
| 95          | 82.7 | 82.9 | 83.1 | 83.2 | 83.3 | 83.3 | 83.4 | 83.4 | 83.4 | 83.3 | 83.2 | 83.1 | 83.0 | 82.8 | 82.6 | 82.4 | 82.2 | 82.0 | 81.8 | 81.5 |
| 98          | 82.2 | 82.2 | 82.2 | 82.2 | 82.2 | 82.2 | 82.2 | 82.2 | 82.1 | 82.1 | 82.1 | 82.0 | 82.0 | 81.9 | 81.9 | 81.8 | 81.7 | 81.7 | 81.6 | 81.5 |

**Mean Annual Mass Removal Efficiencies for 1.75-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.4 | 99.5 | 99.5 | 99.4 | 99.1 | 98.8 | 98.3 | 97.8 | 97.2 | 96.4 | 95.6 | 94.6 | 93.6 | 92.6 | 91.5 | 90.4 | 89.2 | 88.0 | 86.8 | 85.6 |
| 35          | 98.9 | 99.2 | 99.2 | 99.1 | 98.9 | 98.6 | 98.1 | 97.6 | 97.0 | 96.3 | 95.4 | 94.5 | 93.5 | 92.5 | 91.4 | 90.3 | 89.2 | 88.0 | 86.8 | 85.6 |
| 40          | 98.3 | 98.8 | 98.9 | 98.8 | 98.6 | 98.3 | 97.9 | 97.4 | 96.8 | 96.1 | 95.3 | 94.4 | 93.4 | 92.4 | 91.4 | 90.3 | 89.1 | 88.0 | 86.8 | 85.6 |
| 45          | 97.5 | 98.3 | 98.4 | 98.4 | 98.2 | 97.9 | 97.5 | 97.1 | 96.5 | 95.8 | 95.0 | 94.2 | 93.2 | 92.3 | 91.2 | 90.2 | 89.1 | 87.9 | 86.8 | 85.6 |
| 50          | 96.7 | 97.6 | 97.8 | 97.8 | 97.7 | 97.5 | 97.1 | 96.7 | 96.2 | 95.5 | 94.8 | 93.9 | 93.0 | 92.1 | 91.1 | 90.1 | 89.0 | 87.9 | 86.7 | 85.6 |
| 55          | 95.7 | 96.8 | 97.1 | 97.2 | 97.1 | 96.9 | 96.6 | 96.2 | 95.7 | 95.1 | 94.4 | 93.6 | 92.8 | 91.9 | 90.9 | 89.9 | 88.9 | 87.8 | 86.7 | 85.6 |
| 60          | 94.5 | 95.8 | 96.3 | 96.4 | 96.4 | 96.3 | 96.0 | 95.7 | 95.2 | 94.6 | 94.0 | 93.3 | 92.5 | 91.6 | 90.7 | 89.8 | 88.8 | 87.7 | 86.7 | 85.6 |
| 65          | 93.3 | 94.7 | 95.3 | 95.5 | 95.6 | 95.5 | 95.3 | 95.0 | 94.5 | 94.0 | 93.4 | 92.8 | 92.1 | 91.3 | 90.4 | 89.5 | 88.6 | 87.6 | 86.6 | 85.6 |
| 70          | 92.0 | 93.5 | 94.2 | 94.5 | 94.6 | 94.5 | 94.4 | 94.1 | 93.7 | 93.3 | 92.8 | 92.2 | 91.5 | 90.8 | 90.1 | 89.3 | 88.4 | 87.5 | 86.6 | 85.6 |
| 75          | 90.8 | 92.1 | 92.9 | 93.2 | 93.4 | 93.4 | 93.3 | 93.1 | 92.8 | 92.4 | 92.0 | 91.5 | 90.9 | 90.3 | 89.6 | 88.9 | 88.2 | 87.3 | 86.5 | 85.6 |
| 80          | 89.6 | 90.7 | 91.4 | 91.8 | 92.0 | 92.0 | 92.0 | 91.9 | 91.6 | 91.3 | 91.0 | 90.6 | 90.1 | 89.6 | 89.1 | 88.5 | 87.8 | 87.1 | 86.4 | 85.6 |
| 85          | 88.4 | 89.2 | 89.8 | 90.2 | 90.4 | 90.5 | 90.5 | 90.4 | 90.3 | 90.1 | 89.8 | 89.5 | 89.2 | 88.8 | 88.4 | 87.9 | 87.4 | 86.8 | 86.2 | 85.6 |
| 90          | 87.3 | 87.8 | 88.2 | 88.4 | 88.6 | 88.7 | 88.8 | 88.7 | 88.7 | 88.6 | 88.4 | 88.2 | 88.0 | 87.8 | 87.5 | 87.2 | 86.8 | 86.4 | 86.0 | 85.6 |
| 95          | 86.2 | 86.4 | 86.6 | 86.7 | 86.8 | 86.8 | 86.9 | 86.9 | 86.9 | 86.8 | 86.8 | 86.7 | 86.7 | 86.6 | 86.4 | 86.3 | 86.1 | 86.0 | 85.8 | 85.6 |
| 98          | 86.0 | 86.0 | 86.0 | 86.0 | 86.1 | 86.1 | 86.1 | 86.0 | 86.0 | 86.0 | 86.0 | 86.0 | 85.9 | 85.9 | 85.9 | 85.8 | 85.8 | 85.7 | 85.6 | 85.6 |

**Mean Annual Mass Removal Efficiencies for 2.00-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.5 | 99.7 | 99.6 | 99.6 | 99.4 | 99.1 | 98.8 | 98.4 | 97.9 | 97.4 | 96.8 | 96.1 | 95.3 | 94.4 | 93.6 | 92.6 | 91.7 | 90.7 | 89.7 | 88.7 |
| 35          | 99.2 | 99.4 | 99.4 | 99.4 | 99.2 | 99.0 | 98.6 | 98.2 | 97.8 | 97.3 | 96.6 | 95.9 | 95.2 | 94.4 | 93.5 | 92.6 | 91.6 | 90.7 | 89.7 | 88.7 |
| 40          | 98.6 | 99.0 | 99.1 | 99.1 | 98.9 | 98.7 | 98.4 | 98.0 | 97.6 | 97.1 | 96.5 | 95.8 | 95.1 | 94.3 | 93.4 | 92.5 | 91.6 | 90.6 | 89.7 | 88.7 |
| 45          | 98.0 | 98.6 | 98.8 | 98.7 | 98.6 | 98.4 | 98.1 | 97.8 | 97.4 | 96.9 | 96.3 | 95.6 | 94.9 | 94.1 | 93.3 | 92.5 | 91.5 | 90.6 | 89.6 | 88.7 |
| 50          | 97.3 | 98.1 | 98.3 | 98.3 | 98.2 | 98.0 | 97.8 | 97.5 | 97.1 | 96.6 | 96.1 | 95.4 | 94.7 | 94.0 | 93.2 | 92.4 | 91.5 | 90.6 | 89.6 | 88.7 |
| 55          | 96.6 | 97.4 | 97.7 | 97.8 | 97.7 | 97.6 | 97.4 | 97.1 | 96.7 | 96.3 | 95.8 | 95.2 | 94.5 | 93.8 | 93.0 | 92.2 | 91.4 | 90.5 | 89.6 | 88.7 |
| 60          | 95.6 | 96.6 | 97.0 | 97.1 | 97.1 | 97.0 | 96.9 | 96.6 | 96.3 | 95.9 | 95.4 | 94.9 | 94.2 | 93.6 | 92.8 | 92.1 | 91.3 | 90.4 | 89.6 | 88.7 |
| 65          | 94.5 | 95.7 | 96.2 | 96.4 | 96.5 | 96.4 | 96.3 | 96.0 | 95.7 | 95.4 | 94.9 | 94.4 | 93.9 | 93.3 | 92.6 | 91.9 | 91.1 | 90.3 | 89.5 | 88.7 |
| 70          | 93.5 | 94.7 | 95.3 | 95.5 | 95.7 | 95.6 | 95.5 | 95.3 | 95.1 | 94.8 | 94.4 | 93.9 | 93.4 | 92.9 | 92.3 | 91.6 | 90.9 | 90.2 | 89.5 | 88.7 |
| 75          | 92.5 | 93.6 | 94.2 | 94.5 | 94.7 | 94.7 | 94.7 | 94.5 | 94.3 | 94.0 | 93.7 | 93.3 | 92.9 | 92.4 | 91.9 | 91.3 | 90.7 | 90.1 | 89.4 | 88.7 |
| 80          | 91.5 | 92.5 | 93.1 | 93.4 | 93.6 | 93.7 | 93.6 | 93.5 | 93.4 | 93.2 | 92.9 | 92.6 | 92.2 | 91.8 | 91.4 | 90.9 | 90.4 | 89.9 | 89.3 | 88.7 |
| 85          | 90.6 | 91.3 | 91.8 | 92.1 | 92.3 | 92.4 | 92.4 | 92.4 | 92.3 | 92.1 | 91.9 | 91.7 | 91.4 | 91.1 | 90.8 | 90.4 | 90.0 | 89.6 | 89.2 | 88.7 |
| 90          | 89.7 | 90.1 | 90.5 | 90.7 | 90.9 | 91.0 | 91.0 | 91.0 | 91.0 | 90.9 | 90.8 | 90.6 | 90.5 | 90.3 | 90.1 | 89.9 | 89.6 | 89.3 | 89.0 | 88.7 |
| 95          | 88.9 | 89.1 | 89.2 | 89.3 | 89.4 | 89.5 | 89.5 | 89.5 | 89.5 | 89.5 | 89.5 | 89.4 | 89.4 | 89.3 | 89.2 | 89.2 | 89.0 | 88.9 | 88.8 | 88.7 |
| 98          | 88.8 | 88.8 | 88.9 | 88.9 | 88.9 | 88.9 | 88.9 | 88.9 | 88.9 | 88.9 | 88.9 | 88.9 | 88.9 | 88.8 | 88.8 | 88.8 | 88.8 | 88.7 | 88.7 | 88.7 |

**Mean Annual Mass Removal Efficiencies for 2.25-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.7 | 99.7 | 99.7 | 99.7 | 99.6 | 99.4 | 99.1 | 98.8 | 98.5 | 98.1 | 97.6 | 97.0 | 96.4 | 95.8 | 95.0 | 94.3 | 93.5 | 92.7 | 91.8 | 91.0 |
| 35          | 99.3 | 99.5 | 99.6 | 99.5 | 99.4 | 99.2 | 99.0 | 98.7 | 98.3 | 97.9 | 97.5 | 96.9 | 96.3 | 95.7 | 95.0 | 94.3 | 93.5 | 92.7 | 91.8 | 91.0 |
| 40          | 99.0 | 99.2 | 99.3 | 99.3 | 99.2 | 99.0 | 98.8 | 98.5 | 98.2 | 97.8 | 97.3 | 96.8 | 96.2 | 95.6 | 94.9 | 94.2 | 93.4 | 92.6 | 91.8 | 91.0 |
| 45          | 98.4 | 98.9 | 99.0 | 99.0 | 98.9 | 98.8 | 98.6 | 98.3 | 98.0 | 97.6 | 97.2 | 96.7 | 96.1 | 95.5 | 94.8 | 94.1 | 93.4 | 92.6 | 91.8 | 91.0 |
| 50          | 97.8 | 98.5 | 98.6 | 98.7 | 98.6 | 98.5 | 98.3 | 98.0 | 97.7 | 97.4 | 97.0 | 96.5 | 95.9 | 95.4 | 94.7 | 94.0 | 93.3 | 92.5 | 91.8 | 91.0 |
| 55          | 97.2 | 97.9 | 98.2 | 98.2 | 98.2 | 98.1 | 97.9 | 97.7 | 97.4 | 97.1 | 96.7 | 96.3 | 95.8 | 95.2 | 94.6 | 93.9 | 93.2 | 92.5 | 91.7 | 91.0 |
| 60          | 96.5 | 97.3 | 97.6 | 97.7 | 97.7 | 97.6 | 97.5 | 97.3 | 97.0 | 96.8 | 96.4 | 96.0 | 95.5 | 95.0 | 94.4 | 93.8 | 93.1 | 92.4 | 91.7 | 91.0 |
| 65          | 95.6 | 96.5 | 96.9 | 97.1 | 97.1 | 97.1 | 97.0 | 96.8 | 96.6 | 96.3 | 96.0 | 95.6 | 95.2 | 94.7 | 94.2 | 93.6 | 93.0 | 92.3 | 91.7 | 91.0 |
| 70          | 94.6 | 95.6 | 96.1 | 96.3 | 96.4 | 96.4 | 96.4 | 96.3 | 96.1 | 95.8 | 95.5 | 95.2 | 94.8 | 94.4 | 93.9 | 93.4 | 92.8 | 92.2 | 91.6 | 91.0 |
| 75          | 93.8 | 94.7 | 95.2 | 95.5 | 95.7 | 95.7 | 95.7 | 95.6 | 95.4 | 95.2 | 95.0 | 94.7 | 94.4 | 94.0 | 93.6 | 93.1 | 92.6 | 92.1 | 91.5 | 91.0 |
| 80          | 93.0 | 93.8 | 94.3 | 94.6 | 94.8 | 94.9 | 94.9 | 94.8 | 94.7 | 94.5 | 94.3 | 94.1 | 93.8 | 93.5 | 93.1 | 92.8 | 92.4 | 91.9 | 91.4 | 91.0 |
| 85          | 92.3 | 92.9 | 93.3 | 93.6 | 93.7 | 93.8 | 93.9 | 93.8 | 93.8 | 93.7 | 93.5 | 93.4 | 93.1 | 92.9 | 92.6 | 92.4 | 92.0 | 91.7 | 91.3 | 91.0 |
| 90          | 91.6 | 92.0 | 92.3 | 92.5 | 92.6 | 92.7 | 92.7 | 92.7 | 92.7 | 92.7 | 92.6 | 92.5 | 92.4 | 92.2 | 92.1 | 91.9 | 91.7 | 91.5 | 91.2 | 91.0 |
| 95          | 91.0 | 91.2 | 91.3 | 91.4 | 91.4 | 91.5 | 91.5 | 91.5 | 91.6 | 91.5 | 91.5 | 91.5 | 91.5 | 91.4 | 91.4 | 91.3 | 91.2 | 91.1 | 91.1 | 91.0 |
| 98          | 91.0 | 91.0 | 91.0 | 91.0 | 91.1 | 91.1 | 91.1 | 91.1 | 91.1 | 91.1 | 91.1 | 91.1 | 91.1 | 91.1 | 91.0 | 91.0 | 91.0 | 91.0 | 91.0 | 91.0 |

**Mean Annual Mass Removal Efficiencies for 2.50-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.7 | 99.8 | 99.8 | 99.8 | 99.7 | 99.6 | 99.4 | 99.1 | 98.8 | 98.5 | 98.1 | 97.7 | 97.2 | 96.7 | 96.1 | 95.5 | 94.9 | 94.2 | 93.5 | 92.7 |
| 35          | 99.5 | 99.6 | 99.7 | 99.6 | 99.6 | 99.4 | 99.3 | 99.0 | 98.7 | 98.4 | 98.0 | 97.6 | 97.2 | 96.6 | 96.1 | 95.5 | 94.8 | 94.2 | 93.4 | 92.7 |
| 40          | 99.2 | 99.4 | 99.5 | 99.5 | 99.4 | 99.3 | 99.1 | 98.9 | 98.6 | 98.3 | 97.9 | 97.5 | 97.1 | 96.6 | 96.0 | 95.4 | 94.8 | 94.1 | 93.4 | 92.7 |
| 45          | 98.7 | 99.1 | 99.2 | 99.2 | 99.2 | 99.0 | 98.9 | 98.7 | 98.4 | 98.1 | 97.8 | 97.4 | 97.0 | 96.5 | 95.9 | 95.4 | 94.7 | 94.1 | 93.4 | 92.7 |
| 50          | 98.2 | 98.8 | 98.9 | 98.9 | 98.9 | 98.8 | 98.6 | 98.4 | 98.2 | 97.9 | 97.6 | 97.2 | 96.8 | 96.4 | 95.8 | 95.3 | 94.7 | 94.1 | 93.4 | 92.7 |
| 55          | 97.7 | 98.3 | 98.5 | 98.6 | 98.5 | 98.5 | 98.3 | 98.1 | 97.9 | 97.7 | 97.4 | 97.0 | 96.6 | 96.2 | 95.7 | 95.2 | 94.6 | 94.0 | 93.4 | 92.7 |
| 60          | 97.1 | 97.8 | 98.0 | 98.1 | 98.1 | 98.1 | 97.9 | 97.8 | 97.6 | 97.4 | 97.1 | 96.8 | 96.4 | 96.0 | 95.6 | 95.1 | 94.5 | 93.9 | 93.3 | 92.7 |
| 65          | 96.4 | 97.1 | 97.5 | 97.6 | 97.6 | 97.6 | 97.5 | 97.4 | 97.2 | 97.0 | 96.8 | 96.5 | 96.2 | 95.8 | 95.4 | 94.9 | 94.4 | 93.9 | 93.3 | 92.7 |
| 70          | 95.6 | 96.4 | 96.8 | 97.0 | 97.1 | 97.1 | 97.0 | 96.9 | 96.8 | 96.6 | 96.4 | 96.1 | 95.8 | 95.5 | 95.1 | 94.7 | 94.2 | 93.8 | 93.3 | 92.7 |
| 75          | 94.8 | 95.6 | 96.0 | 96.3 | 96.4 | 96.5 | 96.4 | 96.4 | 96.3 | 96.1 | 95.9 | 95.7 | 95.5 | 95.2 | 94.8 | 94.5 | 94.1 | 93.6 | 93.2 | 92.7 |
| 80          | 94.1 | 94.8 | 95.3 | 95.5 | 95.7 | 95.8 | 95.8 | 95.7 | 95.7 | 95.5 | 95.4 | 95.2 | 95.0 | 94.8 | 94.5 | 94.2 | 93.8 | 93.5 | 93.1 | 92.7 |
| 85          | 93.6 | 94.1 | 94.4 | 94.7 | 94.8 | 94.9 | 95.0 | 95.0 | 94.9 | 94.9 | 94.7 | 94.6 | 94.5 | 94.3 | 94.1 | 93.8 | 93.6 | 93.3 | 93.0 | 92.7 |
| 90          | 93.1 | 93.4 | 93.6 | 93.8 | 93.9 | 94.0 | 94.1 | 94.1 | 94.1 | 94.0 | 94.0 | 93.9 | 93.8 | 93.7 | 93.6 | 93.4 | 93.3 | 93.1 | 92.9 | 92.7 |
| 95          | 92.7 | 92.8 | 92.9 | 93.0 | 93.0 | 93.1 | 93.1 | 93.1 | 93.1 | 93.1 | 93.1 | 93.1 | 93.1 | 93.1 | 93.0 | 93.0 | 92.9 | 92.9 | 92.8 | 92.7 |
| 98          | 92.7 | 92.7 | 92.7 | 92.7 | 92.7 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.7 | 92.7 | 92.7 | 92.7 |

**Mean Annual Mass Removal Efficiencies for 2.75-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.8 | 99.9 | 99.9 | 99.8 | 99.8 | 99.7 | 99.5 | 99.4 | 99.1 | 98.8 | 98.5 | 98.2 | 97.8 | 97.4 | 96.9 | 96.4 | 95.9 | 95.3 | 94.7 | 94.1 |
| 35          | 99.6 | 99.7 | 99.7 | 99.7 | 99.7 | 99.6 | 99.4 | 99.3 | 99.0 | 98.8 | 98.5 | 98.1 | 97.8 | 97.4 | 96.9 | 96.4 | 95.9 | 95.3 | 94.7 | 94.1 |
| 40          | 99.4 | 99.5 | 99.6 | 99.6 | 99.5 | 99.4 | 99.3 | 99.1 | 98.9 | 98.6 | 98.4 | 98.0 | 97.7 | 97.3 | 96.8 | 96.4 | 95.8 | 95.3 | 94.7 | 94.1 |
| 45          | 99.0 | 99.3 | 99.4 | 99.4 | 99.3 | 99.2 | 99.1 | 98.9 | 98.7 | 98.5 | 98.2 | 97.9 | 97.6 | 97.2 | 96.8 | 96.3 | 95.8 | 95.2 | 94.7 | 94.1 |
| 50          | 98.6 | 99.0 | 99.1 | 99.2 | 99.1 | 99.0 | 98.9 | 98.7 | 98.6 | 98.3 | 98.1 | 97.8 | 97.5 | 97.1 | 96.7 | 96.2 | 95.7 | 95.2 | 94.7 | 94.1 |
| 55          | 98.1 | 98.6 | 98.8 | 98.8 | 98.8 | 98.7 | 98.6 | 98.5 | 98.3 | 98.1 | 97.9 | 97.6 | 97.3 | 97.0 | 96.6 | 96.1 | 95.7 | 95.2 | 94.6 | 94.1 |
| 60          | 97.6 | 98.2 | 98.4 | 98.5 | 98.5 | 98.4 | 98.3 | 98.2 | 98.0 | 97.9 | 97.6 | 97.4 | 97.1 | 96.8 | 96.4 | 96.0 | 95.6 | 95.1 | 94.6 | 94.1 |
| 65          | 97.0 | 97.6 | 97.9 | 98.0 | 98.1 | 98.0 | 98.0 | 97.9 | 97.7 | 97.6 | 97.4 | 97.2 | 96.9 | 96.6 | 96.2 | 95.9 | 95.5 | 95.0 | 94.6 | 94.1 |
| 70          | 96.4 | 97.0 | 97.3 | 97.5 | 97.6 | 97.6 | 97.5 | 97.5 | 97.4 | 97.2 | 97.1 | 96.9 | 96.6 | 96.3 | 96.0 | 95.7 | 95.3 | 94.9 | 94.5 | 94.1 |
| 75          | 95.7 | 96.4 | 96.7 | 96.9 | 97.0 | 97.1 | 97.0 | 97.0 | 96.9 | 96.8 | 96.7 | 96.5 | 96.3 | 96.1 | 95.8 | 95.5 | 95.2 | 94.8 | 94.5 | 94.1 |
| 80          | 95.1 | 95.6 | 96.0 | 96.3 | 96.4 | 96.5 | 96.5 | 96.5 | 96.4 | 96.3 | 96.2 | 96.1 | 95.9 | 95.7 | 95.5 | 95.3 | 95.0 | 94.7 | 94.4 | 94.1 |
| 85          | 94.6 | 95.0 | 95.3 | 95.6 | 95.7 | 95.8 | 95.8 | 95.8 | 95.8 | 95.8 | 95.7 | 95.6 | 95.5 | 95.3 | 95.2 | 95.0 | 94.8 | 94.6 | 94.3 | 94.1 |
| 90          | 94.2 | 94.5 | 94.7 | 94.9 | 95.0 | 95.0 | 95.1 | 95.1 | 95.1 | 95.1 | 95.1 | 95.0 | 94.9 | 94.9 | 94.8 | 94.6 | 94.5 | 94.4 | 94.2 | 94.1 |
| 95          | 93.9 | 94.0 | 94.1 | 94.2 | 94.3 | 94.3 | 94.3 | 94.4 | 94.4 | 94.4 | 94.4 | 94.4 | 94.4 | 94.3 | 94.3 | 94.3 | 94.2 | 94.2 | 94.1 | 94.1 |
| 98          | 94.0 | 94.0 | 94.0 | 94.0 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 | 94.1 |

**Mean Annual Mass Removal Efficiencies for 3.00-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.9 | 99.9 | 99.9 | 99.9 | 99.8 | 99.8 | 99.7 | 99.5 | 99.3 | 99.1 | 98.9 | 98.6 | 98.3 | 97.9 | 97.6 | 97.1 | 96.7 | 96.2 | 95.7 | 95.1 |
| 35          | 99.7 | 99.8 | 99.8 | 99.8 | 99.7 | 99.7 | 99.6 | 99.4 | 99.2 | 99.0 | 98.8 | 98.5 | 98.2 | 97.9 | 97.5 | 97.1 | 96.7 | 96.2 | 95.7 | 95.1 |
| 40          | 99.5 | 99.6 | 99.7 | 99.7 | 99.6 | 99.6 | 99.5 | 99.3 | 99.1 | 98.9 | 98.7 | 98.4 | 98.1 | 97.8 | 97.5 | 97.1 | 96.6 | 96.2 | 95.7 | 95.1 |
| 45          | 99.2 | 99.4 | 99.5 | 99.5 | 99.5 | 99.4 | 99.3 | 99.2 | 99.0 | 98.8 | 98.6 | 98.3 | 98.1 | 97.7 | 97.4 | 97.0 | 96.6 | 96.1 | 95.6 | 95.1 |
| 50          | 98.8 | 99.2 | 99.3 | 99.3 | 99.3 | 99.2 | 99.1 | 99.0 | 98.8 | 98.6 | 98.4 | 98.2 | 97.9 | 97.6 | 97.3 | 96.9 | 96.5 | 96.1 | 95.6 | 95.1 |
| 55          | 98.4 | 98.9 | 99.0 | 99.1 | 99.0 | 99.0 | 98.9 | 98.8 | 98.6 | 98.5 | 98.3 | 98.0 | 97.8 | 97.5 | 97.2 | 96.9 | 96.5 | 96.1 | 95.6 | 95.1 |
| 60          | 98.0 | 98.5 | 98.7 | 98.7 | 98.7 | 98.7 | 98.6 | 98.5 | 98.4 | 98.2 | 98.1 | 97.9 | 97.6 | 97.4 | 97.1 | 96.8 | 96.4 | 96.0 | 95.6 | 95.1 |
| 65          | 97.5 | 98.0 | 98.3 | 98.4 | 98.4 | 98.4 | 98.3 | 98.2 | 98.1 | 98.0 | 97.8 | 97.6 | 97.4 | 97.2 | 96.9 | 96.6 | 96.3 | 95.9 | 95.6 | 95.1 |
| 70          | 97.0 | 97.5 | 97.8 | 97.9 | 98.0 | 98.0 | 97.9 | 97.9 | 97.8 | 97.7 | 97.6 | 97.4 | 97.2 | 97.0 | 96.8 | 96.5 | 96.2 | 95.9 | 95.5 | 95.1 |
| 75          | 96.4 | 97.0 | 97.2 | 97.4 | 97.5 | 97.5 | 97.5 | 97.5 | 97.4 | 97.3 | 97.2 | 97.1 | 96.9 | 96.8 | 96.5 | 96.3 | 96.1 | 95.8 | 95.5 | 95.1 |
| 80          | 95.9 | 96.3 | 96.6 | 96.8 | 97.0 | 97.0 | 97.0 | 97.0 | 97.0 | 96.9 | 96.9 | 96.8 | 96.6 | 96.5 | 96.3 | 96.1 | 95.9 | 95.7 | 95.4 | 95.1 |
| 85          | 95.4 | 95.8 | 96.1 | 96.2 | 96.4 | 96.5 | 96.5 | 96.5 | 96.5 | 96.5 | 96.4 | 96.3 | 96.3 | 96.1 | 96.0 | 95.9 | 95.7 | 95.5 | 95.3 | 95.1 |
| 90          | 95.1 | 95.4 | 95.5 | 95.7 | 95.8 | 95.9 | 95.9 | 95.9 | 95.9 | 95.9 | 95.9 | 95.9 | 95.8 | 95.8 | 95.7 | 95.6 | 95.5 | 95.4 | 95.3 | 95.1 |
| 95          | 95.0 | 95.0 | 95.1 | 95.2 | 95.2 | 95.3 | 95.3 | 95.3 | 95.3 | 95.4 | 95.4 | 95.4 | 95.3 | 95.3 | 95.3 | 95.3 | 95.3 | 95.2 | 95.2 | 95.1 |
| 98          | 95.0 | 95.1 | 95.1 | 95.1 | 95.1 | 95.1 | 95.1 | 95.1 | 95.1 | 95.1 | 95.2 | 95.2 | 95.2 | 95.2 | 95.2 | 95.2 | 95.1 | 95.1 | 95.1 | 95.1 |

**Mean Annual Mass Removal Efficiencies for 3.25-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.9 | 99.9 | 99.9 | 99.9 | 99.9 | 99.8 | 99.8 | 99.6 | 99.5 | 99.3 | 99.1 | 98.9 | 98.6 | 98.3 | 98.0 | 97.7 | 97.3 | 96.9 | 96.4 | 96.0 |
| 35          | 99.8 | 99.8 | 99.9 | 99.8 | 99.8 | 99.8 | 99.7 | 99.6 | 99.4 | 99.2 | 99.0 | 98.8 | 98.5 | 98.3 | 98.0 | 97.6 | 97.3 | 96.9 | 96.4 | 96.0 |
| 40          | 99.6 | 99.7 | 99.7 | 99.7 | 99.7 | 99.7 | 99.6 | 99.5 | 99.3 | 99.1 | 99.0 | 98.7 | 98.5 | 98.2 | 97.9 | 97.6 | 97.2 | 96.8 | 96.4 | 96.0 |
| 45          | 99.4 | 99.5 | 99.6 | 99.6 | 99.6 | 99.5 | 99.4 | 99.3 | 99.2 | 99.0 | 98.8 | 98.6 | 98.4 | 98.2 | 97.9 | 97.5 | 97.2 | 96.8 | 96.4 | 96.0 |
| 50          | 99.1 | 99.3 | 99.4 | 99.4 | 99.4 | 99.4 | 99.3 | 99.2 | 99.1 | 98.9 | 98.7 | 98.5 | 98.3 | 98.1 | 97.8 | 97.5 | 97.2 | 96.8 | 96.4 | 96.0 |
| 55          | 98.7 | 99.1 | 99.2 | 99.2 | 99.2 | 99.2 | 99.1 | 99.0 | 98.9 | 98.7 | 98.6 | 98.4 | 98.2 | 98.0 | 97.7 | 97.4 | 97.1 | 96.8 | 96.4 | 96.0 |
| 60          | 98.4 | 98.8 | 98.9 | 99.0 | 99.0 | 98.9 | 98.9 | 98.8 | 98.7 | 98.5 | 98.4 | 98.2 | 98.0 | 97.8 | 97.6 | 97.3 | 97.0 | 96.7 | 96.4 | 96.0 |
| 65          | 98.0 | 98.4 | 98.6 | 98.6 | 98.7 | 98.6 | 98.6 | 98.5 | 98.4 | 98.3 | 98.2 | 98.0 | 97.9 | 97.7 | 97.5 | 97.2 | 96.9 | 96.7 | 96.3 | 96.0 |
| 70          | 97.5 | 97.9 | 98.2 | 98.3 | 98.3 | 98.3 | 98.3 | 98.2 | 98.2 | 98.1 | 98.0 | 97.8 | 97.7 | 97.5 | 97.3 | 97.1 | 96.8 | 96.6 | 96.3 | 96.0 |
| 75          | 97.0 | 97.4 | 97.7 | 97.8 | 97.9 | 97.9 | 97.9 | 97.9 | 97.8 | 97.8 | 97.7 | 97.6 | 97.4 | 97.3 | 97.1 | 96.9 | 96.7 | 96.5 | 96.3 | 96.0 |
| 80          | 96.5 | 96.9 | 97.2 | 97.3 | 97.4 | 97.5 | 97.5 | 97.5 | 97.5 | 97.4 | 97.4 | 97.3 | 97.2 | 97.1 | 96.9 | 96.8 | 96.6 | 96.4 | 96.2 | 96.0 |
| 85          | 96.1 | 96.4 | 96.7 | 96.8 | 96.9 | 97.0 | 97.0 | 97.1 | 97.1 | 97.0 | 97.0 | 96.9 | 96.9 | 96.8 | 96.7 | 96.6 | 96.4 | 96.3 | 96.1 | 96.0 |
| 90          | 95.9 | 96.1 | 96.2 | 96.3 | 96.4 | 96.5 | 96.5 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.5 | 96.5 | 96.4 | 96.3 | 96.3 | 96.2 | 96.1 | 96.0 |
| 95          | 95.8 | 95.8 | 95.9 | 96.0 | 96.0 | 96.0 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.0 | 96.0 | 96.0 |
| 98          | 95.9 | 95.9 | 95.9 | 95.9 | 95.9 | 95.9 | 95.9 | 96.0 | 96.0 | 96.0 | 96.0 | 96.0 | 96.0 | 96.0 | 96.0 | 96.0 | 96.0 | 96.0 | 96.0 | 96.0 |

**Mean Annual Mass Removal Efficiencies for 3.50-inches of Retention in Zone 2 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.9 | 99.9 | 99.9 | 99.9 | 99.9 | 99.9 | 99.8 | 99.7 | 99.6 | 99.5 | 99.3 | 99.1 | 98.9 | 98.6 | 98.4 | 98.1 | 97.8 | 97.4 | 97.0 | 96.7 |
| 35          | 99.8 | 99.9 | 99.9 | 99.9 | 99.8 | 99.8 | 99.8 | 99.7 | 99.5 | 99.4 | 99.2 | 99.0 | 98.8 | 98.6 | 98.3 | 98.0 | 97.7 | 97.4 | 97.0 | 96.7 |
| 40          | 99.7 | 99.8 | 99.8 | 99.8 | 99.8 | 99.7 | 99.7 | 99.6 | 99.5 | 99.3 | 99.2 | 99.0 | 98.8 | 98.5 | 98.3 | 98.0 | 97.7 | 97.4 | 97.0 | 96.7 |
| 45          | 99.5 | 99.7 | 99.7 | 99.7 | 99.7 | 99.6 | 99.6 | 99.5 | 99.4 | 99.2 | 99.1 | 98.9 | 98.7 | 98.5 | 98.2 | 98.0 | 97.7 | 97.4 | 97.0 | 96.7 |
| 50          | 99.3 | 99.5 | 99.5 | 99.5 | 99.5 | 99.5 | 99.4 | 99.3 | 99.2 | 99.1 | 98.9 | 98.8 | 98.6 | 98.4 | 98.2 | 97.9 | 97.6 | 97.3 | 97.0 | 96.7 |
| 55          | 98.9 | 99.2 | 99.3 | 99.4 | 99.4 | 99.3 | 99.3 | 99.2 | 99.1 | 99.0 | 98.8 | 98.7 | 98.5 | 98.3 | 98.1 | 97.9 | 97.6 | 97.3 | 97.0 | 96.7 |
| 60          | 98.6 | 99.0 | 99.1 | 99.2 | 99.2 | 99.1 | 99.1 | 99.0 | 98.9 | 98.8 | 98.7 | 98.5 | 98.4 | 98.2 | 98.0 | 97.8 | 97.5 | 97.3 | 97.0 | 96.7 |
| 65          | 98.3 | 98.7 | 98.8 | 98.9 | 98.9 | 98.9 | 98.8 | 98.8 | 98.7 | 98.6 | 98.5 | 98.4 | 98.2 | 98.1 | 97.9 | 97.7 | 97.5 | 97.2 | 96.9 | 96.7 |
| 70          | 97.9 | 98.3 | 98.5 | 98.5 | 98.6 | 98.6 | 98.6 | 98.5 | 98.4 | 98.4 | 98.3 | 98.2 | 98.0 | 97.9 | 97.7 | 97.6 | 97.4 | 97.2 | 96.9 | 96.7 |
| 75          | 97.5 | 97.8 | 98.1 | 98.2 | 98.2 | 98.3 | 98.2 | 98.2 | 98.2 | 98.1 | 98.0 | 97.9 | 97.8 | 97.7 | 97.6 | 97.4 | 97.3 | 97.1 | 96.9 | 96.7 |
| 80          | 97.1 | 97.4 | 97.6 | 97.7 | 97.8 | 97.9 | 97.9 | 97.9 | 97.9 | 97.8 | 97.8 | 97.7 | 97.6 | 97.5 | 97.4 | 97.3 | 97.2 | 97.0 | 96.8 | 96.7 |
| 85          | 96.7 | 97.0 | 97.1 | 97.3 | 97.4 | 97.4 | 97.5 | 97.5 | 97.5 | 97.5 | 97.5 | 97.4 | 97.4 | 97.3 | 97.2 | 97.1 | 97.0 | 96.9 | 96.8 | 96.7 |
| 90          | 96.5 | 96.6 | 96.8 | 96.9 | 97.0 | 97.0 | 97.1 | 97.1 | 97.1 | 97.1 | 97.1 | 97.1 | 97.1 | 97.0 | 97.0 | 96.9 | 96.9 | 96.8 | 96.7 | 96.7 |
| 95          | 96.4 | 96.5 | 96.5 | 96.6 | 96.6 | 96.7 | 96.7 | 96.7 | 96.7 | 96.7 | 96.8 | 96.8 | 96.8 | 96.8 | 96.7 | 96.7 | 96.7 | 96.7 | 96.7 | 96.7 |
| 98          | 96.5 | 96.5 | 96.5 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.6 | 96.7 | 96.7 | 96.7 | 96.7 |

### Mean Annual Mass Removal Efficiencies for 3.75-inches of Retention in Zone 2 by Percent DCIA

[illegible]

### Mean Annual Mass Removal Efficiencies for 4.00-inches of Retention in Zone 2 by Percent DCIA

[illegible]

**Mean Annual Mass Removal Efficiencies for 0.25-inches of Retention for Zone 3 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 82.7 | 81.2 | 75.5 | 69.3 | 63.6 | 58.6 | 54.2 | 50.4 | 47.0 | 44.1 | 41.4 | 39.1 | 37.1 | 35.2 | 33.5 | 32.0 | 30.6 | 29.3 | 28.1 | 27.0 |
| 35          | 77.8 | 78.2 | 73.6 | 68.0 | 62.7 | 58.0 | 53.7 | 50.0 | 46.8 | 43.9 | 41.3 | 39.0 | 37.0 | 35.1 | 33.4 | 31.9 | 30.5 | 29.2 | 28.1 | 27.0 |
| 40          | 72.7 | 74.9 | 71.5 | 66.6 | 61.7 | 57.2 | 53.2 | 49.6 | 46.4 | 43.6 | 41.1 | 38.9 | 36.8 | 35.0 | 33.4 | 31.9 | 30.5 | 29.2 | 28.1 | 27.0 |
| 45          | 67.3 | 71.3 | 69.0 | 64.9 | 60.5 | 56.3 | 52.5 | 49.1 | 46.0 | 43.3 | 40.9 | 38.7 | 36.7 | 34.9 | 33.3 | 31.8 | 30.5 | 29.2 | 28.1 | 27.0 |
| 50          | 61.8 | 67.4 | 66.3 | 62.9 | 59.1 | 55.3 | 51.7 | 48.5 | 45.6 | 42.9 | 40.6 | 38.5 | 36.5 | 34.8 | 33.2 | 31.7 | 30.4 | 29.2 | 28.0 | 27.0 |
| 55          | 56.5 | 63.2 | 63.2 | 60.7 | 57.4 | 54.0 | 50.8 | 47.8 | 45.0 | 42.5 | 40.2 | 38.2 | 36.3 | 34.6 | 33.1 | 31.7 | 30.4 | 29.1 | 28.0 | 27.0 |
| 60          | 51.5 | 58.8 | 59.9 | 58.2 | 55.5 | 52.6 | 49.7 | 46.9 | 44.3 | 42.0 | 39.8 | 37.9 | 36.1 | 34.4 | 32.9 | 31.6 | 30.3 | 29.1 | 28.0 | 27.0 |
| 65          | 46.7 | 54.3 | 56.2 | 55.4 | 53.4 | 50.9 | 48.3 | 45.9 | 43.5 | 41.3 | 39.3 | 37.5 | 35.8 | 34.2 | 32.8 | 31.4 | 30.2 | 29.0 | 28.0 | 27.0 |
| 70          | 42.4 | 49.7 | 52.3 | 52.2 | 50.8 | 48.9 | 46.8 | 44.6 | 42.5 | 40.5 | 38.7 | 37.0 | 35.4 | 33.9 | 32.5 | 31.3 | 30.1 | 29.0 | 28.0 | 27.0 |
| 75          | 38.8 | 45.1 | 48.0 | 48.6 | 47.9 | 46.5 | 44.8 | 43.1 | 41.3 | 39.5 | 37.9 | 36.3 | 34.9 | 33.5 | 32.2 | 31.1 | 29.9 | 28.9 | 27.9 | 27.0 |
| 80          | 35.5 | 40.7 | 43.4 | 44.5 | 44.4 | 43.7 | 42.5 | 41.1 | 39.7 | 38.3 | 36.9 | 35.5 | 34.2 | 33.0 | 31.9 | 30.8 | 29.7 | 28.8 | 27.9 | 27.0 |
| 85          | 32.7 | 36.5 | 38.7 | 39.9 | 40.3 | 40.1 | 39.5 | 38.6 | 37.6 | 36.5 | 35.4 | 34.4 | 33.3 | 32.3 | 31.3 | 30.4 | 29.5 | 28.6 | 27.8 | 27.0 |
| 90          | 30.6 | 32.8 | 34.3 | 35.2 | 35.7 | 35.8 | 35.6 | 35.2 | 34.7 | 34.1 | 33.4 | 32.7 | 31.9 | 31.2 | 30.4 | 29.7 | 29.0 | 28.3 | 27.6 | 27.0 |
| 95          | 29.1 | 29.8 | 30.3 | 30.7 | 30.9 | 31.0 | 31.0 | 31.0 | 30.8 | 30.6 | 30.3 | 30.0 | 29.7 | 29.4 | 29.0 | 28.6 | 28.2 | 27.8 | 27.4 | 27.0 |
| 98          | 28.5 | 28.5 | 28.6 | 28.6 | 28.6 | 28.6 | 28.6 | 28.5 | 28.5 | 28.4 | 28.3 | 28.2 | 28.0 | 27.9 | 27.8 | 27.6 | 27.5 | 27.3 | 27.2 | 27.0 |

**Mean Annual Mass Removal Efficiencies for 0.50-inches of Retention for Zone 3 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 87.6 | 89.1 | 87.6 | 84.8 | 81.5 | 77.8 | 74.3 | 70.9 | 67.8 | 64.9 | 62.1 | 59.6 | 57.2 | 55.0 | 52.9 | 51.0 | 49.2 | 47.6 | 46.0 | 44.5 |
| 35          | 83.5 | 86.5 | 85.6 | 83.4 | 80.4 | 77.0 | 73.6 | 70.4 | 67.4 | 64.5 | 61.9 | 59.4 | 57.0 | 54.9 | 52.8 | 51.0 | 49.2 | 47.5 | 46.0 | 44.5 |
| 40          | 79.3 | 83.5 | 83.4 | 81.7 | 79.1 | 76.0 | 72.9 | 69.8 | 66.9 | 64.2 | 61.6 | 59.1 | 56.9 | 54.7 | 52.7 | 50.9 | 49.1 | 47.5 | 46.0 | 44.5 |
| 45          | 74.9 | 80.3 | 80.9 | 79.7 | 77.6 | 74.9 | 72.0 | 69.1 | 66.4 | 63.7 | 61.2 | 58.9 | 56.6 | 54.6 | 52.6 | 50.8 | 49.1 | 47.5 | 45.9 | 44.5 |
| 50          | 70.5 | 76.7 | 78.1 | 77.6 | 75.9 | 73.5 | 70.9 | 68.3 | 65.7 | 63.2 | 60.8 | 58.5 | 56.4 | 54.4 | 52.5 | 50.7 | 49.0 | 47.4 | 45.9 | 44.5 |
| 55          | 66.3 | 72.9 | 75.0 | 75.1 | 73.9 | 71.9 | 69.6 | 67.3 | 64.9 | 62.6 | 60.3 | 58.1 | 56.1 | 54.1 | 52.3 | 50.6 | 48.9 | 47.4 | 45.9 | 44.5 |
| 60          | 62.1 | 68.9 | 71.7 | 72.4 | 71.6 | 70.1 | 68.2 | 66.1 | 64.0 | 61.8 | 59.7 | 57.7 | 55.7 | 53.8 | 52.1 | 50.4 | 48.8 | 47.3 | 45.9 | 44.5 |
| 65          | 58.0 | 64.9 | 68.1 | 69.3 | 69.1 | 68.0 | 66.5 | 64.7 | 62.8 | 60.9 | 59.0 | 57.1 | 55.2 | 53.5 | 51.8 | 50.2 | 48.7 | 47.2 | 45.8 | 44.5 |
| 70          | 54.4 | 60.9 | 64.2 | 65.8 | 66.2 | 65.6 | 64.5 | 63.0 | 61.5 | 59.8 | 58.1 | 56.3 | 54.6 | 53.0 | 51.4 | 49.9 | 48.5 | 47.1 | 45.8 | 44.5 |
| 75          | 51.1 | 57.0 | 60.4 | 62.2 | 62.9 | 62.7 | 62.1 | 61.0 | 59.8 | 58.4 | 56.9 | 55.4 | 53.9 | 52.4 | 51.0 | 49.6 | 48.3 | 47.0 | 45.7 | 44.5 |
| 80          | 48.5 | 53.5 | 56.5 | 58.3 | 59.1 | 59.3 | 59.1 | 58.5 | 57.6 | 56.6 | 55.4 | 54.2 | 52.9 | 51.6 | 50.4 | 49.2 | 47.9 | 46.8 | 45.6 | 44.5 |
| 85          | 46.7 | 50.3 | 52.7 | 54.2 | 55.1 | 55.5 | 55.6 | 55.3 | 54.9 | 54.2 | 53.4 | 52.6 | 51.6 | 50.6 | 49.6 | 48.5 | 47.5 | 46.5 | 45.5 | 44.5 |
| 90          | 45.4 | 47.6 | 49.1 | 50.2 | 51.0 | 51.4 | 51.7 | 51.7 | 51.5 | 51.2 | 50.8 | 50.3 | 49.7 | 49.0 | 48.3 | 47.6 | 46.8 | 46.1 | 45.3 | 44.5 |
| 95          | 44.8 | 45.6 | 46.2 | 46.7 | 47.1 | 47.3 | 47.5 | 47.6 | 47.6 | 47.5 | 47.4 | 47.2 | 47.0 | 46.7 | 46.4 | 46.1 | 45.7 | 45.3 | 44.9 | 44.5 |
| 98          | 45.2 | 45.3 | 45.4 | 45.4 | 45.5 | 45.5 | 45.5 | 45.6 | 45.5 | 45.5 | 45.5 | 45.4 | 45.3 | 45.3 | 45.2 | 45.0 | 44.9 | 44.8 | 44.7 | 44.5 |

### Mean Annual Mass Removal Efficiencies for 0.75-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 89.7 | 92.3 | 91.6 | 90.3 | 88.4 | 86.2 | 83.8 | 81.3 | 78.7 | 76.2 | 73.8 | 71.5 | 69.3 | 67.3 | 65.3 | 63.4 | 61.6 | 59.9 | 58.3 | 56.7 |
| 35          | 86.6 | 89.8 | 89.8 | 88.9 | 87.2 | 85.3 | 83.1 | 80.7 | 78.2 | 75.8 | 73.5 | 71.3 | 69.2 | 67.1 | 65.2 | 63.3 | 61.6 | 59.9 | 58.3 | 56.7 |
| 40          | 82.9 | 87.1 | 87.9 | 87.3 | 85.9 | 84.2 | 82.2 | 80.0 | 77.7 | 75.4 | 73.2 | 71.0 | 69.0 | 67.0 | 65.1 | 63.2 | 61.5 | 59.8 | 58.2 | 56.7 |
| 45          | 79.3 | 84.4 | 85.7 | 85.5 | 84.5 | 83.0 | 81.2 | 79.2 | 77.1 | 74.9 | 72.8 | 70.7 | 68.7 | 66.8 | 64.9 | 63.1 | 61.4 | 59.8 | 58.2 | 56.7 |
| 50          | 75.8 | 81.4 | 83.2 | 83.5 | 82.8 | 81.6 | 80.1 | 78.3 | 76.3 | 74.3 | 72.3 | 70.3 | 68.4 | 66.5 | 64.7 | 63.0 | 61.3 | 59.7 | 58.2 | 56.7 |
| 55          | 72.2 | 78.3 | 80.5 | 81.2 | 80.9 | 80.1 | 78.8 | 77.2 | 75.4 | 73.5 | 71.7 | 69.8 | 68.0 | 66.2 | 64.5 | 62.8 | 61.2 | 59.7 | 58.2 | 56.7 |
| 60          | 69.0 | 75.0 | 77.6 | 78.6 | 78.7 | 78.3 | 77.3 | 75.9 | 74.3 | 72.7 | 71.0 | 69.2 | 67.5 | 65.9 | 64.2 | 62.6 | 61.1 | 59.6 | 58.1 | 56.7 |
| 65          | 65.7 | 71.6 | 74.4 | 75.8 | 76.3 | 76.2 | 75.5 | 74.4 | 73.1 | 71.7 | 70.1 | 68.6 | 67.0 | 65.4 | 63.9 | 62.4 | 60.9 | 59.5 | 58.1 | 56.7 |
| 70          | 62.5 | 68.2 | 71.2 | 72.8 | 73.6 | 73.8 | 73.4 | 72.7 | 71.6 | 70.4 | 69.1 | 67.7 | 66.3 | 64.9 | 63.5 | 62.1 | 60.7 | 59.3 | 58.0 | 56.7 |
| 75          | 59.8 | 64.9 | 67.9 | 69.7 | 70.6 | 71.1 | 71.0 | 70.6 | 69.8 | 68.9 | 67.8 | 66.7 | 65.5 | 64.2 | 62.9 | 61.7 | 60.4 | 59.2 | 57.9 | 56.7 |
| 80          | 57.5 | 61.8 | 64.6 | 66.4 | 67.5 | 68.1 | 68.2 | 68.0 | 67.6 | 67.0 | 66.2 | 65.3 | 64.3 | 63.3 | 62.2 | 61.2 | 60.0 | 58.9 | 57.8 | 56.7 |
| 85          | 56.0 | 59.3 | 61.6 | 63.1 | 64.2 | 64.8 | 65.1 | 65.1 | 64.9 | 64.6 | 64.1 | 63.5 | 62.8 | 62.1 | 61.3 | 60.4 | 59.5 | 58.6 | 57.7 | 56.7 |
| 90          | 55.4 | 57.4 | 58.9 | 60.0 | 60.8 | 61.3 | 61.7 | 61.9 | 61.9 | 61.8 | 61.6 | 61.3 | 60.9 | 60.5 | 59.9 | 59.4 | 58.8 | 58.1 | 57.4 | 56.7 |
| 95          | 55.5 | 56.2 | 56.8 | 57.3 | 57.7 | 58.1 | 58.3 | 58.5 | 58.6 | 58.7 | 58.7 | 58.6 | 58.5 | 58.4 | 58.2 | 57.9 | 57.7 | 57.4 | 57.1 | 56.7 |
| 98          | 56.5 | 56.6 | 56.8 | 56.9 | 57.0 | 57.1 | 57.1 | 57.2 | 57.2 | 57.2 | 57.2 | 57.2 | 57.2 | 57.2 | 57.1 | 57.1 | 57.0 | 56.9 | 56.8 | 56.7 |

### Mean Annual Mass Removal Efficiencies for 1.00-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 91.1 | 93.7 | 94.0 | 92.9 | 91.7 | 90.3 | 88.6 | 86.8 | 85.0 | 83.1 | 81.1 | 79.1 | 77.2 | 75.3 | 73.5 | 71.8 | 70.1 | 68.5 | 67.0 | 65.5 |
| 35          | 88.6 | 91.8 | 92.2 | 91.6 | 90.7 | 89.5 | 87.9 | 86.3 | 84.5 | 82.7 | 80.8 | 78.9 | 77.0 | 75.2 | 73.4 | 71.7 | 70.1 | 68.5 | 67.0 | 65.5 |
| 40          | 85.9 | 89.4 | 90.4 | 90.3 | 89.6 | 88.5 | 87.1 | 85.6 | 83.9 | 82.2 | 80.4 | 78.6 | 76.8 | 75.0 | 73.3 | 71.6 | 70.0 | 68.5 | 66.9 | 65.5 |
| 45          | 82.5 | 86.9 | 88.5 | 88.7 | 88.2 | 87.3 | 86.1 | 84.8 | 83.3 | 81.7 | 80.0 | 78.2 | 76.5 | 74.8 | 73.1 | 71.5 | 69.9 | 68.4 | 66.9 | 65.5 |
| 50          | 79.4 | 84.4 | 86.4 | 86.9 | 86.7 | 86.0 | 85.0 | 83.9 | 82.5 | 81.0 | 79.4 | 77.8 | 76.1 | 74.5 | 72.9 | 71.3 | 69.8 | 68.3 | 66.9 | 65.5 |
| 55          | 76.6 | 81.9 | 84.0 | 84.9 | 85.0 | 84.5 | 83.7 | 82.8 | 81.6 | 80.3 | 78.8 | 77.3 | 75.7 | 74.2 | 72.7 | 71.2 | 69.7 | 68.3 | 66.9 | 65.5 |
| 60          | 73.8 | 79.1 | 81.6 | 82.7 | 83.0 | 82.8 | 82.3 | 81.6 | 80.6 | 79.4 | 78.1 | 76.7 | 75.2 | 73.8 | 72.4 | 70.9 | 69.5 | 68.2 | 66.8 | 65.5 |
| 65          | 71.1 | 76.4 | 78.9 | 80.3 | 80.8 | 80.9 | 80.6 | 80.1 | 79.4 | 78.4 | 77.2 | 75.9 | 74.6 | 73.3 | 72.0 | 70.7 | 69.4 | 68.0 | 66.8 | 65.5 |
| 70          | 68.6 | 73.5 | 76.2 | 77.6 | 78.4 | 78.8 | 78.7 | 78.5 | 77.9 | 77.1 | 76.2 | 75.1 | 73.9 | 72.8 | 71.5 | 70.3 | 69.1 | 67.9 | 66.7 | 65.5 |
| 75          | 66.3 | 70.6 | 73.3 | 74.9 | 75.9 | 76.4 | 76.6 | 76.5 | 76.1 | 75.6 | 74.9 | 74.0 | 73.0 | 72.0 | 71.0 | 69.9 | 68.8 | 67.7 | 66.6 | 65.5 |
| 80          | 64.3 | 68.0 | 70.5 | 72.1 | 73.2 | 73.9 | 74.2 | 74.3 | 74.1 | 73.8 | 73.3 | 72.6 | 71.9 | 71.1 | 70.2 | 69.3 | 68.4 | 67.5 | 66.5 | 65.5 |
| 85          | 63.1 | 65.9 | 67.9 | 69.4 | 70.4 | 71.2 | 71.6 | 71.8 | 71.8 | 71.6 | 71.3 | 70.9 | 70.5 | 69.9 | 69.3 | 68.6 | 67.9 | 67.1 | 66.3 | 65.5 |
| 90          | 62.7 | 64.5 | 65.9 | 67.0 | 67.8 | 68.4 | 68.8 | 69.1 | 69.2 | 69.2 | 69.1 | 68.9 | 68.7 | 68.4 | 68.0 | 67.6 | 67.1 | 66.6 | 66.1 | 65.5 |
| 95          | 63.3 | 64.0 | 64.6 | 65.1 | 65.5 | 65.8 | 66.1 | 66.3 | 66.4 | 66.5 | 66.6 | 66.6 | 66.6 | 66.5 | 66.4 | 66.3 | 66.1 | 66.0 | 65.7 | 65.5 |
| 98          | 64.7 | 64.8 | 65.0 | 65.1 | 65.2 | 65.3 | 65.4 | 65.5 | 65.5 | 65.6 | 65.6 | 65.6 | 65.6 | 65.7 | 65.7 | 65.6 | 65.6 | 65.6 | 65.5 | 65.5 |



### Mean Annual Mass Removal Efficiencies for 1.75-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 93.3 | 95.6 | 96.4 | 96.6 | 96.3 | 95.6 | 94.7 | 93.8 | 92.9 | 92.0 | 91.0 | 89.9 | 88.8 | 87.8 | 86.6 | 85.5 | 84.3 | 83.2 | 82.0 | 80.8 |
| 35          | 91.8 | 94.4 | 95.4 | 95.7 | 95.5 | 94.8 | 94.1 | 93.3 | 92.5 | 91.6 | 90.7 | 89.7 | 88.6 | 87.6 | 86.5 | 85.4 | 84.3 | 83.1 | 82.0 | 80.8 |
| 40          | 90.2 | 93.1 | 94.3 | 94.7 | 94.5 | 94.0 | 93.4 | 92.7 | 92.0 | 91.2 | 90.4 | 89.4 | 88.4 | 87.4 | 86.3 | 85.3 | 84.2 | 83.1 | 82.0 | 80.8 |
| 45          | 88.6 | 91.8 | 93.1 | 93.5 | 93.4 | 93.1 | 92.6 | 92.1 | 91.5 | 90.8 | 89.9 | 89.0 | 88.1 | 87.1 | 86.2 | 85.1 | 84.1 | 83.0 | 81.9 | 80.8 |
| 50          | 86.9 | 90.3 | 91.6 | 92.1 | 92.2 | 92.1 | 91.8 | 91.4 | 90.9 | 90.2 | 89.5 | 88.6 | 87.7 | 86.9 | 85.9 | 85.0 | 84.0 | 82.9 | 81.9 | 80.8 |
| 55          | 84.9 | 88.3 | 89.9 | 90.6 | 91.0 | 91.1 | 90.9 | 90.6 | 90.2 | 89.6 | 88.9 | 88.1 | 87.4 | 86.6 | 85.7 | 84.8 | 83.8 | 82.9 | 81.9 | 80.8 |
| 60          | 82.7 | 86.4 | 88.2 | 89.2 | 89.7 | 89.9 | 89.9 | 89.7 | 89.3 | 88.8 | 88.2 | 87.6 | 86.9 | 86.2 | 85.4 | 84.6 | 83.7 | 82.8 | 81.8 | 80.8 |
| 65          | 80.9 | 84.6 | 86.7 | 87.7 | 88.4 | 88.6 | 88.7 | 88.6 | 88.3 | 87.9 | 87.5 | 86.9 | 86.4 | 85.7 | 85.0 | 84.3 | 83.5 | 82.6 | 81.8 | 80.8 |
| 70          | 79.6 | 83.0 | 85.0 | 86.2 | 86.8 | 87.2 | 87.4 | 87.4 | 87.2 | 87.0 | 86.6 | 86.2 | 85.7 | 85.2 | 84.6 | 84.0 | 83.2 | 82.5 | 81.7 | 80.8 |
| 75          | 78.3 | 81.4 | 83.2 | 84.4 | 85.2 | 85.7 | 85.9 | 86.0 | 86.0 | 85.8 | 85.6 | 85.3 | 85.0 | 84.6 | 84.1 | 83.5 | 82.9 | 82.3 | 81.6 | 80.8 |
| 80          | 77.2 | 79.8 | 81.5 | 82.7 | 83.5 | 84.0 | 84.3 | 84.5 | 84.6 | 84.6 | 84.5 | 84.4 | 84.1 | 83.8 | 83.5 | 83.1 | 82.6 | 82.0 | 81.5 | 80.8 |
| 85          | 76.6 | 78.5 | 79.9 | 80.9 | 81.7 | 82.2 | 82.7 | 83.0 | 83.2 | 83.3 | 83.3 | 83.3 | 83.2 | 83.0 | 82.8 | 82.5 | 82.1 | 81.7 | 81.3 | 80.8 |
| 90          | 76.4 | 77.7 | 78.7 | 79.5 | 80.2 | 80.7 | 81.1 | 81.4 | 81.7 | 81.9 | 82.0 | 82.1 | 82.1 | 82.0 | 81.9 | 81.8 | 81.6 | 81.4 | 81.1 | 80.8 |
| 95          | 77.6 | 78.1 | 78.6 | 79.0 | 79.4 | 79.7 | 80.0 | 80.3 | 80.5 | 80.6 | 80.8 | 80.9 | 80.9 | 81.0 | 81.0 | 81.0 | 81.0 | 81.0 | 80.9 | 80.8 |
| 98          | 79.5 | 79.7 | 79.8 | 79.9 | 80.0 | 80.1 | 80.2 | 80.3 | 80.4 | 80.5 | 80.5 | 80.6 | 80.6 | 80.7 | 80.7 | 80.8 | 80.8 | 80.8 | 80.8 | 80.8 |

### Mean Annual Mass Removal Efficiencies for 2.00-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 93.8 | 95.9 | 96.7 | 97.0 | 97.0 | 96.6 | 95.8 | 95.0 | 94.2 | 93.4 | 92.6 | 91.7 | 90.8 | 89.8 | 88.9 | 87.9 | 86.9 | 85.9 | 84.9 | 83.9 |
| 35          | 92.4 | 94.9 | 95.8 | 96.2 | 96.3 | 95.9 | 95.2 | 94.5 | 93.8 | 93.1 | 92.3 | 91.5 | 90.6 | 89.7 | 88.7 | 87.8 | 86.8 | 85.9 | 84.9 | 83.9 |
| 40          | 91.0 | 93.8 | 94.9 | 95.4 | 95.4 | 95.1 | 94.5 | 93.9 | 93.3 | 92.7 | 92.0 | 91.2 | 90.4 | 89.5 | 88.6 | 87.7 | 86.8 | 85.8 | 84.8 | 83.9 |
| 45          | 89.7 | 92.7 | 93.9 | 94.5 | 94.4 | 94.2 | 93.8 | 93.3 | 92.8 | 92.3 | 91.6 | 90.9 | 90.1 | 89.2 | 88.4 | 87.6 | 86.7 | 85.8 | 84.8 | 83.9 |
| 50          | 88.2 | 91.4 | 92.8 | 93.3 | 93.3 | 93.3 | 93.0 | 92.7 | 92.3 | 91.8 | 91.2 | 90.5 | 89.8 | 89.0 | 88.2 | 87.4 | 86.6 | 85.7 | 84.8 | 83.9 |
| 55          | 86.9 | 90.0 | 91.3 | 91.9 | 92.2 | 92.2 | 92.2 | 91.9 | 91.6 | 91.2 | 90.7 | 90.1 | 89.4 | 88.7 | 87.9 | 87.2 | 86.4 | 85.6 | 84.7 | 83.9 |
| 60          | 85.0 | 88.2 | 89.7 | 90.6 | 91.0 | 91.2 | 91.2 | 91.1 | 90.9 | 90.5 | 90.1 | 89.6 | 88.9 | 88.3 | 87.7 | 87.0 | 86.3 | 85.5 | 84.7 | 83.9 |
| 65          | 83.2 | 86.4 | 88.2 | 89.2 | 89.8 | 90.1 | 90.2 | 90.2 | 90.0 | 89.7 | 89.4 | 88.9 | 88.4 | 87.9 | 87.3 | 86.7 | 86.1 | 85.4 | 84.6 | 83.9 |
| 70          | 81.7 | 85.0 | 86.7 | 87.8 | 88.5 | 88.9 | 89.1 | 89.1 | 89.1 | 88.8 | 88.6 | 88.2 | 87.8 | 87.4 | 86.9 | 86.4 | 85.8 | 85.2 | 84.6 | 83.9 |
| 75          | 80.8 | 83.5 | 85.3 | 86.4 | 87.1 | 87.6 | 87.9 | 88.0 | 87.9 | 87.9 | 87.7 | 87.4 | 87.1 | 86.8 | 86.4 | 86.0 | 85.6 | 85.0 | 84.5 | 83.9 |
| 80          | 80.0 | 82.3 | 83.8 | 84.9 | 85.6 | 86.2 | 86.5 | 86.6 | 86.7 | 86.8 | 86.7 | 86.6 | 86.4 | 86.2 | 85.9 | 85.6 | 85.2 | 84.8 | 84.4 | 83.9 |
| 85          | 79.5 | 81.2 | 82.5 | 83.4 | 84.1 | 84.6 | 85.0 | 85.3 | 85.5 | 85.6 | 85.6 | 85.6 | 85.5 | 85.4 | 85.3 | 85.1 | 84.9 | 84.6 | 84.2 | 83.9 |
| 90          | 79.5 | 80.6 | 81.5 | 82.2 | 82.8 | 83.3 | 83.6 | 83.9 | 84.2 | 84.3 | 84.5 | 84.6 | 84.6 | 84.6 | 84.6 | 84.5 | 84.4 | 84.3 | 84.1 | 83.9 |
| 95          | 80.6 | 81.1 | 81.5 | 81.9 | 82.2 | 82.5 | 82.8 | 83.0 | 83.2 | 83.4 | 83.5 | 83.6 | 83.7 | 83.8 | 83.9 | 83.9 | 83.9 | 83.9 | 83.9 | 83.9 |
| 98          | 82.4 | 82.6 | 82.7 | 82.8 | 82.9 | 83.1 | 83.2 | 83.2 | 83.3 | 83.4 | 83.5 | 83.5 | 83.6 | 83.7 | 83.7 | 83.7 | 83.8 | 83.8 | 83.9 | 83.9 |

### Mean Annual Mass Removal Efficiencies for 2.25-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 94.1 | 96.2 | 97.0 | 97.3 | 97.4 | 97.2 | 96.7 | 96.0 | 95.2 | 94.5 | 93.8 | 93.0 | 92.3 | 91.5 | 90.6 | 89.8 | 88.9 | 88.0 | 87.1 | 86.2 |
| 35          | 92.9 | 95.3 | 96.2 | 96.6 | 96.8 | 96.6 | 96.1 | 95.5 | 94.8 | 94.2 | 93.5 | 92.8 | 92.1 | 91.3 | 90.5 | 89.7 | 88.8 | 88.0 | 87.1 | 86.2 |
| 40          | 91.7 | 94.3 | 95.4 | 95.9 | 96.1 | 95.9 | 95.5 | 95.0 | 94.4 | 93.8 | 93.2 | 92.5 | 91.9 | 91.1 | 90.4 | 89.5 | 88.7 | 87.9 | 87.1 | 86.2 |
| 45          | 90.6 | 93.3 | 94.6 | 95.1 | 95.3 | 95.1 | 94.8 | 94.4 | 93.9 | 93.4 | 92.8 | 92.2 | 91.6 | 90.9 | 90.2 | 89.4 | 88.6 | 87.9 | 87.1 | 86.2 |
| 50          | 89.4 | 92.3 | 93.6 | 94.2 | 94.3 | 94.2 | 94.0 | 93.7 | 93.3 | 92.9 | 92.5 | 91.9 | 91.3 | 90.7 | 90.0 | 89.3 | 88.5 | 87.8 | 87.0 | 86.2 |
| 55          | 88.2 | 91.2 | 92.5 | 93.1 | 93.3 | 93.3 | 93.2 | 93.0 | 92.7 | 92.4 | 92.0 | 91.5 | 91.0 | 90.4 | 89.7 | 89.1 | 88.4 | 87.7 | 87.0 | 86.2 |
| 60          | 87.0 | 89.7 | 91.1 | 91.8 | 92.1 | 92.3 | 92.3 | 92.2 | 92.0 | 91.8 | 91.5 | 91.0 | 90.6 | 90.1 | 89.5 | 88.9 | 88.2 | 87.6 | 86.9 | 86.2 |
| 65          | 85.3 | 88.1 | 89.6 | 90.5 | 91.0 | 91.3 | 91.4 | 91.4 | 91.3 | 91.1 | 90.9 | 90.5 | 90.1 | 89.7 | 89.1 | 88.6 | 88.1 | 87.5 | 86.9 | 86.2 |
| 70          | 83.8 | 86.6 | 88.2 | 89.2 | 89.8 | 90.2 | 90.4 | 90.5 | 90.5 | 90.4 | 90.2 | 89.9 | 89.6 | 89.2 | 88.8 | 88.3 | 87.9 | 87.4 | 86.8 | 86.2 |
| 75          | 82.9 | 85.3 | 86.9 | 87.9 | 88.6 | 89.1 | 89.3 | 89.5 | 89.6 | 89.5 | 89.4 | 89.2 | 89.0 | 88.7 | 88.3 | 88.0 | 87.6 | 87.2 | 86.7 | 86.2 |
| 80          | 82.2 | 84.3 | 85.7 | 86.7 | 87.4 | 87.9 | 88.2 | 88.4 | 88.5 | 88.5 | 88.5 | 88.4 | 88.3 | 88.1 | 87.8 | 87.6 | 87.3 | 87.0 | 86.6 | 86.2 |
| 85          | 81.9 | 83.4 | 84.6 | 85.5 | 86.1 | 86.6 | 86.9 | 87.2 | 87.4 | 87.5 | 87.5 | 87.5 | 87.5 | 87.4 | 87.3 | 87.1 | 87.0 | 86.8 | 86.5 | 86.2 |
| 90          | 82.1 | 83.0 | 83.8 | 84.5 | 85.0 | 85.4 | 85.7 | 86.0 | 86.2 | 86.4 | 86.5 | 86.6 | 86.7 | 86.7 | 86.7 | 86.7 | 86.6 | 86.5 | 86.4 | 86.2 |
| 95          | 83.0 | 83.5 | 83.9 | 84.2 | 84.5 | 84.8 | 85.0 | 85.2 | 85.4 | 85.6 | 85.7 | 85.8 | 85.9 | 86.0 | 86.1 | 86.2 | 86.2 | 86.2 | 86.3 | 86.2 |
| 98          | 84.8 | 84.9 | 85.0 | 85.1 | 85.3 | 85.4 | 85.5 | 85.6 | 85.6 | 85.7 | 85.8 | 85.9 | 85.9 | 86.0 | 86.0 | 86.1 | 86.1 | 86.2 | 86.2 | 86.2 |

### Mean Annual Mass Removal Efficiencies for 2.50-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 94.3 | 96.4 | 97.2 | 97.5 | 97.6 | 97.6 | 97.3 | 96.8 | 96.1 | 95.4 | 94.7 | 94.1 | 93.4 | 92.7 | 92.0 | 91.3 | 90.5 | 89.7 | 88.9 | 88.1 |
| 35          | 93.3 | 95.6 | 96.5 | 96.9 | 97.1 | 97.1 | 96.8 | 96.3 | 95.7 | 95.1 | 94.5 | 93.9 | 93.2 | 92.6 | 91.9 | 91.2 | 90.4 | 89.7 | 88.9 | 88.1 |
| 40          | 92.3 | 94.7 | 95.8 | 96.3 | 96.5 | 96.5 | 96.3 | 95.8 | 95.3 | 94.7 | 94.2 | 93.6 | 93.0 | 92.4 | 91.7 | 91.1 | 90.3 | 89.6 | 88.9 | 88.1 |
| 45          | 91.2 | 93.9 | 95.0 | 95.6 | 95.9 | 95.9 | 95.6 | 95.2 | 94.8 | 94.3 | 93.8 | 93.3 | 92.8 | 92.2 | 91.6 | 90.9 | 90.2 | 89.5 | 88.8 | 88.1 |
| 50          | 90.3 | 93.0 | 94.2 | 94.9 | 95.1 | 95.1 | 94.9 | 94.6 | 94.3 | 93.8 | 93.4 | 93.0 | 92.5 | 92.0 | 91.4 | 90.8 | 90.1 | 89.5 | 88.8 | 88.1 |
| 55          | 89.3 | 92.1 | 93.4 | 94.0 | 94.2 | 94.2 | 94.1 | 93.9 | 93.7 | 93.3 | 93.0 | 92.6 | 92.2 | 91.7 | 91.2 | 90.6 | 90.0 | 89.4 | 88.8 | 88.1 |
| 60          | 88.4 | 91.0 | 92.2 | 92.9 | 93.1 | 93.3 | 93.3 | 93.2 | 93.0 | 92.8 | 92.5 | 92.2 | 91.8 | 91.4 | 90.9 | 90.4 | 89.9 | 89.3 | 88.7 | 88.1 |
| 65          | 87.2 | 89.6 | 90.9 | 91.6 | 92.1 | 92.3 | 92.4 | 92.4 | 92.3 | 92.2 | 92.0 | 91.7 | 91.4 | 91.0 | 90.7 | 90.2 | 89.7 | 89.2 | 88.7 | 88.1 |
| 70          | 85.8 | 88.2 | 89.5 | 90.5 | 91.0 | 91.3 | 91.5 | 91.6 | 91.6 | 91.5 | 91.4 | 91.2 | 90.9 | 90.6 | 90.3 | 89.9 | 89.5 | 89.0 | 88.6 | 88.1 |
| 75          | 84.7 | 87.0 | 88.3 | 89.2 | 89.9 | 90.3 | 90.6 | 90.7 | 90.8 | 90.8 | 90.7 | 90.6 | 90.4 | 90.2 | 89.9 | 89.6 | 89.2 | 88.9 | 88.5 | 88.1 |
| 80          | 84.0 | 85.9 | 87.2 | 88.1 | 88.8 | 89.2 | 89.6 | 89.8 | 89.9 | 90.0 | 90.0 | 89.9 | 89.8 | 89.7 | 89.5 | 89.2 | 89.0 | 88.7 | 88.4 | 88.1 |
| 85          | 83.8 | 85.3 | 86.3 | 87.1 | 87.7 | 88.2 | 88.5 | 88.8 | 89.0 | 89.1 | 89.1 | 89.1 | 89.1 | 89.1 | 89.0 | 88.8 | 88.7 | 88.5 | 88.3 | 88.1 |
| 90          | 84.1 | 85.0 | 85.8 | 86.4 | 86.8 | 87.2 | 87.5 | 87.8 | 88.0 | 88.1 | 88.3 | 88.3 | 88.4 | 88.4 | 88.4 | 88.4 | 88.3 | 88.3 | 88.2 | 88.1 |
| 95          | 85.1 | 85.5 | 85.9 | 86.2 | 86.5 | 86.7 | 86.9 | 87.1 | 87.3 | 87.4 | 87.5 | 87.7 | 87.8 | 87.8 | 87.9 | 88.0 | 88.0 | 88.1 | 88.1 | 88.1 |
| 98          | 86.7 | 86.8 | 86.9 | 87.0 | 87.1 | 87.2 | 87.3 | 87.4 | 87.5 | 87.6 | 87.6 | 87.7 | 87.8 | 87.8 | 87.9 | 87.9 | 88.0 | 88.0 | 88.1 | 88.1 |

### Mean Annual Mass Removal Efficiencies for 2.75-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 94.6 | 96.5 | 97.3 | 97.7 | 97.8 | 97.9 | 97.7 | 97.4 | 96.8 | 96.2 | 95.6 | 94.9 | 94.4 | 93.7 | 93.1 | 92.4 | 91.8 | 91.1 | 90.4 | 89.6 |
| 35          | 93.6 | 95.9 | 96.7 | 97.1 | 97.3 | 97.4 | 97.3 | 97.0 | 96.5 | 95.9 | 95.3 | 94.7 | 94.2 | 93.6 | 93.0 | 92.4 | 91.7 | 91.0 | 90.3 | 89.6 |
| 40          | 92.8 | 95.1 | 96.1 | 96.6 | 96.8 | 97.0 | 96.8 | 96.5 | 96.0 | 95.5 | 95.0 | 94.5 | 94.0 | 93.4 | 92.8 | 92.2 | 91.6 | 91.0 | 90.3 | 89.6 |
| 45          | 91.8 | 94.3 | 95.4 | 96.0 | 96.3 | 96.4 | 96.3 | 96.0 | 95.6 | 95.1 | 94.7 | 94.2 | 93.7 | 93.2 | 92.7 | 92.1 | 91.6 | 90.9 | 90.3 | 89.6 |
| 50          | 91.0 | 93.6 | 94.8 | 95.4 | 95.7 | 95.8 | 95.6 | 95.4 | 95.0 | 94.7 | 94.3 | 93.9 | 93.5 | 93.0 | 92.5 | 92.0 | 91.5 | 90.9 | 90.3 | 89.6 |
| 55          | 90.2 | 92.8 | 94.0 | 94.7 | 95.0 | 95.0 | 94.9 | 94.7 | 94.5 | 94.2 | 93.9 | 93.5 | 93.2 | 92.8 | 92.3 | 91.8 | 91.3 | 90.8 | 90.2 | 89.6 |
| 60          | 89.4 | 92.0 | 93.2 | 93.8 | 94.0 | 94.1 | 94.2 | 94.0 | 93.9 | 93.7 | 93.4 | 93.1 | 92.9 | 92.5 | 92.1 | 91.7 | 91.2 | 90.7 | 90.2 | 89.6 |
| 65          | 88.7 | 90.9 | 92.0 | 92.7 | 93.1 | 93.3 | 93.3 | 93.3 | 93.2 | 93.1 | 92.9 | 92.7 | 92.5 | 92.2 | 91.8 | 91.4 | 91.1 | 90.6 | 90.1 | 89.6 |
| 70          | 87.5 | 89.6 | 90.8 | 91.6 | 92.1 | 92.3 | 92.5 | 92.5 | 92.5 | 92.5 | 92.4 | 92.2 | 92.0 | 91.8 | 91.5 | 91.2 | 90.9 | 90.5 | 90.1 | 89.6 |
| 75          | 86.4 | 88.4 | 89.7 | 90.4 | 91.0 | 91.3 | 91.6 | 91.7 | 91.8 | 91.8 | 91.8 | 91.7 | 91.6 | 91.4 | 91.2 | 90.9 | 90.7 | 90.3 | 90.0 | 89.6 |
| 80          | 85.8 | 87.4 | 88.6 | 89.4 | 90.0 | 90.4 | 90.7 | 90.9 | 91.0 | 91.1 | 91.1 | 91.1 | 91.0 | 90.9 | 90.8 | 90.6 | 90.4 | 90.2 | 89.9 | 89.6 |
| 85          | 85.5 | 86.8 | 87.7 | 88.5 | 89.0 | 89.4 | 89.8 | 90.0 | 90.2 | 90.3 | 90.4 | 90.4 | 90.4 | 90.4 | 90.4 | 90.3 | 90.1 | 90.0 | 89.8 | 89.6 |
| 90          | 85.8 | 86.6 | 87.3 | 87.9 | 88.3 | 88.7 | 89.0 | 89.2 | 89.4 | 89.6 | 89.7 | 89.8 | 89.8 | 89.9 | 89.9 | 89.9 | 89.8 | 89.8 | 89.7 | 89.6 |
| 95          | 86.9 | 87.2 | 87.6 | 87.8 | 88.1 | 88.3 | 88.5 | 88.7 | 88.9 | 89.0 | 89.1 | 89.2 | 89.3 | 89.4 | 89.5 | 89.5 | 89.5 | 89.6 | 89.6 | 89.6 |
| 98          | 88.4 | 88.5 | 88.6 | 88.7 | 88.8 | 88.9 | 88.9 | 89.0 | 89.1 | 89.1 | 89.2 | 89.3 | 89.3 | 89.4 | 89.4 | 89.5 | 89.5 | 89.6 | 89.6 | 89.6 |

### Mean Annual Mass Removal Efficiencies for 3.00-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 94.9 | 96.7 | 97.4 | 97.8 | 98.0 | 98.0 | 98.0 | 97.8 | 97.4 | 96.9 | 96.3 | 95.7 | 95.1 | 94.6 | 94.0 | 93.4 | 92.8 | 92.2 | 91.6 | 90.9 |
| 35          | 93.9 | 96.0 | 96.9 | 97.3 | 97.5 | 97.6 | 97.7 | 97.4 | 97.1 | 96.6 | 96.0 | 95.5 | 94.9 | 94.4 | 93.9 | 93.3 | 92.7 | 92.2 | 91.6 | 90.9 |
| 40          | 93.1 | 95.4 | 96.3 | 96.8 | 97.1 | 97.2 | 97.2 | 97.1 | 96.7 | 96.2 | 95.7 | 95.2 | 94.7 | 94.3 | 93.7 | 93.2 | 92.7 | 92.1 | 91.5 | 90.9 |
| 45          | 92.4 | 94.7 | 95.7 | 96.3 | 96.6 | 96.8 | 96.8 | 96.6 | 96.2 | 95.8 | 95.4 | 95.0 | 94.5 | 94.1 | 93.6 | 93.1 | 92.6 | 92.1 | 91.5 | 90.9 |
| 50          | 91.6 | 94.0 | 95.2 | 95.8 | 96.1 | 96.3 | 96.2 | 96.0 | 95.8 | 95.4 | 95.1 | 94.7 | 94.3 | 93.9 | 93.4 | 93.0 | 92.5 | 92.0 | 91.5 | 90.9 |
| 55          | 91.0 | 93.4 | 94.6 | 95.2 | 95.6 | 95.7 | 95.6 | 95.4 | 95.2 | 94.9 | 94.6 | 94.3 | 94.0 | 93.6 | 93.3 | 92.8 | 92.4 | 91.9 | 91.4 | 90.9 |
| 60          | 90.4 | 92.7 | 93.9 | 94.6 | 94.8 | 94.9 | 94.9 | 94.8 | 94.6 | 94.4 | 94.2 | 93.9 | 93.7 | 93.4 | 93.0 | 92.7 | 92.3 | 91.9 | 91.4 | 90.9 |
| 65          | 89.8 | 92.0 | 93.0 | 93.6 | 93.9 | 94.1 | 94.2 | 94.1 | 94.0 | 93.9 | 93.7 | 93.5 | 93.3 | 93.1 | 92.8 | 92.5 | 92.1 | 91.8 | 91.4 | 90.9 |
| 70          | 89.0 | 90.9 | 91.9 | 92.6 | 93.0 | 93.2 | 93.3 | 93.4 | 93.4 | 93.3 | 93.2 | 93.1 | 92.9 | 92.8 | 92.5 | 92.2 | 92.0 | 91.6 | 91.3 | 90.9 |
| 75          | 88.0 | 89.7 | 90.8 | 91.6 | 92.0 | 92.3 | 92.5 | 92.6 | 92.7 | 92.7 | 92.7 | 92.6 | 92.5 | 92.4 | 92.2 | 92.0 | 91.8 | 91.5 | 91.2 | 90.9 |
| 80          | 87.3 | 88.8 | 89.8 | 90.5 | 91.0 | 91.4 | 91.7 | 91.8 | 92.0 | 92.0 | 92.1 | 92.1 | 92.1 | 92.0 | 91.8 | 91.7 | 91.6 | 91.4 | 91.2 | 90.9 |
| 85          | 87.0 | 88.1 | 89.0 | 89.7 | 90.1 | 90.5 | 90.8 | 91.1 | 91.3 | 91.4 | 91.5 | 91.5 | 91.5 | 91.5 | 91.5 | 91.4 | 91.3 | 91.2 | 91.1 | 90.9 |
| 90          | 87.2 | 88.0 | 88.6 | 89.1 | 89.5 | 89.9 | 90.2 | 90.4 | 90.6 | 90.7 | 90.8 | 90.9 | 91.0 | 91.0 | 91.1 | 91.1 | 91.1 | 91.0 | 91.0 | 90.9 |
| 95          | 88.3 | 88.7 | 88.9 | 89.2 | 89.4 | 89.6 | 89.8 | 90.0 | 90.1 | 90.2 | 90.4 | 90.5 | 90.6 | 90.7 | 90.7 | 90.8 | 90.8 | 90.9 | 90.9 | 90.9 |
| 98          | 89.7 | 89.8 | 89.9 | 90.0 | 90.1 | 90.2 | 90.3 | 90.3 | 90.4 | 90.5 | 90.5 | 90.6 | 90.6 | 90.7 | 90.7 | 90.8 | 90.8 | 90.9 | 90.9 | 90.9 |

### Mean Annual Mass Removal Efficiencies for 3.25-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 95.2 | 96.9 | 97.5 | 97.9 | 98.1 | 98.2 | 98.2 | 98.1 | 97.8 | 97.5 | 96.9 | 96.4 | 95.8 | 95.3 | 94.7 | 94.2 | 93.7 | 93.1 | 92.6 | 92.0 |
| 35          | 94.1 | 96.2 | 97.0 | 97.5 | 97.7 | 97.8 | 97.9 | 97.8 | 97.5 | 97.2 | 96.7 | 96.2 | 95.6 | 95.1 | 94.6 | 94.1 | 93.6 | 93.1 | 92.5 | 92.0 |
| 40          | 93.4 | 95.6 | 96.6 | 97.0 | 97.3 | 97.5 | 97.5 | 97.4 | 97.2 | 96.8 | 96.4 | 95.9 | 95.4 | 95.0 | 94.5 | 94.0 | 93.5 | 93.0 | 92.5 | 92.0 |
| 45          | 92.8 | 95.0 | 96.0 | 96.6 | 96.9 | 97.1 | 97.1 | 97.1 | 96.8 | 96.5 | 96.1 | 95.7 | 95.2 | 94.8 | 94.4 | 93.9 | 93.5 | 93.0 | 92.5 | 92.0 |
| 50          | 92.1 | 94.4 | 95.5 | 96.1 | 96.5 | 96.7 | 96.7 | 96.6 | 96.3 | 96.1 | 95.7 | 95.4 | 95.0 | 94.6 | 94.2 | 93.8 | 93.4 | 92.9 | 92.5 | 92.0 |
| 55          | 91.5 | 93.8 | 95.0 | 95.6 | 96.0 | 96.2 | 96.2 | 96.0 | 95.9 | 95.6 | 95.3 | 95.0 | 94.7 | 94.4 | 94.0 | 93.7 | 93.3 | 92.9 | 92.4 | 92.0 |
| 60          | 91.1 | 93.3 | 94.4 | 95.1 | 95.5 | 95.6 | 95.5 | 95.5 | 95.3 | 95.1 | 94.9 | 94.7 | 94.4 | 94.1 | 93.8 | 93.5 | 93.2 | 92.8 | 92.4 | 92.0 |
| 65          | 90.7 | 92.7 | 93.8 | 94.4 | 94.7 | 94.8 | 94.9 | 94.9 | 94.8 | 94.6 | 94.5 | 94.3 | 94.0 | 93.8 | 93.6 | 93.3 | 93.0 | 92.7 | 92.4 | 92.0 |
| 70          | 90.3 | 92.0 | 92.9 | 93.4 | 93.8 | 94.0 | 94.2 | 94.2 | 94.1 | 94.1 | 94.0 | 93.8 | 93.7 | 93.5 | 93.4 | 93.1 | 92.9 | 92.6 | 92.3 | 92.0 |
| 75          | 89.4 | 90.9 | 91.8 | 92.5 | 93.0 | 93.2 | 93.4 | 93.5 | 93.5 | 93.5 | 93.4 | 93.4 | 93.3 | 93.2 | 93.1 | 92.9 | 92.7 | 92.5 | 92.2 | 92.0 |
| 80          | 88.7 | 90.1 | 91.0 | 91.6 | 92.0 | 92.3 | 92.6 | 92.7 | 92.8 | 92.9 | 92.9 | 92.9 | 92.9 | 92.9 | 92.8 | 92.6 | 92.5 | 92.3 | 92.2 | 92.0 |
| 85          | 88.4 | 89.4 | 90.2 | 90.7 | 91.2 | 91.5 | 91.8 | 92.0 | 92.1 | 92.3 | 92.4 | 92.4 | 92.5 | 92.5 | 92.4 | 92.4 | 92.3 | 92.2 | 92.1 | 92.0 |
| 90          | 88.5 | 89.2 | 89.7 | 90.2 | 90.6 | 90.9 | 91.2 | 91.4 | 91.6 | 91.7 | 91.9 | 91.9 | 92.0 | 92.0 | 92.0 | 92.1 | 92.1 | 92.1 | 92.0 | 92.0 |
| 95          | 89.6 | 89.9 | 90.1 | 90.4 | 90.6 | 90.8 | 90.9 | 91.1 | 91.2 | 91.3 | 91.4 | 91.5 | 91.6 | 91.7 | 91.8 | 91.8 | 91.9 | 91.9 | 92.0 | 92.0 |
| 98          | 90.8 | 90.9 | 91.0 | 91.1 | 91.2 | 91.2 | 91.3 | 91.4 | 91.4 | 91.5 | 91.6 | 91.6 | 91.7 | 91.7 | 91.8 | 91.8 | 91.9 | 91.9 | 92.0 | 92.0 |

### Mean Annual Mass Removal Efficiencies for 3.50-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 95.5 | 97.0 | 97.6 | 98.0 | 98.2 | 98.3 | 98.3 | 98.3 | 98.1 | 97.9 | 97.5 | 96.9 | 96.4 | 95.9 | 95.4 | 94.9 | 94.4 | 93.9 | 93.4 | 92.9 |
| 35          | 94.4 | 96.3 | 97.2 | 97.6 | 97.9 | 98.0 | 98.0 | 98.0 | 97.9 | 97.6 | 97.2 | 96.7 | 96.3 | 95.8 | 95.3 | 94.8 | 94.4 | 93.9 | 93.4 | 92.9 |
| 40          | 93.6 | 95.8 | 96.8 | 97.2 | 97.5 | 97.6 | 97.7 | 97.7 | 97.6 | 97.3 | 96.9 | 96.5 | 96.1 | 95.6 | 95.2 | 94.7 | 94.3 | 93.8 | 93.4 | 92.9 |
| 45          | 93.2 | 95.3 | 96.3 | 96.8 | 97.1 | 97.3 | 97.4 | 97.4 | 97.3 | 97.0 | 96.6 | 96.3 | 95.9 | 95.4 | 95.0 | 94.6 | 94.2 | 93.8 | 93.3 | 92.9 |
| 50          | 92.6 | 94.7 | 95.8 | 96.4 | 96.7 | 97.0 | 97.1 | 97.0 | 96.9 | 96.6 | 96.3 | 96.0 | 95.6 | 95.2 | 94.9 | 94.5 | 94.1 | 93.7 | 93.3 | 92.9 |
| 55          | 92.1 | 94.2 | 95.3 | 96.0 | 96.4 | 96.6 | 96.7 | 96.6 | 96.4 | 96.2 | 95.9 | 95.6 | 95.3 | 95.0 | 94.7 | 94.4 | 94.0 | 93.7 | 93.3 | 92.9 |
| 60          | 91.7 | 93.8 | 94.9 | 95.5 | 95.9 | 96.1 | 96.1 | 96.0 | 95.9 | 95.8 | 95.5 | 95.3 | 95.0 | 94.8 | 94.5 | 94.2 | 93.9 | 93.6 | 93.2 | 92.9 |
| 65          | 91.4 | 93.3 | 94.4 | 95.0 | 95.4 | 95.5 | 95.5 | 95.5 | 95.4 | 95.3 | 95.1 | 94.9 | 94.7 | 94.5 | 94.3 | 94.0 | 93.8 | 93.5 | 93.2 | 92.9 |
| 70          | 91.2 | 92.9 | 93.8 | 94.3 | 94.5 | 94.7 | 94.8 | 94.9 | 94.8 | 94.8 | 94.7 | 94.5 | 94.4 | 94.2 | 94.0 | 93.9 | 93.7 | 93.4 | 93.1 | 92.9 |
| 75          | 90.7 | 92.0 | 92.8 | 93.3 | 93.7 | 94.0 | 94.1 | 94.2 | 94.2 | 94.2 | 94.2 | 94.1 | 94.0 | 93.9 | 93.8 | 93.7 | 93.5 | 93.3 | 93.1 | 92.9 |
| 80          | 89.9 | 91.1 | 91.9 | 92.5 | 92.9 | 93.2 | 93.4 | 93.5 | 93.6 | 93.6 | 93.7 | 93.6 | 93.6 | 93.6 | 93.5 | 93.4 | 93.3 | 93.2 | 93.0 | 92.9 |
| 85          | 89.7 | 90.5 | 91.2 | 91.7 | 92.1 | 92.4 | 92.7 | 92.8 | 93.0 | 93.0 | 93.1 | 93.2 | 93.2 | 93.2 | 93.2 | 93.2 | 93.1 | 93.1 | 93.0 | 92.9 |
| 90          | 89.7 | 90.3 | 90.8 | 91.2 | 91.5 | 91.8 | 92.0 | 92.2 | 92.4 | 92.5 | 92.7 | 92.8 | 92.8 | 92.9 | 92.9 | 92.9 | 92.9 | 92.9 | 92.9 | 92.9 |
| 95          | 90.6 | 90.9 | 91.1 | 91.3 | 91.5 | 91.7 | 91.9 | 92.0 | 92.2 | 92.3 | 92.4 | 92.4 | 92.5 | 92.6 | 92.7 | 92.7 | 92.8 | 92.8 | 92.8 | 92.9 |
| 98          | 91.8 | 91.9 | 92.0 | 92.0 | 92.1 | 92.2 | 92.2 | 92.3 | 92.4 | 92.4 | 92.5 | 92.5 | 92.6 | 92.6 | 92.7 | 92.7 | 92.8 | 92.8 | 92.8 | 92.9 |

### Mean Annual Mass Removal Efficiencies for 3.75-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 95.8 | 97.2 | 97.8 | 98.1 | 98.2 | 98.4 | 98.4 | 98.4 | 98.3 | 98.2 | 97.9 | 97.5 | 97.0 | 96.5 | 96.0 | 95.5 | 95.0 | 94.6 | 94.1 | 93.6 |
| 35          | 94.7 | 96.5 | 97.3 | 97.7 | 98.0 | 98.1 | 98.2 | 98.2 | 98.1 | 97.9 | 97.7 | 97.3 | 96.8 | 96.3 | 95.9 | 95.4 | 95.0 | 94.5 | 94.1 | 93.6 |
| 40          | 93.9 | 95.9 | 96.9 | 97.4 | 97.7 | 97.8 | 97.9 | 97.9 | 97.9 | 97.7 | 97.4 | 97.0 | 96.6 | 96.2 | 95.8 | 95.3 | 94.9 | 94.5 | 94.1 | 93.6 |
| 45          | 93.4 | 95.5 | 96.5 | 97.0 | 97.3 | 97.5 | 97.6 | 97.7 | 97.6 | 97.4 | 97.1 | 96.8 | 96.4 | 96.0 | 95.6 | 95.2 | 94.8 | 94.5 | 94.1 | 93.6 |
| 50          | 93.1 | 95.1 | 96.0 | 96.6 | 97.0 | 97.2 | 97.3 | 97.4 | 97.3 | 97.1 | 96.8 | 96.5 | 96.2 | 95.8 | 95.5 | 95.1 | 94.8 | 94.4 | 94.0 | 93.6 |
| 55          | 92.5 | 94.6 | 95.6 | 96.2 | 96.6 | 96.9 | 97.0 | 97.0 | 96.9 | 96.7 | 96.5 | 96.2 | 95.9 | 95.6 | 95.3 | 95.0 | 94.7 | 94.3 | 94.0 | 93.6 |
| 60          | 92.2 | 94.1 | 95.2 | 95.9 | 96.3 | 96.5 | 96.6 | 96.6 | 96.4 | 96.3 | 96.1 | 95.9 | 95.6 | 95.4 | 95.1 | 94.8 | 94.6 | 94.3 | 94.0 | 93.6 |
| 65          | 92.0 | 93.8 | 94.8 | 95.5 | 95.9 | 96.1 | 96.1 | 96.0 | 96.0 | 95.9 | 95.7 | 95.5 | 95.3 | 95.1 | 94.9 | 94.7 | 94.4 | 94.2 | 93.9 | 93.6 |
| 70          | 91.9 | 93.5 | 94.4 | 95.0 | 95.3 | 95.4 | 95.4 | 95.5 | 95.5 | 95.4 | 95.3 | 95.2 | 95.0 | 94.8 | 94.7 | 94.5 | 94.3 | 94.1 | 93.9 | 93.6 |
| 75          | 91.8 | 93.0 | 93.7 | 94.1 | 94.4 | 94.7 | 94.8 | 94.9 | 94.9 | 94.9 | 94.8 | 94.7 | 94.7 | 94.5 | 94.4 | 94.3 | 94.2 | 94.0 | 93.8 | 93.6 |
| 80          | 91.1 | 92.1 | 92.8 | 93.3 | 93.7 | 94.0 | 94.1 | 94.2 | 94.3 | 94.3 | 94.3 | 94.3 | 94.3 | 94.2 | 94.2 | 94.1 | 94.0 | 93.9 | 93.8 | 93.6 |
| 85          | 90.7 | 91.6 | 92.2 | 92.6 | 93.0 | 93.2 | 93.4 | 93.6 | 93.7 | 93.8 | 93.8 | 93.9 | 93.9 | 93.9 | 93.9 | 93.9 | 93.8 | 93.8 | 93.7 | 93.6 |
| 90          | 90.8 | 91.3 | 91.8 | 92.1 | 92.4 | 92.7 | 92.9 | 93.0 | 93.2 | 93.3 | 93.4 | 93.5 | 93.5 | 93.6 | 93.6 | 93.7 | 93.7 | 93.7 | 93.7 | 93.6 |
| 95          | 91.5 | 91.7 | 92.0 | 92.2 | 92.3 | 92.5 | 92.7 | 92.8 | 92.9 | 93.0 | 93.1 | 93.2 | 93.3 | 93.4 | 93.4 | 93.5 | 93.5 | 93.6 | 93.6 | 93.6 |
| 98          | 92.6 | 92.7 | 92.8 | 92.9 | 92.9 | 93.0 | 93.1 | 93.1 | 93.2 | 93.2 | 93.3 | 93.3 | 93.4 | 93.4 | 93.4 | 93.5 | 93.5 | 93.6 | 93.6 | 93.6 |

### Mean Annual Mass Removal Efficiencies for 4.00-inches of Retention for Zone 3 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 96.1 | 97.4 | 97.9 | 98.1 | 98.3 | 98.4 | 98.5 | 98.5 | 98.5 | 98.4 | 98.2 | 97.9 | 97.4 | 97.0 | 96.5 | 96.1 | 95.6 | 95.2 | 94.7 | 94.3 |
| 35          | 95.0 | 96.7 | 97.4 | 97.8 | 98.0 | 98.2 | 98.3 | 98.3 | 98.3 | 98.2 | 98.0 | 97.7 | 97.3 | 96.9 | 96.4 | 96.0 | 95.5 | 95.1 | 94.7 | 94.3 |
| 40          | 94.1 | 96.1 | 97.0 | 97.5 | 97.8 | 97.9 | 98.0 | 98.1 | 98.1 | 98.0 | 97.8 | 97.5 | 97.1 | 96.7 | 96.3 | 95.9 | 95.5 | 95.1 | 94.7 | 94.3 |
| 45          | 93.6 | 95.7 | 96.7 | 97.2 | 97.5 | 97.7 | 97.8 | 97.8 | 97.8 | 97.7 | 97.5 | 97.3 | 96.9 | 96.5 | 96.2 | 95.8 | 95.4 | 95.0 | 94.7 | 94.3 |
| 50          | 93.3 | 95.4 | 96.3 | 96.8 | 97.1 | 97.4 | 97.5 | 97.6 | 97.6 | 97.5 | 97.3 | 97.0 | 96.7 | 96.4 | 96.0 | 95.7 | 95.3 | 95.0 | 94.6 | 94.3 |
| 55          | 93.0 | 94.9 | 95.9 | 96.4 | 96.8 | 97.1 | 97.3 | 97.3 | 97.3 | 97.1 | 96.9 | 96.7 | 96.4 | 96.1 | 95.9 | 95.5 | 95.2 | 94.9 | 94.6 | 94.3 |
| 60          | 92.7 | 94.5 | 95.5 | 96.1 | 96.5 | 96.8 | 97.0 | 97.0 | 96.9 | 96.8 | 96.6 | 96.4 | 96.2 | 95.9 | 95.7 | 95.4 | 95.1 | 94.9 | 94.6 | 94.3 |
| 65          | 92.4 | 94.2 | 95.2 | 95.8 | 96.2 | 96.5 | 96.6 | 96.6 | 96.5 | 96.4 | 96.2 | 96.1 | 95.9 | 95.7 | 95.5 | 95.2 | 95.0 | 94.8 | 94.6 | 94.3 |
| 70          | 92.5 | 94.0 | 94.9 | 95.5 | 95.8 | 96.0 | 96.0 | 96.0 | 96.0 | 95.9 | 95.8 | 95.7 | 95.6 | 95.4 | 95.2 | 95.1 | 94.9 | 94.7 | 94.5 | 94.3 |
| 75          | 92.5 | 93.7 | 94.5 | 94.9 | 95.1 | 95.3 | 95.4 | 95.5 | 95.5 | 95.5 | 95.4 | 95.3 | 95.3 | 95.1 | 95.0 | 94.9 | 94.8 | 94.6 | 94.5 | 94.3 |
| 80          | 92.2 | 93.1 | 93.7 | 94.1 | 94.4 | 94.6 | 94.8 | 94.9 | 94.9 | 95.0 | 95.0 | 94.9 | 94.9 | 94.8 | 94.8 | 94.7 | 94.6 | 94.5 | 94.4 | 94.3 |
| 85          | 91.7 | 92.5 | 93.0 | 93.4 | 93.7 | 94.0 | 94.1 | 94.3 | 94.4 | 94.5 | 94.5 | 94.5 | 94.5 | 94.5 | 94.5 | 94.5 | 94.5 | 94.4 | 94.4 | 94.3 |
| 90          | 91.7 | 92.2 | 92.6 | 92.9 | 93.2 | 93.4 | 93.6 | 93.7 | 93.9 | 94.0 | 94.0 | 94.1 | 94.2 | 94.2 | 94.3 | 94.3 | 94.3 | 94.3 | 94.3 | 94.3 |
| 95          | 92.4 | 92.6 | 92.8 | 92.9 | 93.1 | 93.2 | 93.4 | 93.5 | 93.6 | 93.7 | 93.8 | 93.9 | 93.9 | 94.0 | 94.1 | 94.1 | 94.2 | 94.2 | 94.3 | 94.3 |
| 98          | 93.3 | 93.4 | 93.5 | 93.6 | 93.6 | 93.7 | 93.7 | 93.8 | 93.8 | 93.9 | 93.9 | 94.0 | 94.0 | 94.1 | 94.1 | 94.2 | 94.2 | 94.2 | 94.3 | 94.3 |

### Mean Annual Mass Removal Efficiencies for 0.25-inches of Retention for Zone 4 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 90.1 | 86.6 | 79.2 | 71.4 | 64.5 | 58.6 | 53.5 | 49.2 | 45.5 | 42.3 | 39.5 | 37.1 | 34.9 | 33.0 | 31.3 | 29.7 | 28.3 | 27.1 | 25.9 | 24.8 |
| 35          | 86.2 | 84.3 | 77.8 | 70.5 | 63.9 | 58.2 | 53.2 | 49.0 | 45.3 | 42.2 | 39.4 | 37.0 | 34.9 | 33.0 | 31.2 | 29.7 | 28.3 | 27.0 | 25.9 | 24.8 |
| 40          | 81.6 | 81.5 | 75.9 | 69.3 | 63.1 | 57.6 | 52.8 | 48.7 | 45.1 | 42.0 | 39.3 | 36.9 | 34.8 | 32.9 | 31.2 | 29.7 | 28.3 | 27.0 | 25.9 | 24.8 |
| 45          | 76.5 | 78.1 | 73.7 | 67.8 | 62.0 | 56.8 | 52.2 | 48.2 | 44.8 | 41.8 | 39.1 | 36.8 | 34.7 | 32.8 | 31.1 | 29.6 | 28.3 | 27.0 | 25.9 | 24.8 |
| 50          | 71.0 | 74.2 | 71.0 | 65.9 | 60.7 | 55.8 | 51.5 | 47.7 | 44.4 | 41.4 | 38.9 | 36.6 | 34.5 | 32.7 | 31.1 | 29.6 | 28.2 | 27.0 | 25.9 | 24.8 |
| 55          | 65.3 | 69.9 | 67.9 | 63.7 | 59.1 | 54.7 | 50.6 | 47.0 | 43.8 | 41.1 | 38.5 | 36.3 | 34.4 | 32.6 | 31.0 | 29.5 | 28.2 | 27.0 | 25.8 | 24.8 |
| 60          | 59.7 | 65.2 | 64.4 | 61.2 | 57.2 | 53.2 | 49.6 | 46.2 | 43.2 | 40.6 | 38.2 | 36.1 | 34.1 | 32.4 | 30.8 | 29.4 | 28.1 | 26.9 | 25.8 | 24.8 |
| 65          | 54.2 | 60.2 | 60.5 | 58.2 | 55.0 | 51.5 | 48.2 | 45.2 | 42.4 | 39.9 | 37.7 | 35.7 | 33.8 | 32.2 | 30.7 | 29.3 | 28.0 | 26.9 | 25.8 | 24.8 |
| 70          | 49.1 | 54.9 | 56.1 | 54.7 | 52.3 | 49.4 | 46.6 | 43.9 | 41.4 | 39.2 | 37.1 | 35.2 | 33.5 | 31.9 | 30.5 | 29.1 | 27.9 | 26.8 | 25.8 | 24.8 |
| 75          | 44.3 | 49.4 | 51.1 | 50.7 | 49.1 | 46.9 | 44.6 | 42.3 | 40.1 | 38.1 | 36.3 | 34.6 | 33.0 | 31.5 | 30.2 | 28.9 | 27.8 | 26.7 | 25.7 | 24.8 |
| 80          | 40.0 | 44.1 | 45.8 | 46.0 | 45.2 | 43.7 | 42.0 | 40.2 | 38.5 | 36.8 | 35.2 | 33.7 | 32.3 | 31.0 | 29.8 | 28.7 | 27.6 | 26.6 | 25.7 | 24.8 |
| 85          | 36.2 | 38.9 | 40.4 | 40.8 | 40.6 | 39.8 | 38.8 | 37.5 | 36.3 | 35.0 | 33.7 | 32.5 | 31.4 | 30.2 | 29.2 | 28.2 | 27.3 | 26.4 | 25.6 | 24.8 |
| 90          | 32.8 | 34.2 | 35.0 | 35.4 | 35.4 | 35.1 | 34.6 | 33.9 | 33.2 | 32.4 | 31.6 | 30.8 | 29.9 | 29.1 | 28.3 | 27.6 | 26.9 | 26.1 | 25.5 | 24.8 |
| 95          | 29.3 | 29.7 | 29.9 | 30.0 | 29.9 | 29.8 | 29.7 | 29.4 | 29.1 | 28.8 | 28.5 | 28.1 | 27.7 | 27.3 | 26.9 | 26.5 | 26.1 | 25.6 | 25.2 | 24.8 |
| 98          | 27.2 | 27.2 | 27.2 | 27.1 | 27.0 | 27.0 | 26.8 | 26.7 | 26.6 | 26.5 | 26.3 | 26.2 | 26.0 | 25.9 | 25.7 | 25.5 | 25.4 | 25.2 | 25.0 | 24.8 |

### Mean Annual Mass Removal Efficiencies for 0.50-inches of Retention for Zone 4 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 94.0 | 94.2 | 92.1 | 88.8 | 84.8 | 80.5 | 76.3 | 72.4 | 68.6 | 65.2 | 62.0 | 59.1 | 56.4 | 53.9 | 51.7 | 49.5 | 47.6 | 45.8 | 44.1 | 42.6 |
| 35          | 91.1 | 92.3 | 90.7 | 87.7 | 84.0 | 79.9 | 75.9 | 72.0 | 68.4 | 65.0 | 61.9 | 59.0 | 56.3 | 53.9 | 51.6 | 49.5 | 47.6 | 45.8 | 44.1 | 42.6 |
| 40          | 87.8 | 90.0 | 88.9 | 86.4 | 82.9 | 79.1 | 75.3 | 71.5 | 68.0 | 64.7 | 61.6 | 58.8 | 56.2 | 53.8 | 51.5 | 49.4 | 47.5 | 45.7 | 44.1 | 42.6 |
| 45          | 84.0 | 87.2 | 86.8 | 84.7 | 81.6 | 78.1 | 74.5 | 70.9 | 67.5 | 64.3 | 61.3 | 58.6 | 56.0 | 53.6 | 51.4 | 49.4 | 47.5 | 45.7 | 44.1 | 42.6 |
| 50          | 79.9 | 84.0 | 84.3 | 82.7 | 80.1 | 76.9 | 73.5 | 70.2 | 66.9 | 63.9 | 61.0 | 58.3 | 55.8 | 53.5 | 51.3 | 49.3 | 47.4 | 45.7 | 44.1 | 42.6 |
| 55          | 75.6 | 80.4 | 81.4 | 80.4 | 78.2 | 75.4 | 72.3 | 69.2 | 66.2 | 63.3 | 60.5 | 57.9 | 55.5 | 53.2 | 51.1 | 49.2 | 47.3 | 45.6 | 44.0 | 42.6 |
| 60          | 71.3 | 76.5 | 78.1 | 77.6 | 75.9 | 73.6 | 70.9 | 68.0 | 65.2 | 62.5 | 59.9 | 57.4 | 55.1 | 53.0 | 50.9 | 49.0 | 47.2 | 45.6 | 44.0 | 42.6 |
| 65          | 67.1 | 72.4 | 74.4 | 74.5 | 73.3 | 71.4 | 69.1 | 66.6 | 64.1 | 61.6 | 59.2 | 56.9 | 54.7 | 52.6 | 50.6 | 48.8 | 47.1 | 45.5 | 44.0 | 42.6 |
| 70          | 63.0 | 68.1 | 70.3 | 70.8 | 70.2 | 68.9 | 67.0 | 64.9 | 62.7 | 60.5 | 58.3 | 56.1 | 54.1 | 52.1 | 50.3 | 48.6 | 46.9 | 45.4 | 43.9 | 42.6 |
| 75          | 59.2 | 63.7 | 65.9 | 66.7 | 66.6 | 65.7 | 64.4 | 62.7 | 60.9 | 59.0 | 57.1 | 55.2 | 53.3 | 51.5 | 49.8 | 48.2 | 46.7 | 45.2 | 43.8 | 42.6 |
| 80          | 55.8 | 59.4 | 61.4 | 62.3 | 62.4 | 61.9 | 61.1 | 59.9 | 58.6 | 57.1 | 55.5 | 53.9 | 52.3 | 50.7 | 49.2 | 47.8 | 46.4 | 45.0 | 43.8 | 42.6 |
| 85          | 52.7 | 55.2 | 56.7 | 57.5 | 57.7 | 57.6 | 57.1 | 56.4 | 55.5 | 54.5 | 53.3 | 52.1 | 50.8 | 49.6 | 48.3 | 47.1 | 45.9 | 44.7 | 43.6 | 42.6 |
| 90          | 49.7 | 51.1 | 52.0 | 52.5 | 52.8 | 52.8 | 52.6 | 52.2 | 51.7 | 51.1 | 50.3 | 49.6 | 48.7 | 47.9 | 47.0 | 46.1 | 45.2 | 44.3 | 43.4 | 42.6 |
| 95          | 46.7 | 47.1 | 47.4 | 47.5 | 47.6 | 47.6 | 47.5 | 47.3 | 47.1 | 46.8 | 46.5 | 46.2 | 45.8 | 45.4 | 44.9 | 44.5 | 44.0 | 43.5 | 43.0 | 42.6 |
| 98          | 44.9 | 44.9 | 44.8 | 44.8 | 44.7 | 44.7 | 44.6 | 44.5 | 44.3 | 44.2 | 44.1 | 44.0 | 43.8 | 43.6 | 43.5 | 43.3 | 43.1 | 42.9 | 42.7 | 42.6 |

### Mean Annual Mass Removal Efficiencies for 0.75-inches of Retention for Zone 4 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 95.6 | 96.4 | 95.6 | 94.1 | 92.1 | 89.6 | 86.8 | 83.9 | 81.0 | 78.1 | 75.3 | 72.7 | 70.1 | 67.7 | 65.4 | 63.3 | 61.2 | 59.3 | 57.4 | 55.7 |
| 35          | 93.5 | 94.9 | 94.5 | 93.2 | 91.3 | 89.0 | 86.3 | 83.5 | 80.7 | 77.9 | 75.1 | 72.5 | 70.0 | 67.6 | 65.4 | 63.2 | 61.2 | 59.3 | 57.4 | 55.7 |
| 40          | 91.0 | 93.1 | 93.0 | 92.0 | 90.3 | 88.1 | 85.7 | 83.0 | 80.2 | 77.5 | 74.9 | 72.3 | 69.8 | 67.5 | 65.3 | 63.1 | 61.1 | 59.2 | 57.4 | 55.7 |
| 45          | 88.1 | 90.9 | 91.3 | 90.5 | 89.1 | 87.1 | 84.8 | 82.3 | 79.7 | 77.1 | 74.5 | 72.0 | 69.6 | 67.3 | 65.1 | 63.0 | 61.1 | 59.2 | 57.4 | 55.7 |
| 50          | 85.0 | 88.4 | 89.2 | 88.8 | 87.6 | 85.9 | 83.8 | 81.5 | 79.0 | 76.5 | 74.1 | 71.7 | 69.3 | 67.1 | 65.0 | 62.9 | 61.0 | 59.1 | 57.4 | 55.7 |
| 55          | 81.7 | 85.7 | 86.8 | 86.8 | 85.9 | 84.5 | 82.6 | 80.5 | 78.2 | 75.9 | 73.5 | 71.2 | 69.0 | 66.8 | 64.8 | 62.8 | 60.9 | 59.1 | 57.4 | 55.7 |
| 60          | 78.4 | 82.6 | 84.1 | 84.4 | 83.9 | 82.7 | 81.1 | 79.2 | 77.2 | 75.0 | 72.8 | 70.7 | 68.6 | 66.5 | 64.5 | 62.6 | 60.8 | 59.0 | 57.3 | 55.7 |
| 65          | 75.0 | 79.3 | 81.1 | 81.7 | 81.5 | 80.7 | 79.4 | 77.8 | 76.0 | 74.0 | 72.0 | 70.0 | 68.0 | 66.1 | 64.2 | 62.3 | 60.6 | 58.9 | 57.3 | 55.7 |
| 70          | 71.7 | 75.9 | 77.9 | 78.7 | 78.7 | 78.2 | 77.3 | 76.0 | 74.4 | 72.7 | 71.0 | 69.1 | 67.3 | 65.5 | 63.8 | 62.0 | 60.4 | 58.8 | 57.2 | 55.7 |
| 75          | 68.7 | 72.5 | 74.4 | 75.4 | 75.6 | 75.3 | 74.7 | 73.7 | 72.5 | 71.1 | 69.6 | 68.0 | 66.4 | 64.8 | 63.2 | 61.6 | 60.1 | 58.6 | 57.1 | 55.7 |
| 80          | 65.9 | 69.0 | 70.8 | 71.7 | 72.1 | 72.1 | 71.7 | 71.0 | 70.1 | 69.0 | 67.8 | 66.6 | 65.2 | 63.9 | 62.5 | 61.1 | 59.7 | 58.3 | 57.0 | 55.7 |
| 85          | 63.5 | 65.7 | 67.1 | 67.9 | 68.3 | 68.3 | 68.1 | 67.7 | 67.1 | 66.4 | 65.5 | 64.6 | 63.6 | 62.5 | 61.4 | 60.3 | 59.1 | 58.0 | 56.8 | 55.7 |
| 90          | 61.2 | 62.4 | 63.2 | 63.8 | 64.1 | 64.2 | 64.1 | 63.9 | 63.6 | 63.2 | 62.7 | 62.1 | 61.4 | 60.7 | 59.9 | 59.1 | 58.3 | 57.4 | 56.6 | 55.7 |
| 95          | 58.7 | 59.1 | 59.4 | 59.6 | 59.7 | 59.7 | 59.7 | 59.7 | 59.5 | 59.4 | 59.1 | 58.9 | 58.6 | 58.2 | 57.9 | 57.5 | 57.1 | 56.6 | 56.2 | 55.7 |
| 98          | 57.5 | 57.5 | 57.5 | 57.5 | 57.5 | 57.4 | 57.4 | 57.3 | 57.2 | 57.1 | 57.0 | 56.9 | 56.8 | 56.6 | 56.5 | 56.4 | 56.2 | 56.0 | 55.9 | 55.7 |

### Mean Annual Mass Removal Efficiencies for 1.00-inches of Retention for Zone 4 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 96.6 | 97.5 | 97.2 | 96.4 | 95.2 | 93.7 | 91.9 | 90.0 | 87.9 | 85.7 | 83.5 | 81.2 | 79.0 | 76.9 | 74.8 | 72.8 | 70.9 | 69.1 | 67.3 | 65.6 |
| 35          | 95.0 | 96.3 | 96.2 | 95.6 | 94.5 | 93.1 | 91.4 | 89.6 | 87.5 | 85.4 | 83.2 | 81.1 | 78.9 | 76.8 | 74.8 | 72.8 | 70.9 | 69.0 | 67.2 | 65.6 |
| 40          | 93.0 | 94.9 | 95.1 | 94.6 | 93.6 | 92.4 | 90.8 | 89.0 | 87.1 | 85.1 | 82.9 | 80.8 | 78.7 | 76.7 | 74.7 | 72.7 | 70.8 | 69.0 | 67.2 | 65.6 |
| 45          | 90.8 | 93.1 | 93.6 | 93.4 | 92.6 | 91.5 | 90.0 | 88.4 | 86.5 | 84.6 | 82.6 | 80.5 | 78.5 | 76.5 | 74.5 | 72.6 | 70.7 | 68.9 | 67.2 | 65.6 |
| 50          | 88.3 | 91.1 | 92.0 | 91.9 | 91.4 | 90.4 | 89.1 | 87.6 | 85.9 | 84.0 | 82.1 | 80.1 | 78.2 | 76.2 | 74.3 | 72.5 | 70.6 | 68.9 | 67.2 | 65.6 |
| 55          | 85.7 | 89.0 | 90.1 | 90.2 | 89.9 | 89.1 | 88.0 | 86.6 | 85.1 | 83.4 | 81.5 | 79.7 | 77.8 | 75.9 | 74.1 | 72.3 | 70.5 | 68.8 | 67.1 | 65.6 |
| 60          | 83.1 | 86.6 | 87.9 | 88.3 | 88.1 | 87.6 | 86.7 | 85.5 | 84.1 | 82.5 | 80.8 | 79.1 | 77.3 | 75.6 | 73.8 | 72.1 | 70.4 | 68.7 | 67.1 | 65.6 |
| 65          | 80.4 | 83.9 | 85.5 | 86.1 | 86.1 | 85.8 | 85.1 | 84.1 | 82.9 | 81.5 | 80.0 | 78.4 | 76.8 | 75.1 | 73.5 | 71.8 | 70.2 | 68.6 | 67.1 | 65.6 |
| 70          | 77.7 | 81.2 | 82.8 | 83.6 | 83.9 | 83.7 | 83.2 | 82.4 | 81.4 | 80.3 | 78.9 | 77.5 | 76.0 | 74.5 | 73.0 | 71.5 | 70.0 | 68.5 | 67.0 | 65.6 |
| 75          | 75.2 | 78.4 | 80.1 | 81.0 | 81.3 | 81.3 | 81.0 | 80.4 | 79.6 | 78.7 | 77.6 | 76.4 | 75.1 | 73.8 | 72.4 | 71.0 | 69.6 | 68.3 | 66.9 | 65.6 |
| 80          | 73.0 | 75.6 | 77.2 | 78.1 | 78.5 | 78.6 | 78.4 | 78.1 | 77.5 | 76.8 | 75.9 | 74.9 | 73.9 | 72.8 | 71.6 | 70.4 | 69.2 | 68.0 | 66.8 | 65.6 |
| 85          | 71.1 | 73.0 | 74.2 | 75.0 | 75.4 | 75.6 | 75.5 | 75.3 | 74.9 | 74.4 | 73.8 | 73.1 | 72.3 | 71.4 | 70.5 | 69.6 | 68.6 | 67.6 | 66.6 | 65.6 |
| 90          | 69.4 | 70.5 | 71.2 | 71.7 | 72.0 | 72.2 | 72.2 | 72.1 | 71.9 | 71.6 | 71.2 | 70.8 | 70.3 | 69.7 | 69.1 | 68.5 | 67.8 | 67.1 | 66.3 | 65.6 |
| 95          | 67.6 | 67.9 | 68.1 | 68.3 | 68.4 | 68.5 | 68.5 | 68.5 | 68.4 | 68.3 | 68.2 | 68.0 | 67.8 | 67.6 | 67.3 | 67.0 | 66.7 | 66.3 | 65.9 | 65.6 |
| 98          | 66.7 | 66.8 | 66.8 | 66.8 | 66.8 | 66.7 | 66.7 | 66.7 | 66.6 | 66.6 | 66.5 | 66.4 | 66.3 | 66.3 | 66.1 | 66.0 | 65.9 | 65.8 | 65.7 | 65.6 |

### Mean Annual Mass Removal Efficiencies for 1.25-inches of Retention for Zone 4 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 97.3 | 98.0 | 98.0 | 97.5 | 96.8 | 95.8 | 94.6 | 93.3 | 91.8 | 90.2 | 88.5 | 86.8 | 85.0 | 83.2 | 81.4 | 79.6 | 77.9 | 76.2 | 74.5 | 72.9 |
| 35          | 95.9 | 97.2 | 97.3 | 96.9 | 96.2 | 95.3 | 94.2 | 92.9 | 91.5 | 89.9 | 88.3 | 86.6 | 84.8 | 83.0 | 81.3 | 79.5 | 77.8 | 76.2 | 74.5 | 72.9 |
| 40          | 94.5 | 96.0 | 96.3 | 96.1 | 95.5 | 94.6 | 93.6 | 92.4 | 91.1 | 89.6 | 88.0 | 86.3 | 84.6 | 82.9 | 81.2 | 79.5 | 77.8 | 76.1 | 74.5 | 72.9 |
| 45          | 92.7 | 94.6 | 95.1 | 95.0 | 94.6 | 93.9 | 93.0 | 91.8 | 90.6 | 89.1 | 87.6 | 86.0 | 84.4 | 82.7 | 81.0 | 79.3 | 77.7 | 76.1 | 74.5 | 72.9 |
| 50          | 90.7 | 93.1 | 93.8 | 93.8 | 93.6 | 93.0 | 92.1 | 91.1 | 89.9 | 88.6 | 87.2 | 85.7 | 84.1 | 82.4 | 80.8 | 79.2 | 77.6 | 76.0 | 74.5 | 72.9 |
| 55          | 88.6 | 91.3 | 92.2 | 92.5 | 92.3 | 91.9 | 91.2 | 90.3 | 89.2 | 88.0 | 86.6 | 85.2 | 83.7 | 82.1 | 80.6 | 79.0 | 77.5 | 75.9 | 74.4 | 72.9 |
| 60          | 86.4 | 89.3 | 90.5 | 90.9 | 90.9 | 90.6 | 90.0 | 89.2 | 88.3 | 87.2 | 86.0 | 84.6 | 83.2 | 81.8 | 80.3 | 78.8 | 77.3 | 75.8 | 74.4 | 72.9 |
| 65          | 84.3 | 87.2 | 88.5 | 89.1 | 89.2 | 89.0 | 88.6 | 88.0 | 87.2 | 86.3 | 85.2 | 84.0 | 82.7 | 81.3 | 79.9 | 78.5 | 77.1 | 75.7 | 74.3 | 72.9 |
| 70          | 82.1 | 85.0 | 86.4 | 87.1 | 87.4 | 87.3 | 87.0 | 86.6 | 85.9 | 85.1 | 84.2 | 83.1 | 82.0 | 80.7 | 79.5 | 78.2 | 76.9 | 75.6 | 74.3 | 72.9 |
| 75          | 80.1 | 82.7 | 84.1 | 84.9 | 85.3 | 85.4 | 85.2 | 84.9 | 84.4 | 83.7 | 82.9 | 82.0 | 81.1 | 80.0 | 78.9 | 77.7 | 76.6 | 75.4 | 74.2 | 72.9 |
| 80          | 78.2 | 80.4 | 81.7 | 82.5 | 83.0 | 83.2 | 83.1 | 82.9 | 82.5 | 82.0 | 81.4 | 80.7 | 79.9 | 79.1 | 78.1 | 77.1 | 76.1 | 75.1 | 74.0 | 72.9 |
| 85          | 76.7 | 78.3 | 79.3 | 80.1 | 80.5 | 80.7 | 80.7 | 80.6 | 80.4 | 80.1 | 79.6 | 79.1 | 78.5 | 77.8 | 77.1 | 76.4 | 75.5 | 74.7 | 73.8 | 72.9 |
| 90          | 75.4 | 76.3 | 77.0 | 77.5 | 77.8 | 78.0 | 78.1 | 78.0 | 77.9 | 77.7 | 77.5 | 77.1 | 76.8 | 76.3 | 75.9 | 75.3 | 74.8 | 74.2 | 73.6 | 72.9 |
| 95          | 74.2 | 74.5 | 74.7 | 74.9 | 75.0 | 75.1 | 75.1 | 75.1 | 75.1 | 75.0 | 74.9 | 74.8 | 74.6 | 74.5 | 74.3 | 74.0 | 73.8 | 73.5 | 73.3 | 72.9 |
| 98          | 73.7 | 73.7 | 73.7 | 73.7 | 73.7 | 73.7 | 73.7 | 73.7 | 73.7 | 73.6 | 73.6 | 73.6 | 73.5 | 73.4 | 73.4 | 73.3 | 73.2 | 73.1 | 73.0 | 72.9 |

### Mean Annual Mass Removal Efficiencies for 1.50-inches of Retention for Zone 4 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 97.8 | 98.4 | 98.5 | 98.2 | 97.7 | 97.1 | 96.2 | 95.3 | 94.2 | 93.0 | 91.7 | 90.4 | 89.0 | 87.5 | 86.0 | 84.5 | 83.0 | 81.5 | 80.0 | 78.5 |
| 35          | 96.7 | 97.7 | 97.9 | 97.7 | 97.3 | 96.6 | 95.8 | 94.9 | 93.9 | 92.8 | 91.5 | 90.2 | 88.8 | 87.4 | 85.9 | 84.4 | 82.9 | 81.4 | 80.0 | 78.5 |
| 40          | 95.5 | 96.8 | 97.1 | 97.0 | 96.6 | 96.1 | 95.4 | 94.5 | 93.5 | 92.4 | 91.2 | 89.9 | 88.6 | 87.2 | 85.8 | 84.3 | 82.9 | 81.4 | 80.0 | 78.5 |
| 45          | 94.1 | 95.7 | 96.2 | 96.2 | 95.9 | 95.4 | 94.8 | 94.0 | 93.1 | 92.0 | 90.9 | 89.7 | 88.4 | 87.0 | 85.6 | 84.2 | 82.8 | 81.3 | 79.9 | 78.5 |
| 50          | 92.5 | 94.4 | 95.1 | 95.2 | 95.0 | 94.6 | 94.1 | 93.3 | 92.5 | 91.5 | 90.5 | 89.3 | 88.1 | 86.8 | 85.4 | 84.1 | 82.7 | 81.3 | 79.9 | 78.5 |
| 55          | 90.8 | 93.0 | 93.8 | 94.0 | 94.0 | 93.7 | 93.2 | 92.6 | 91.8 | 91.0 | 90.0 | 88.9 | 87.7 | 86.5 | 85.2 | 83.9 | 82.5 | 81.2 | 79.9 | 78.5 |
| 60          | 88.9 | 91.3 | 92.3 | 92.7 | 92.8 | 92.6 | 92.2 | 91.7 | 91.0 | 90.3 | 89.4 | 88.4 | 87.3 | 86.1 | 84.9 | 83.7 | 82.4 | 81.1 | 79.8 | 78.5 |
| 65          | 87.1 | 89.6 | 90.7 | 91.3 | 91.4 | 91.3 | 91.1 | 90.6 | 90.1 | 89.4 | 88.6 | 87.7 | 86.8 | 85.7 | 84.6 | 83.4 | 82.2 | 81.0 | 79.8 | 78.5 |
| 70          | 85.4 | 87.8 | 89.0 | 89.6 | 89.9 | 89.9 | 89.7 | 89.4 | 89.0 | 88.4 | 87.7 | 87.0 | 86.1 | 85.1 | 84.1 | 83.1 | 82.0 | 80.8 | 79.7 | 78.5 |
| 75          | 83.8 | 85.9 | 87.1 | 87.8 | 88.2 | 88.3 | 88.2 | 88.0 | 87.7 | 87.2 | 86.7 | 86.0 | 85.3 | 84.4 | 83.6 | 82.6 | 81.6 | 80.6 | 79.6 | 78.5 |
| 80          | 82.2 | 84.0 | 85.2 | 85.9 | 86.3 | 86.4 | 86.5 | 86.4 | 86.2 | 85.8 | 85.4 | 84.9 | 84.3 | 83.6 | 82.9 | 82.1 | 81.2 | 80.4 | 79.5 | 78.5 |
| 85          | 81.0 | 82.3 | 83.2 | 83.8 | 84.2 | 84.4 | 84.5 | 84.5 | 84.4 | 84.2 | 83.9 | 83.5 | 83.0 | 82.5 | 82.0 | 81.4 | 80.7 | 80.0 | 79.3 | 78.5 |
| 90          | 80.0 | 80.7 | 81.3 | 81.8 | 82.1 | 82.3 | 82.4 | 82.4 | 82.4 | 82.2 | 82.1 | 81.8 | 81.6 | 81.2 | 80.9 | 80.5 | 80.0 | 79.6 | 79.1 | 78.5 |
| 95          | 79.1 | 79.4 | 79.6 | 79.8 | 79.9 | 80.0 | 80.1 | 80.1 | 80.1 | 80.1 | 80.0 | 79.9 | 79.8 | 79.7 | 79.6 | 79.4 | 79.2 | 79.0 | 78.8 | 78.5 |
| 98          | 79.0 | 79.0 | 79.0 | 79.1 | 79.1 | 79.1 | 79.1 | 79.1 | 79.0 | 79.0 | 79.0 | 79.0 | 78.9 | 78.9 | 78.8 | 78.8 | 78.7 | 78.7 | 78.6 | 78.5 |

### Mean Annual Mass Removal Efficiencies for 1.75-inches of Retention for Zone 4 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 98.2 | 98.7 | 98.8 | 98.7 | 98.4 | 97.9 | 97.3 | 96.5 | 95.7 | 94.8 | 93.8 | 92.8 | 91.7 | 90.5 | 89.3 | 88.0 | 86.7 | 85.4 | 84.1 | 82.8 |
| 35          | 97.3 | 98.1 | 98.3 | 98.2 | 97.9 | 97.5 | 96.9 | 96.2 | 95.5 | 94.6 | 93.6 | 92.6 | 91.5 | 90.4 | 89.2 | 87.9 | 86.7 | 85.4 | 84.1 | 82.8 |
| 40          | 96.2 | 97.4 | 97.7 | 97.7 | 97.4 | 97.0 | 96.5 | 95.9 | 95.1 | 94.3 | 93.4 | 92.4 | 91.3 | 90.2 | 89.0 | 87.8 | 86.6 | 85.4 | 84.1 | 82.8 |
| 45          | 95.1 | 96.5 | 96.9 | 97.0 | 96.8 | 96.5 | 96.0 | 95.4 | 94.7 | 93.9 | 93.1 | 92.1 | 91.1 | 90.0 | 88.9 | 87.7 | 86.5 | 85.3 | 84.1 | 82.8 |
| 50          | 93.9 | 95.5 | 96.0 | 96.1 | 96.0 | 95.8 | 95.4 | 94.8 | 94.2 | 93.5 | 92.7 | 91.8 | 90.8 | 89.8 | 88.7 | 87.6 | 86.4 | 85.2 | 84.0 | 82.8 |
| 55          | 92.4 | 94.3 | 95.0 | 95.2 | 95.2 | 95.0 | 94.6 | 94.2 | 93.6 | 93.0 | 92.2 | 91.4 | 90.5 | 89.5 | 88.5 | 87.4 | 86.3 | 85.2 | 84.0 | 82.8 |
| 60          | 90.9 | 92.9 | 93.7 | 94.1 | 94.2 | 94.0 | 93.8 | 93.4 | 92.9 | 92.4 | 91.7 | 90.9 | 90.1 | 89.2 | 88.2 | 87.2 | 86.2 | 85.1 | 83.9 | 82.8 |
| 65          | 89.4 | 91.4 | 92.4 | 92.9 | 93.0 | 93.0 | 92.8 | 92.5 | 92.1 | 91.6 | 91.0 | 90.4 | 89.6 | 88.8 | 87.9 | 87.0 | 86.0 | 84.9 | 83.9 | 82.8 |
| 70          | 87.9 | 89.9 | 90.9 | 91.5 | 91.7 | 91.8 | 91.7 | 91.5 | 91.2 | 90.7 | 90.3 | 89.7 | 89.0 | 88.3 | 87.5 | 86.6 | 85.7 | 84.8 | 83.8 | 82.8 |
| 75          | 86.5 | 88.4 | 89.4 | 90.0 | 90.3 | 90.5 | 90.4 | 90.3 | 90.1 | 89.7 | 89.3 | 88.9 | 88.3 | 87.7 | 87.0 | 86.2 | 85.4 | 84.6 | 83.7 | 82.8 |
| 80          | 85.3 | 86.8 | 87.8 | 88.4 | 88.8 | 88.9 | 89.0 | 88.9 | 88.8 | 88.6 | 88.3 | 87.9 | 87.4 | 86.9 | 86.4 | 85.7 | 85.1 | 84.4 | 83.6 | 82.8 |
| 85          | 84.3 | 85.4 | 86.2 | 86.7 | 87.1 | 87.3 | 87.4 | 87.4 | 87.3 | 87.2 | 87.0 | 86.7 | 86.4 | 86.0 | 85.6 | 85.1 | 84.6 | 84.0 | 83.4 | 82.8 |
| 90          | 83.5 | 84.1 | 84.7 | 85.0 | 85.3 | 85.5 | 85.7 | 85.7 | 85.7 | 85.6 | 85.5 | 85.4 | 85.2 | 84.9 | 84.7 | 84.4 | 84.0 | 83.7 | 83.3 | 82.8 |
| 95          | 82.9 | 83.2 | 83.4 | 83.6 | 83.7 | 83.8 | 83.9 | 83.9 | 83.9 | 83.9 | 83.9 | 83.8 | 83.8 | 83.7 | 83.6 | 83.5 | 83.3 | 83.2 | 83.0 | 82.8 |
| 98          | 83.0 | 83.1 | 83.1 | 83.1 | 83.1 | 83.1 | 83.2 | 83.2 | 83.2 | 83.1 | 83.1 | 83.1 | 83.1 | 83.1 | 83.0 | 83.0 | 83.0 | 82.9 | 82.9 | 82.8 |

### Mean Annual Mass Removal Efficiencies for 2.00-inches of Retention for Zone 4 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 98.5 | 99.0 | 99.1 | 99.0 | 98.7 | 98.4 | 98.0 | 97.4 | 96.8 | 96.1 | 95.3 | 94.5 | 93.6 | 92.6 | 91.6 | 90.6 | 89.5 | 88.4 | 87.3 | 86.1 |
| 35          | 97.8 | 98.5 | 98.6 | 98.6 | 98.4 | 98.1 | 97.7 | 97.1 | 96.5 | 95.9 | 95.1 | 94.3 | 93.4 | 92.5 | 91.5 | 90.5 | 89.4 | 88.4 | 87.3 | 86.1 |
| 40          | 96.9 | 97.8 | 98.1 | 98.1 | 98.0 | 97.7 | 97.3 | 96.8 | 96.2 | 95.6 | 94.9 | 94.1 | 93.3 | 92.4 | 91.4 | 90.4 | 89.4 | 88.3 | 87.2 | 86.1 |
| 45          | 95.9 | 97.1 | 97.5 | 97.6 | 97.5 | 97.2 | 96.8 | 96.4 | 95.9 | 95.3 | 94.6 | 93.8 | 93.0 | 92.2 | 91.3 | 90.3 | 89.3 | 88.3 | 87.2 | 86.1 |
| 50          | 94.9 | 96.3 | 96.7 | 96.9 | 96.8 | 96.6 | 96.3 | 95.9 | 95.4 | 94.9 | 94.2 | 93.6 | 92.8 | 92.0 | 91.1 | 90.2 | 89.2 | 88.2 | 87.2 | 86.1 |
| 55          | 93.7 | 95.3 | 95.9 | 96.1 | 96.1 | 95.9 | 95.7 | 95.3 | 94.9 | 94.4 | 93.8 | 93.2 | 92.5 | 91.7 | 90.9 | 90.0 | 89.1 | 88.1 | 87.1 | 86.1 |
| 60          | 92.5 | 94.1 | 94.9 | 95.1 | 95.2 | 95.1 | 95.0 | 94.7 | 94.3 | 93.9 | 93.4 | 92.8 | 92.1 | 91.4 | 90.6 | 89.8 | 88.9 | 88.0 | 87.1 | 86.1 |
| 65          | 91.2 | 92.9 | 93.7 | 94.1 | 94.3 | 94.3 | 94.1 | 93.9 | 93.6 | 93.2 | 92.8 | 92.3 | 91.7 | 91.0 | 90.3 | 89.6 | 88.8 | 87.9 | 87.1 | 86.1 |
| 70          | 89.9 | 91.6 | 92.5 | 92.9 | 93.2 | 93.2 | 93.2 | 93.0 | 92.8 | 92.5 | 92.1 | 91.7 | 91.2 | 90.6 | 90.0 | 89.3 | 88.6 | 87.8 | 87.0 | 86.1 |
| 75          | 88.7 | 90.2 | 91.2 | 91.7 | 92.0 | 92.1 | 92.1 | 92.0 | 91.9 | 91.6 | 91.3 | 91.0 | 90.5 | 90.1 | 89.5 | 88.9 | 88.3 | 87.6 | 86.9 | 86.1 |
| 80          | 87.7 | 89.0 | 89.8 | 90.3 | 90.7 | 90.9 | 90.9 | 90.9 | 90.8 | 90.6 | 90.4 | 90.1 | 89.8 | 89.4 | 89.0 | 88.5 | 88.0 | 87.4 | 86.8 | 86.1 |
| 85          | 86.9 | 87.8 | 88.5 | 89.0 | 89.3 | 89.5 | 89.6 | 89.6 | 89.6 | 89.5 | 89.4 | 89.2 | 88.9 | 88.7 | 88.3 | 88.0 | 87.6 | 87.1 | 86.6 | 86.1 |
| 90          | 86.3 | 86.8 | 87.3 | 87.6 | 87.9 | 88.0 | 88.2 | 88.2 | 88.3 | 88.2 | 88.2 | 88.1 | 87.9 | 87.8 | 87.6 | 87.3 | 87.1 | 86.8 | 86.5 | 86.1 |
| 95          | 85.9 | 86.1 | 86.3 | 86.5 | 86.6 | 86.7 | 86.8 | 86.8 | 86.8 | 86.9 | 86.9 | 86.8 | 86.8 | 86.8 | 86.7 | 86.6 | 86.5 | 86.4 | 86.3 | 86.1 |
| 98          | 86.1 | 86.2 | 86.2 | 86.2 | 86.3 | 86.3 | 86.3 | 86.3 | 86.3 | 86.3 | 86.3 | 86.3 | 86.3 | 86.3 | 86.3 | 86.2 | 86.2 | 86.2 | 86.2 | 86.1 |

**Mean Annual Mass Removal Efficiencies for 2.25-inches of Retention for Zone 4 by Percent DCIA**

[illegible]

**Mean Annual Mass Removal Efficiencies for 2.50-inches of Retention for Zone 4 by Percent DCIA**

[illegible]

### Mean Annual Mass Removal Efficiencies for 2.75-inches of Retention for Zone 4 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.1 | 99.4 | 99.5 | 99.5 | 99.4 | 99.2 | 99.0 | 98.8 | 98.5 | 98.1 | 97.7 | 97.2 | 96.7 | 96.2 | 95.6 | 95.0 | 94.3 | 93.7 | 93.0 | 92.3 |
| 35          | 98.7 | 99.1 | 99.2 | 99.2 | 99.2 | 99.0 | 98.9 | 98.6 | 98.3 | 98.0 | 97.5 | 97.1 | 96.6 | 96.1 | 95.5 | 94.9 | 94.3 | 93.6 | 93.0 | 92.3 |
| 40          | 98.1 | 98.7 | 98.9 | 98.9 | 98.9 | 98.8 | 98.6 | 98.4 | 98.1 | 97.8 | 97.4 | 96.9 | 96.5 | 96.0 | 95.4 | 94.9 | 94.2 | 93.6 | 92.9 | 92.3 |
| 45          | 97.6 | 98.3 | 98.5 | 98.6 | 98.6 | 98.5 | 98.3 | 98.1 | 97.9 | 97.5 | 97.2 | 96.8 | 96.3 | 95.8 | 95.3 | 94.8 | 94.2 | 93.6 | 92.9 | 92.3 |
| 50          | 96.9 | 97.8 | 98.1 | 98.2 | 98.2 | 98.1 | 98.0 | 97.8 | 97.6 | 97.3 | 96.9 | 96.6 | 96.1 | 95.7 | 95.2 | 94.7 | 94.1 | 93.5 | 92.9 | 92.3 |
| 55          | 96.2 | 97.2 | 97.6 | 97.7 | 97.8 | 97.7 | 97.6 | 97.4 | 97.2 | 96.9 | 96.6 | 96.3 | 95.9 | 95.5 | 95.0 | 94.5 | 94.0 | 93.5 | 92.9 | 92.3 |
| 60          | 95.5 | 96.6 | 97.0 | 97.2 | 97.3 | 97.2 | 97.1 | 97.0 | 96.8 | 96.6 | 96.3 | 96.0 | 95.6 | 95.3 | 94.8 | 94.4 | 93.9 | 93.4 | 92.8 | 92.3 |
| 65          | 94.7 | 95.8 | 96.3 | 96.5 | 96.6 | 96.7 | 96.6 | 96.5 | 96.3 | 96.1 | 95.9 | 95.6 | 95.3 | 95.0 | 94.6 | 94.2 | 93.8 | 93.3 | 92.8 | 92.3 |
| 70          | 93.9 | 95.0 | 95.5 | 95.8 | 96.0 | 96.0 | 96.0 | 95.9 | 95.8 | 95.7 | 95.5 | 95.2 | 95.0 | 94.7 | 94.4 | 94.0 | 93.6 | 93.2 | 92.7 | 92.3 |
| 75          | 93.1 | 94.1 | 94.7 | 95.0 | 95.2 | 95.3 | 95.3 | 95.3 | 95.2 | 95.1 | 95.0 | 94.8 | 94.6 | 94.3 | 94.1 | 93.8 | 93.4 | 93.1 | 92.7 | 92.3 |
| 80          | 92.5 | 93.3 | 93.8 | 94.1 | 94.4 | 94.5 | 94.6 | 94.6 | 94.6 | 94.5 | 94.4 | 94.3 | 94.1 | 93.9 | 93.7 | 93.5 | 93.2 | 92.9 | 92.6 | 92.3 |
| 85          | 91.9 | 92.6 | 93.0 | 93.3 | 93.5 | 93.7 | 93.8 | 93.8 | 93.8 | 93.8 | 93.8 | 93.7 | 93.6 | 93.5 | 93.3 | 93.2 | 93.0 | 92.7 | 92.5 | 92.3 |
| 90          | 91.6 | 92.0 | 92.3 | 92.5 | 92.7 | 92.9 | 93.0 | 93.0 | 93.1 | 93.1 | 93.1 | 93.1 | 93.0 | 93.0 | 92.9 | 92.8 | 92.7 | 92.6 | 92.4 | 92.3 |
| 95          | 91.6 | 91.8 | 91.9 | 92.0 | 92.1 | 92.2 | 92.3 | 92.3 | 92.4 | 92.4 | 92.4 | 92.4 | 92.4 | 92.4 | 92.4 | 92.4 | 92.4 | 92.3 | 92.3 | 92.3 |
| 98          | 92.0 | 92.0 | 92.1 | 92.1 | 92.1 | 92.1 | 92.2 | 92.2 | 92.2 | 92.2 | 92.2 | 92.2 | 92.2 | 92.3 | 92.3 | 92.3 | 92.3 | 92.3 | 92.3 | 92.3 |

### Mean Annual Mass Removal Efficiencies for 3.00-inches of Retention for Zone 4 by Percent DCIA

[illegible]



### Mean Annual Mass Removal Efficiencies for 3.75-inches of Retention for Zone 4 by Percent DCIA

[illegible]

**Mean Annual Mass Removal Efficiencies for 4.00-inches of Retention for Zone 4 by Percent DCIA**

[illegible]

### Mean Annual Mass Removal Efficiencies for 0.25-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 83.0 | 80.8 | 74.1 | 67.0 | 60.7 | 55.3 | 50.7 | 46.8 | 43.4 | 40.4 | 37.8 | 35.5 | 33.5 | 31.7 | 30.1 | 28.6 | 27.3 | 26.1 | 25.0 | 24.0 |
| 35          | 77.3 | 77.4 | 72.0 | 65.6 | 59.8 | 54.7 | 50.2 | 46.4 | 43.1 | 40.2 | 37.6 | 35.4 | 33.4 | 31.6 | 30.0 | 28.6 | 27.3 | 26.1 | 25.0 | 24.0 |
| 40          | 71.3 | 73.5 | 69.4 | 63.9 | 58.6 | 53.8 | 49.6 | 45.9 | 42.7 | 39.9 | 37.4 | 35.2 | 33.3 | 31.5 | 30.0 | 28.5 | 27.3 | 26.1 | 25.0 | 24.0 |
| 45          | 65.3 | 69.3 | 66.5 | 61.9 | 57.2 | 52.8 | 48.8 | 45.3 | 42.3 | 39.6 | 37.1 | 35.0 | 33.1 | 31.4 | 29.9 | 28.5 | 27.2 | 26.0 | 25.0 | 24.0 |
| 50          | 59.6 | 64.8 | 63.4 | 59.6 | 55.5 | 51.6 | 47.9 | 44.7 | 41.7 | 39.2 | 36.8 | 34.8 | 32.9 | 31.3 | 29.8 | 28.4 | 27.2 | 26.0 | 25.0 | 24.0 |
| 55          | 54.0 | 60.2 | 59.9 | 57.1 | 53.7 | 50.2 | 46.9 | 43.9 | 41.1 | 38.7 | 36.5 | 34.5 | 32.7 | 31.1 | 29.6 | 28.3 | 27.1 | 26.0 | 24.9 | 24.0 |
| 60          | 49.0 | 55.7 | 56.3 | 54.4 | 51.6 | 48.6 | 45.6 | 42.9 | 40.4 | 38.1 | 36.0 | 34.1 | 32.4 | 30.9 | 29.5 | 28.2 | 27.0 | 25.9 | 24.9 | 24.0 |
| 65          | 44.5 | 51.0 | 52.5 | 51.4 | 49.3 | 46.8 | 44.2 | 41.8 | 39.5 | 37.4 | 35.5 | 33.7 | 32.1 | 30.6 | 29.3 | 28.1 | 26.9 | 25.9 | 24.9 | 24.0 |
| 70          | 40.5 | 46.5 | 48.5 | 48.1 | 46.6 | 44.7 | 42.6 | 40.5 | 38.4 | 36.6 | 34.8 | 33.2 | 31.7 | 30.3 | 29.1 | 27.9 | 26.8 | 25.8 | 24.9 | 24.0 |
| 75          | 37.0 | 42.0 | 44.2 | 44.5 | 43.7 | 42.2 | 40.6 | 38.9 | 37.2 | 35.5 | 34.0 | 32.5 | 31.2 | 29.9 | 28.8 | 27.7 | 26.7 | 25.7 | 24.8 | 24.0 |
| 80          | 33.9 | 37.8 | 39.8 | 40.5 | 40.2 | 39.4 | 38.2 | 36.9 | 35.6 | 34.2 | 32.9 | 31.7 | 30.5 | 29.4 | 28.4 | 27.4 | 26.5 | 25.6 | 24.8 | 24.0 |
| 85          | 31.1 | 33.8 | 35.4 | 36.1 | 36.3 | 35.9 | 35.3 | 34.5 | 33.5 | 32.5 | 31.5 | 30.5 | 29.6 | 28.7 | 27.8 | 27.0 | 26.2 | 25.4 | 24.7 | 24.0 |
| 90          | 28.7 | 30.2 | 31.2 | 31.8 | 32.0 | 32.0 | 31.7 | 31.3 | 30.8 | 30.2 | 29.6 | 29.0 | 28.3 | 27.6 | 27.0 | 26.4 | 25.7 | 25.1 | 24.6 | 24.0 |
| 95          | 26.6 | 27.0 | 27.4 | 27.6 | 27.7 | 27.7 | 27.7 | 27.6 | 27.4 | 27.2 | 26.9 | 26.6 | 26.3 | 26.0 | 25.7 | 25.4 | 25.0 | 24.7 | 24.3 | 24.0 |
| 98          | 25.7 | 25.7 | 25.7 | 25.7 | 25.7 | 25.6 | 25.6 | 25.5 | 25.4 | 25.3 | 25.2 | 25.1 | 25.0 | 24.8 | 24.7 | 24.6 | 24.4 | 24.3 | 24.1 | 24.0 |

### Mean Annual Mass Removal Efficiencies for 0.50-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 88.6 | 89.9 | 87.9 | 84.5 | 80.5 | 76.4 | 72.3 | 68.5 | 65.1 | 61.9 | 58.9 | 56.2 | 53.7 | 51.4 | 49.3 | 47.3 | 45.5 | 43.8 | 42.2 | 40.8 |
| 35          | 84.1 | 86.8 | 85.6 | 82.8 | 79.3 | 75.4 | 71.6 | 68.0 | 64.6 | 61.5 | 58.7 | 56.0 | 53.6 | 51.3 | 49.2 | 47.3 | 45.5 | 43.8 | 42.2 | 40.8 |
| 40          | 79.3 | 83.3 | 82.9 | 80.8 | 77.8 | 74.3 | 70.7 | 67.3 | 64.1 | 61.1 | 58.3 | 55.8 | 53.4 | 51.1 | 49.1 | 47.2 | 45.4 | 43.8 | 42.2 | 40.8 |
| 45          | 74.4 | 79.5 | 80.0 | 78.5 | 76.0 | 72.9 | 69.6 | 66.5 | 63.4 | 60.6 | 57.9 | 55.4 | 53.1 | 51.0 | 48.9 | 47.1 | 45.3 | 43.7 | 42.2 | 40.8 |
| 50          | 69.7 | 75.5 | 76.8 | 76.0 | 73.9 | 71.3 | 68.4 | 65.5 | 62.6 | 60.0 | 57.4 | 55.0 | 52.8 | 50.7 | 48.8 | 47.0 | 45.3 | 43.7 | 42.2 | 40.8 |
| 55          | 65.2 | 71.4 | 73.4 | 73.1 | 71.7 | 69.5 | 66.9 | 64.3 | 61.7 | 59.2 | 56.9 | 54.6 | 52.5 | 50.4 | 48.6 | 46.8 | 45.2 | 43.6 | 42.1 | 40.8 |
| 60          | 61.0 | 67.2 | 69.7 | 70.1 | 69.2 | 67.4 | 65.3 | 63.0 | 60.6 | 58.4 | 56.2 | 54.0 | 52.0 | 50.1 | 48.3 | 46.6 | 45.0 | 43.5 | 42.1 | 40.8 |
| 65          | 57.1 | 63.1 | 65.9 | 66.8 | 66.4 | 65.1 | 63.3 | 61.4 | 59.4 | 57.3 | 55.3 | 53.4 | 51.5 | 49.7 | 48.0 | 46.4 | 44.9 | 43.4 | 42.1 | 40.8 |
| 70          | 53.6 | 59.2 | 62.0 | 63.2 | 63.3 | 62.5 | 61.2 | 59.6 | 57.9 | 56.1 | 54.3 | 52.6 | 50.9 | 49.2 | 47.6 | 46.1 | 44.7 | 43.3 | 42.0 | 40.8 |
| 75          | 50.7 | 55.5 | 58.1 | 59.5 | 59.8 | 59.4 | 58.6 | 57.4 | 56.1 | 54.6 | 53.1 | 51.6 | 50.1 | 48.6 | 47.1 | 45.8 | 44.4 | 43.2 | 41.9 | 40.8 |
| 80          | 48.3 | 52.0 | 54.3 | 55.5 | 56.0 | 56.0 | 55.6 | 54.8 | 53.9 | 52.8 | 51.6 | 50.3 | 49.0 | 47.8 | 46.5 | 45.3 | 44.1 | 43.0 | 41.8 | 40.8 |
| 85          | 46.2 | 48.7 | 50.5 | 51.5 | 52.0 | 52.2 | 52.1 | 51.7 | 51.1 | 50.4 | 49.6 | 48.6 | 47.6 | 46.7 | 45.6 | 44.6 | 43.7 | 42.7 | 41.7 | 40.8 |
| 90          | 44.2 | 45.6 | 46.7 | 47.4 | 47.9 | 48.1 | 48.2 | 48.1 | 47.8 | 47.4 | 46.9 | 46.4 | 45.7 | 45.1 | 44.4 | 43.7 | 43.0 | 42.2 | 41.5 | 40.8 |
| 95          | 42.5 | 43.0 | 43.4 | 43.7 | 43.9 | 44.0 | 44.1 | 44.1 | 44.0 | 43.9 | 43.7 | 43.5 | 43.2 | 43.0 | 42.7 | 42.3 | 42.0 | 41.6 | 41.2 | 40.8 |
| 98          | 42.1 | 42.2 | 42.2 | 42.2 | 42.2 | 42.2 | 42.2 | 42.1 | 42.1 | 42.0 | 41.9 | 41.8 | 41.7 | 41.6 | 41.5 | 41.4 | 41.2 | 41.1 | 40.9 | 40.8 |

### Mean Annual Mass Removal Efficiencies for 0.75-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 91.4 | 93.0 | 92.4 | 90.8 | 88.5 | 85.9 | 83.0 | 80.1 | 77.2 | 74.4 | 71.6 | 69.1 | 66.7 | 64.4 | 62.3 | 60.2 | 58.3 | 56.5 | 54.8 | 53.2 |
| 35          | 87.7 | 90.5 | 90.4 | 89.2 | 87.2 | 84.8 | 82.2 | 79.5 | 76.7 | 73.9 | 71.3 | 68.8 | 66.5 | 64.2 | 62.1 | 60.2 | 58.3 | 56.5 | 54.8 | 53.2 |
| 40          | 83.8 | 87.6 | 88.1 | 87.2 | 85.7 | 83.6 | 81.2 | 78.7 | 76.0 | 73.4 | 70.9 | 68.5 | 66.2 | 64.1 | 62.0 | 60.0 | 58.2 | 56.4 | 54.8 | 53.2 |
| 45          | 80.0 | 84.4 | 85.6 | 85.1 | 83.9 | 82.2 | 80.0 | 77.7 | 75.3 | 72.8 | 70.4 | 68.1 | 65.9 | 63.8 | 61.8 | 59.9 | 58.1 | 56.4 | 54.7 | 53.2 |
| 50          | 76.0 | 81.1 | 82.7 | 82.8 | 82.0 | 80.5 | 78.7 | 76.6 | 74.4 | 72.1 | 69.8 | 67.7 | 65.6 | 63.5 | 61.6 | 59.8 | 58.0 | 56.3 | 54.7 | 53.2 |
| 55          | 72.3 | 77.7 | 79.7 | 80.2 | 79.8 | 78.7 | 77.2 | 75.3 | 73.3 | 71.2 | 69.2 | 67.1 | 65.1 | 63.2 | 61.3 | 59.6 | 57.9 | 56.2 | 54.7 | 53.2 |
| 60          | 68.9 | 74.2 | 76.5 | 77.4 | 77.4 | 76.6 | 75.4 | 73.9 | 72.1 | 70.2 | 68.3 | 66.4 | 64.6 | 62.8 | 61.0 | 59.3 | 57.7 | 56.1 | 54.6 | 53.2 |
| 65          | 65.5 | 70.7 | 73.3 | 74.5 | 74.7 | 74.4 | 73.5 | 72.2 | 70.7 | 69.1 | 67.4 | 65.7 | 64.0 | 62.3 | 60.7 | 59.1 | 57.5 | 56.0 | 54.6 | 53.2 |
| 70          | 62.6 | 67.4 | 70.0 | 71.3 | 71.9 | 71.8 | 71.2 | 70.3 | 69.1 | 67.7 | 66.3 | 64.7 | 63.2 | 61.7 | 60.2 | 58.7 | 57.3 | 55.9 | 54.5 | 53.2 |
| 75          | 60.1 | 64.2 | 66.7 | 68.1 | 68.8 | 68.9 | 68.7 | 68.0 | 67.1 | 66.1 | 64.9 | 63.6 | 62.3 | 60.9 | 59.6 | 58.3 | 57.0 | 55.7 | 54.4 | 53.2 |
| 80          | 58.0 | 61.3 | 63.5 | 64.8 | 65.5 | 65.9 | 65.8 | 65.4 | 64.8 | 64.0 | 63.1 | 62.1 | 61.1 | 60.0 | 58.9 | 57.7 | 56.6 | 55.4 | 54.3 | 53.2 |
| 85          | 56.4 | 58.8 | 60.4 | 61.5 | 62.2 | 62.5 | 62.6 | 62.4 | 62.0 | 61.6 | 61.0 | 60.3 | 59.5 | 58.7 | 57.9 | 57.0 | 56.0 | 55.1 | 54.1 | 53.2 |
| 90          | 55.1 | 56.4 | 57.4 | 58.1 | 58.6 | 58.9 | 59.0 | 59.0 | 58.9 | 58.7 | 58.4 | 58.0 | 57.6 | 57.1 | 56.5 | 55.9 | 55.3 | 54.6 | 53.9 | 53.2 |
| 95          | 53.7 | 54.2 | 54.6 | 54.9 | 55.2 | 55.4 | 55.5 | 55.6 | 55.6 | 55.5 | 55.5 | 55.3 | 55.2 | 55.0 | 54.7 | 54.5 | 54.2 | 53.9 | 53.5 | 53.2 |
| 98          | 53.9 | 54.0 | 54.0 | 54.1 | 54.1 | 54.1 | 54.1 | 54.1 | 54.1 | 54.0 | 54.0 | 53.9 | 53.9 | 53.8 | 53.7 | 53.6 | 53.5 | 53.4 | 53.3 | 53.2 |

### Mean Annual Mass Removal Efficiencies for 1.00-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 93.5 | 94.8 | 94.6 | 93.7 | 92.3 | 90.6 | 88.7 | 86.5 | 84.3 | 82.1 | 79.8 | 77.6 | 75.4 | 73.3 | 71.3 | 69.4 | 67.5 | 65.8 | 64.1 | 62.5 |
| 35          | 90.2 | 92.6 | 92.9 | 92.3 | 91.1 | 89.6 | 87.8 | 85.9 | 83.8 | 81.6 | 79.5 | 77.3 | 75.2 | 73.1 | 71.2 | 69.3 | 67.5 | 65.7 | 64.0 | 62.5 |
| 40          | 87.0 | 90.2 | 91.0 | 90.7 | 89.7 | 88.4 | 86.8 | 85.0 | 83.1 | 81.1 | 79.0 | 77.0 | 74.9 | 72.9 | 71.0 | 69.1 | 67.4 | 65.7 | 64.0 | 62.5 |
| 45          | 83.7 | 87.6 | 88.8 | 88.8 | 88.1 | 87.1 | 85.7 | 84.1 | 82.3 | 80.4 | 78.5 | 76.5 | 74.6 | 72.7 | 70.8 | 69.0 | 67.3 | 65.6 | 64.0 | 62.5 |
| 50          | 80.5 | 84.8 | 86.4 | 86.8 | 86.4 | 85.5 | 84.4 | 83.0 | 81.4 | 79.7 | 77.9 | 76.0 | 74.2 | 72.3 | 70.5 | 68.8 | 67.1 | 65.5 | 64.0 | 62.5 |
| 55          | 77.3 | 82.0 | 83.9 | 84.5 | 84.4 | 83.9 | 83.0 | 81.8 | 80.3 | 78.8 | 77.1 | 75.4 | 73.7 | 72.0 | 70.3 | 68.6 | 67.0 | 65.4 | 63.9 | 62.5 |
| 60          | 74.4 | 79.1 | 81.1 | 82.0 | 82.2 | 82.0 | 81.3 | 80.3 | 79.2 | 77.8 | 76.3 | 74.7 | 73.1 | 71.5 | 69.9 | 68.3 | 66.8 | 65.3 | 63.9 | 62.5 |
| 65          | 71.8 | 76.1 | 78.3 | 79.5 | 79.9 | 79.9 | 79.5 | 78.7 | 77.8 | 76.6 | 75.3 | 73.9 | 72.4 | 71.0 | 69.5 | 68.0 | 66.6 | 65.2 | 63.8 | 62.5 |
| 70          | 69.2 | 73.2 | 75.5 | 76.8 | 77.4 | 77.6 | 77.4 | 76.9 | 76.2 | 75.3 | 74.2 | 72.9 | 71.6 | 70.3 | 69.0 | 67.7 | 66.3 | 65.0 | 63.7 | 62.5 |
| 75          | 67.0 | 70.6 | 72.8 | 74.1 | 74.8 | 75.1 | 75.1 | 74.8 | 74.3 | 73.6 | 72.7 | 71.7 | 70.7 | 69.5 | 68.4 | 67.2 | 66.0 | 64.8 | 63.6 | 62.5 |
| 80          | 65.3 | 68.1 | 70.0 | 71.3 | 72.1 | 72.5 | 72.6 | 72.5 | 72.2 | 71.7 | 71.0 | 70.3 | 69.4 | 68.5 | 67.6 | 66.6 | 65.6 | 64.5 | 63.5 | 62.5 |
| 85          | 63.9 | 66.0 | 67.5 | 68.6 | 69.3 | 69.7 | 69.9 | 69.9 | 69.8 | 69.5 | 69.0 | 68.5 | 67.9 | 67.2 | 66.5 | 65.8 | 65.0 | 64.2 | 63.3 | 62.5 |
| 90          | 63.0 | 64.3 | 65.2 | 65.9 | 66.4 | 66.8 | 67.0 | 67.1 | 67.0 | 66.9 | 66.7 | 66.4 | 66.1 | 65.7 | 65.2 | 64.7 | 64.2 | 63.6 | 63.1 | 62.5 |
| 95          | 62.3 | 62.8 | 63.1 | 63.4 | 63.6 | 63.8 | 63.9 | 64.0 | 64.1 | 64.1 | 64.1 | 64.0 | 63.9 | 63.8 | 63.6 | 63.4 | 63.2 | 63.0 | 62.7 | 62.5 |
| 98          | 62.6 | 62.7 | 62.8 | 62.8 | 62.9 | 62.9 | 62.9 | 62.9 | 62.9 | 62.9 | 62.9 | 62.9 | 62.9 | 62.8 | 62.8 | 62.7 | 62.7 | 62.6 | 62.5 | 62.5 |

**Mean Annual Mass Removal Efficiencies for 1.25-inches of Retention for Zone 5 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 95.1 | 96.1 | 96.0 | 95.4 | 94.5 | 93.3 | 91.9 | 90.4 | 88.7 | 86.9 | 85.1 | 83.3 | 81.5 | 79.7 | 77.8 | 76.1 | 74.4 | 72.7 | 71.1 | 69.5 |
| 35          | 92.3 | 94.2 | 94.5 | 94.2 | 93.4 | 92.4 | 91.1 | 89.7 | 88.2 | 86.5 | 84.8 | 83.0 | 81.2 | 79.5 | 77.7 | 76.0 | 74.3 | 72.6 | 71.1 | 69.5 |
| 40          | 89.3 | 92.0 | 92.8 | 92.8 | 92.2 | 91.3 | 90.2 | 88.9 | 87.5 | 85.9 | 84.3 | 82.6 | 80.9 | 79.2 | 77.5 | 75.8 | 74.2 | 72.6 | 71.0 | 69.5 |
| 45          | 86.5 | 89.8 | 90.9 | 91.2 | 90.9 | 90.1 | 89.2 | 88.0 | 86.7 | 85.3 | 83.8 | 82.2 | 80.6 | 78.9 | 77.3 | 75.7 | 74.1 | 72.5 | 71.0 | 69.5 |
| 50          | 83.8 | 87.5 | 88.9 | 89.5 | 89.3 | 88.8 | 88.0 | 87.0 | 85.8 | 84.5 | 83.1 | 81.7 | 80.2 | 78.6 | 77.0 | 75.5 | 73.9 | 72.4 | 71.0 | 69.5 |
| 55          | 81.2 | 85.1 | 86.8 | 87.5 | 87.5 | 87.2 | 86.6 | 85.8 | 84.8 | 83.7 | 82.4 | 81.1 | 79.7 | 78.2 | 76.7 | 75.3 | 73.8 | 72.3 | 70.9 | 69.5 |
| 60          | 78.6 | 82.7 | 84.6 | 85.4 | 85.6 | 85.5 | 85.1 | 84.5 | 83.7 | 82.7 | 81.6 | 80.4 | 79.1 | 77.8 | 76.4 | 75.0 | 73.6 | 72.2 | 70.9 | 69.5 |
| 65          | 76.4 | 80.3 | 82.2 | 83.1 | 83.6 | 83.7 | 83.5 | 83.1 | 82.4 | 81.6 | 80.7 | 79.6 | 78.5 | 77.2 | 76.0 | 74.7 | 73.4 | 72.1 | 70.8 | 69.5 |
| 70          | 74.3 | 77.7 | 79.7 | 80.8 | 81.5 | 81.7 | 81.7 | 81.4 | 80.9 | 80.3 | 79.5 | 78.7 | 77.7 | 76.6 | 75.4 | 74.3 | 73.1 | 71.9 | 70.7 | 69.5 |
| 75          | 72.4 | 75.4 | 77.3 | 78.5 | 79.2 | 79.6 | 79.7 | 79.6 | 79.3 | 78.8 | 78.2 | 77.5 | 76.7 | 75.8 | 74.8 | 73.8 | 72.7 | 71.7 | 70.6 | 69.5 |
| 80          | 70.8 | 73.3 | 75.1 | 76.2 | 76.9 | 77.4 | 77.6 | 77.6 | 77.4 | 77.1 | 76.7 | 76.2 | 75.5 | 74.8 | 74.0 | 73.2 | 72.3 | 71.4 | 70.5 | 69.5 |
| 85          | 69.8 | 71.6 | 72.9 | 73.9 | 74.6 | 75.0 | 75.3 | 75.4 | 75.4 | 75.2 | 75.0 | 74.6 | 74.1 | 73.6 | 73.0 | 72.4 | 71.7 | 71.0 | 70.3 | 69.5 |
| 90          | 69.2 | 70.3 | 71.1 | 71.8 | 72.3 | 72.6 | 72.9 | 73.0 | 73.1 | 73.1 | 72.9 | 72.7 | 72.5 | 72.2 | 71.8 | 71.4 | 71.0 | 70.5 | 70.0 | 69.5 |
| 95          | 68.9 | 69.3 | 69.7 | 70.0 | 70.2 | 70.4 | 70.5 | 70.6 | 70.7 | 70.7 | 70.7 | 70.7 | 70.6 | 70.5 | 70.4 | 70.3 | 70.1 | 69.9 | 69.7 | 69.5 |
| 98          | 69.4 | 69.5 | 69.6 | 69.6 | 69.7 | 69.7 | 69.8 | 69.8 | 69.8 | 69.8 | 69.8 | 69.8 | 69.8 | 69.8 | 69.7 | 69.7 | 69.7 | 69.6 | 69.6 | 69.5 |

**Mean Annual Mass Removal Efficiencies for 1.50-inches of Retention for Zone 5 by Percent DCIA**

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 96.3 | 97.1 | 97.0 | 96.5 | 95.9 | 95.0 | 93.9 | 92.8 | 91.5 | 90.2 | 88.7 | 87.2 | 85.7 | 84.1 | 82.6 | 81.1 | 79.5 | 78.0 | 76.5 | 75.1 |
| 35          | 93.9 | 95.4 | 95.6 | 95.4 | 95.0 | 94.2 | 93.2 | 92.2 | 91.0 | 89.7 | 88.3 | 86.9 | 85.4 | 83.9 | 82.4 | 81.0 | 79.5 | 78.0 | 76.5 | 75.1 |
| 40          | 91.3 | 93.5 | 94.1 | 94.2 | 93.9 | 93.3 | 92.4 | 91.5 | 90.4 | 89.2 | 87.9 | 86.5 | 85.1 | 83.7 | 82.3 | 80.8 | 79.4 | 77.9 | 76.5 | 75.1 |
| 45          | 88.8 | 91.5 | 92.5 | 92.8 | 92.7 | 92.2 | 91.5 | 90.6 | 89.6 | 88.6 | 87.4 | 86.1 | 84.8 | 83.4 | 82.0 | 80.6 | 79.2 | 77.8 | 76.4 | 75.1 |
| 50          | 86.4 | 89.6 | 90.8 | 91.3 | 91.4 | 91.0 | 90.4 | 89.7 | 88.8 | 87.9 | 86.8 | 85.6 | 84.4 | 83.1 | 81.8 | 80.4 | 79.1 | 77.7 | 76.4 | 75.1 |
| 55          | 84.2 | 87.5 | 89.0 | 89.7 | 89.8 | 89.6 | 89.2 | 88.6 | 87.9 | 87.1 | 86.1 | 85.0 | 83.9 | 82.7 | 81.5 | 80.2 | 78.9 | 77.6 | 76.3 | 75.1 |
| 60          | 81.9 | 85.4 | 87.1 | 87.9 | 88.2 | 88.1 | 87.9 | 87.4 | 86.9 | 86.2 | 85.3 | 84.4 | 83.3 | 82.2 | 81.1 | 79.9 | 78.7 | 77.5 | 76.3 | 75.1 |
| 65          | 80.0 | 83.4 | 85.1 | 86.0 | 86.4 | 86.5 | 86.4 | 86.1 | 85.7 | 85.1 | 84.4 | 83.6 | 82.7 | 81.7 | 80.7 | 79.6 | 78.5 | 77.4 | 76.2 | 75.1 |
| 70          | 78.3 | 81.3 | 83.0 | 84.0 | 84.5 | 84.8 | 84.8 | 84.7 | 84.4 | 83.9 | 83.4 | 82.7 | 81.9 | 81.1 | 80.2 | 79.3 | 78.2 | 77.2 | 76.1 | 75.1 |
| 75          | 76.6 | 79.3 | 80.9 | 81.9 | 82.6 | 83.0 | 83.1 | 83.1 | 82.9 | 82.6 | 82.2 | 81.6 | 81.0 | 80.4 | 79.6 | 78.8 | 77.9 | 77.0 | 76.0 | 75.1 |
| 80          | 75.3 | 77.4 | 78.9 | 79.9 | 80.6 | 81.1 | 81.3 | 81.4 | 81.3 | 81.1 | 80.8 | 80.4 | 80.0 | 79.5 | 78.9 | 78.2 | 77.5 | 76.7 | 75.9 | 75.1 |
| 85          | 74.4 | 76.0 | 77.2 | 78.0 | 78.7 | 79.1 | 79.4 | 79.5 | 79.5 | 79.5 | 79.3 | 79.1 | 78.8 | 78.4 | 78.0 | 77.5 | 76.9 | 76.3 | 75.7 | 75.1 |
| 90          | 73.9 | 74.9 | 75.7 | 76.3 | 76.8 | 77.1 | 77.4 | 77.6 | 77.7 | 77.7 | 77.7 | 77.6 | 77.4 | 77.2 | 76.9 | 76.6 | 76.3 | 75.9 | 75.5 | 75.1 |
| 95          | 74.0 | 74.4 | 74.7 | 75.0 | 75.2 | 75.4 | 75.6 | 75.7 | 75.8 | 75.9 | 75.9 | 75.9 | 75.9 | 75.8 | 75.7 | 75.6 | 75.5 | 75.4 | 75.2 | 75.1 |
| 98          | 74.8 | 74.9 | 75.0 | 75.0 | 75.1 | 75.1 | 75.1 | 75.2 | 75.2 | 75.2 | 75.2 | 75.2 | 75.2 | 75.2 | 75.2 | 75.2 | 75.2 | 75.1 | 75.1 | 75.1 |

### Mean Annual Mass Removal Efficiencies for 1.75-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 97.2 | 97.7 | 97.7 | 97.4 | 96.8 | 96.2 | 95.4 | 94.4 | 93.5 | 92.4 | 91.2 | 90.0 | 88.7 | 87.4 | 86.1 | 84.8 | 83.4 | 82.1 | 80.8 | 79.4 |
| 35          | 95.1 | 96.3 | 96.6 | 96.4 | 96.0 | 95.5 | 94.7 | 93.9 | 93.0 | 91.9 | 90.8 | 89.7 | 88.5 | 87.2 | 85.9 | 84.6 | 83.3 | 82.0 | 80.7 | 79.4 |
| 40          | 92.9 | 94.7 | 95.2 | 95.2 | 95.0 | 94.6 | 94.0 | 93.2 | 92.4 | 91.4 | 90.4 | 89.3 | 88.2 | 87.0 | 85.7 | 84.5 | 83.2 | 82.0 | 80.7 | 79.4 |
| 45          | 90.7 | 93.0 | 93.7 | 94.0 | 94.0 | 93.7 | 93.2 | 92.5 | 91.7 | 90.9 | 89.9 | 88.9 | 87.8 | 86.7 | 85.5 | 84.3 | 83.1 | 81.9 | 80.7 | 79.4 |
| 50          | 88.5 | 91.2 | 92.2 | 92.7 | 92.8 | 92.6 | 92.2 | 91.7 | 91.0 | 90.2 | 89.4 | 88.4 | 87.4 | 86.4 | 85.3 | 84.1 | 83.0 | 81.8 | 80.6 | 79.4 |
| 55          | 86.5 | 89.4 | 90.7 | 91.3 | 91.5 | 91.5 | 91.2 | 90.7 | 90.2 | 89.5 | 88.7 | 87.9 | 87.0 | 86.0 | 85.0 | 83.9 | 82.8 | 81.7 | 80.6 | 79.4 |
| 60          | 84.6 | 87.5 | 89.0 | 89.8 | 90.2 | 90.2 | 90.0 | 89.6 | 89.2 | 88.6 | 88.0 | 87.3 | 86.4 | 85.6 | 84.6 | 83.6 | 82.6 | 81.6 | 80.5 | 79.4 |
| 65          | 82.9 | 85.8 | 87.4 | 88.3 | 88.6 | 88.7 | 88.7 | 88.5 | 88.1 | 87.7 | 87.2 | 86.6 | 85.8 | 85.1 | 84.2 | 83.3 | 82.4 | 81.4 | 80.5 | 79.4 |
| 70          | 81.4 | 84.1 | 85.6 | 86.5 | 87.0 | 87.2 | 87.2 | 87.2 | 87.0 | 86.6 | 86.2 | 85.7 | 85.1 | 84.5 | 83.7 | 83.0 | 82.1 | 81.3 | 80.4 | 79.4 |
| 75          | 80.2 | 82.4 | 83.8 | 84.7 | 85.2 | 85.6 | 85.8 | 85.8 | 85.7 | 85.5 | 85.2 | 84.8 | 84.3 | 83.8 | 83.2 | 82.5 | 81.8 | 81.1 | 80.3 | 79.4 |
| 80          | 78.9 | 80.8 | 82.0 | 82.9 | 83.5 | 84.0 | 84.2 | 84.3 | 84.3 | 84.2 | 84.0 | 83.7 | 83.4 | 83.0 | 82.5 | 82.0 | 81.4 | 80.8 | 80.1 | 79.4 |
| 85          | 78.1 | 79.5 | 80.5 | 81.3 | 81.9 | 82.3 | 82.6 | 82.8 | 82.8 | 82.8 | 82.7 | 82.5 | 82.3 | 82.1 | 81.7 | 81.4 | 81.0 | 80.5 | 80.0 | 79.4 |
| 90          | 77.8 | 78.6 | 79.3 | 79.9 | 80.4 | 80.7 | 80.9 | 81.1 | 81.2 | 81.3 | 81.3 | 81.2 | 81.1 | 81.0 | 80.9 | 80.6 | 80.4 | 80.1 | 79.8 | 79.4 |
| 95          | 78.0 | 78.4 | 78.7 | 78.9 | 79.1 | 79.3 | 79.5 | 79.6 | 79.7 | 79.8 | 79.9 | 79.9 | 79.9 | 79.9 | 79.9 | 79.8 | 79.8 | 79.7 | 79.6 | 79.4 |
| 98          | 79.0 | 79.0 | 79.1 | 79.2 | 79.2 | 79.3 | 79.3 | 79.4 | 79.4 | 79.4 | 79.5 | 79.5 | 79.5 | 79.5 | 79.5 | 79.5 | 79.5 | 79.5 | 79.5 | 79.4 |

### Mean Annual Mass Removal Efficiencies for 2.00-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 97.8 | 98.3 | 98.3 | 98.0 | 97.5 | 97.0 | 96.4 | 95.6 | 94.8 | 93.9 | 93.0 | 92.0 | 91.0 | 89.9 | 88.7 | 87.6 | 86.4 | 85.2 | 84.0 | 82.9 |
| 35          | 96.2 | 97.1 | 97.3 | 97.1 | 96.8 | 96.3 | 95.8 | 95.1 | 94.4 | 93.6 | 92.7 | 91.7 | 90.7 | 89.7 | 88.6 | 87.4 | 86.3 | 85.2 | 84.0 | 82.9 |
| 40          | 94.3 | 95.7 | 96.1 | 96.1 | 95.9 | 95.6 | 95.2 | 94.5 | 93.8 | 93.1 | 92.3 | 91.4 | 90.4 | 89.4 | 88.4 | 87.3 | 86.2 | 85.1 | 84.0 | 82.9 |
| 45          | 92.3 | 94.2 | 94.8 | 95.0 | 94.9 | 94.8 | 94.4 | 93.9 | 93.3 | 92.6 | 91.8 | 91.0 | 90.1 | 89.2 | 88.2 | 87.1 | 86.1 | 85.0 | 83.9 | 82.9 |
| 50          | 90.3 | 92.5 | 93.4 | 93.8 | 93.9 | 93.8 | 93.6 | 93.1 | 92.6 | 92.0 | 91.3 | 90.5 | 89.7 | 88.8 | 87.9 | 87.0 | 86.0 | 84.9 | 83.9 | 82.9 |
| 55          | 88.4 | 90.9 | 92.0 | 92.6 | 92.8 | 92.8 | 92.6 | 92.3 | 91.8 | 91.3 | 90.7 | 90.0 | 89.3 | 88.5 | 87.6 | 86.7 | 85.8 | 84.8 | 83.9 | 82.9 |
| 60          | 86.8 | 89.3 | 90.6 | 91.3 | 91.6 | 91.7 | 91.6 | 91.3 | 91.0 | 90.6 | 90.0 | 89.4 | 88.8 | 88.1 | 87.3 | 86.5 | 85.6 | 84.7 | 83.8 | 82.9 |
| 65          | 85.3 | 87.7 | 89.1 | 90.0 | 90.4 | 90.5 | 90.5 | 90.3 | 90.0 | 89.7 | 89.3 | 88.8 | 88.2 | 87.6 | 86.9 | 86.2 | 85.4 | 84.6 | 83.7 | 82.9 |
| 70          | 83.9 | 86.3 | 87.7 | 88.5 | 88.9 | 89.2 | 89.2 | 89.1 | 89.0 | 88.8 | 88.4 | 88.0 | 87.6 | 87.1 | 86.5 | 85.8 | 85.1 | 84.4 | 83.7 | 82.9 |
| 75          | 82.9 | 84.9 | 86.2 | 87.0 | 87.4 | 87.7 | 87.9 | 87.9 | 87.9 | 87.7 | 87.5 | 87.2 | 86.9 | 86.4 | 86.0 | 85.4 | 84.8 | 84.2 | 83.6 | 82.9 |
| 80          | 81.9 | 83.5 | 84.6 | 85.4 | 85.9 | 86.3 | 86.5 | 86.7 | 86.7 | 86.6 | 86.5 | 86.3 | 86.1 | 85.7 | 85.4 | 84.9 | 84.5 | 84.0 | 83.4 | 82.9 |
| 85          | 81.1 | 82.3 | 83.3 | 84.0 | 84.5 | 84.9 | 85.1 | 85.3 | 85.4 | 85.4 | 85.4 | 85.3 | 85.1 | 84.9 | 84.7 | 84.4 | 84.1 | 83.7 | 83.3 | 82.9 |
| 90          | 80.9 | 81.7 | 82.3 | 82.8 | 83.2 | 83.5 | 83.8 | 84.0 | 84.1 | 84.2 | 84.2 | 84.2 | 84.1 | 84.0 | 83.9 | 83.8 | 83.6 | 83.4 | 83.1 | 82.9 |
| 95          | 81.3 | 81.6 | 81.9 | 82.1 | 82.3 | 82.5 | 82.6 | 82.8 | 82.9 | 83.0 | 83.0 | 83.1 | 83.1 | 83.1 | 83.1 | 83.1 | 83.1 | 83.0 | 82.9 | 82.9 |
| 98          | 82.3 | 82.3 | 82.4 | 82.5 | 82.5 | 82.6 | 82.6 | 82.7 | 82.7 | 82.7 | 82.8 | 82.8 | 82.8 | 82.8 | 82.9 | 82.9 | 82.9 | 82.9 | 82.9 | 82.9 |

### Mean Annual Mass Removal Efficiencies for 2.25-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 98.2 | 98.7 | 98.6 | 98.5 | 98.1 | 97.6 | 97.1 | 96.5 | 95.9 | 95.1 | 94.3 | 93.5 | 92.6 | 91.7 | 90.7 | 89.7 | 88.7 | 87.7 | 86.6 | 85.6 |
| 35          | 97.0 | 97.7 | 97.8 | 97.7 | 97.5 | 97.0 | 96.6 | 96.1 | 95.4 | 94.7 | 94.0 | 93.2 | 92.4 | 91.5 | 90.6 | 89.6 | 88.6 | 87.6 | 86.6 | 85.6 |
| 40          | 95.3 | 96.5 | 96.9 | 96.8 | 96.6 | 96.3 | 96.0 | 95.5 | 95.0 | 94.3 | 93.6 | 92.9 | 92.1 | 91.3 | 90.4 | 89.5 | 88.5 | 87.6 | 86.6 | 85.6 |
| 45          | 93.6 | 95.2 | 95.7 | 95.8 | 95.7 | 95.6 | 95.3 | 94.9 | 94.4 | 93.9 | 93.2 | 92.6 | 91.8 | 91.0 | 90.2 | 89.3 | 88.4 | 87.5 | 86.5 | 85.6 |
| 50          | 91.9 | 93.7 | 94.5 | 94.7 | 94.8 | 94.8 | 94.6 | 94.3 | 93.8 | 93.3 | 92.8 | 92.1 | 91.5 | 90.7 | 90.0 | 89.1 | 88.3 | 87.4 | 86.5 | 85.6 |
| 55          | 90.1 | 92.2 | 93.2 | 93.6 | 93.8 | 93.9 | 93.8 | 93.5 | 93.2 | 92.7 | 92.2 | 91.7 | 91.1 | 90.4 | 89.7 | 88.9 | 88.1 | 87.3 | 86.5 | 85.6 |
| 60          | 88.6 | 90.8 | 91.9 | 92.5 | 92.8 | 92.9 | 92.9 | 92.7 | 92.4 | 92.0 | 91.6 | 91.1 | 90.6 | 90.0 | 89.4 | 88.7 | 88.0 | 87.2 | 86.4 | 85.6 |
| 65          | 87.2 | 89.4 | 90.6 | 91.3 | 91.7 | 91.9 | 91.9 | 91.8 | 91.6 | 91.3 | 90.9 | 90.6 | 90.1 | 89.6 | 89.0 | 88.4 | 87.8 | 87.1 | 86.3 | 85.6 |
| 70          | 86.0 | 88.1 | 89.3 | 90.1 | 90.6 | 90.8 | 90.8 | 90.8 | 90.6 | 90.4 | 90.2 | 89.9 | 89.5 | 89.1 | 88.6 | 88.1 | 87.5 | 86.9 | 86.3 | 85.6 |
| 75          | 85.1 | 87.0 | 88.1 | 88.8 | 89.3 | 89.5 | 89.6 | 89.7 | 89.6 | 89.6 | 89.4 | 89.1 | 88.9 | 88.5 | 88.2 | 87.7 | 87.2 | 86.7 | 86.2 | 85.6 |
| 80          | 84.5 | 85.8 | 86.8 | 87.5 | 87.9 | 88.2 | 88.4 | 88.6 | 88.6 | 88.6 | 88.5 | 88.3 | 88.1 | 87.9 | 87.6 | 87.3 | 86.9 | 86.5 | 86.1 | 85.6 |
| 85          | 83.8 | 84.8 | 85.6 | 86.1 | 86.6 | 87.0 | 87.2 | 87.4 | 87.5 | 87.5 | 87.5 | 87.5 | 87.4 | 87.2 | 87.0 | 86.8 | 86.5 | 86.3 | 85.9 | 85.6 |
| 90          | 83.5 | 84.2 | 84.7 | 85.2 | 85.6 | 85.8 | 86.1 | 86.2 | 86.4 | 86.5 | 86.5 | 86.5 | 86.5 | 86.5 | 86.4 | 86.3 | 86.1 | 86.0 | 85.8 | 85.6 |
| 95          | 83.9 | 84.2 | 84.5 | 84.7 | 84.9 | 85.1 | 85.2 | 85.3 | 85.4 | 85.5 | 85.6 | 85.6 | 85.7 | 85.7 | 85.7 | 85.7 | 85.7 | 85.7 | 85.6 | 85.6 |
| 98          | 84.9 | 85.0 | 85.1 | 85.1 | 85.2 | 85.2 | 85.3 | 85.3 | 85.4 | 85.4 | 85.4 | 85.5 | 85.5 | 85.5 | 85.5 | 85.5 | 85.6 | 85.6 | 85.6 | 85.6 |

### Mean Annual Mass Removal Efficiencies for 2.50-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 98.6 | 98.9 | 98.9 | 98.8 | 98.6 | 98.2 | 97.7 | 97.2 | 96.7 | 96.0 | 95.3 | 94.6 | 93.9 | 93.1 | 92.3 | 91.4 | 90.6 | 89.6 | 88.7 | 87.8 |
| 35          | 97.6 | 98.1 | 98.3 | 98.2 | 98.0 | 97.6 | 97.2 | 96.8 | 96.3 | 95.7 | 95.0 | 94.4 | 93.7 | 92.9 | 92.1 | 91.3 | 90.5 | 89.6 | 88.7 | 87.8 |
| 40          | 96.2 | 97.1 | 97.4 | 97.4 | 97.3 | 97.0 | 96.7 | 96.3 | 95.9 | 95.3 | 94.7 | 94.1 | 93.4 | 92.7 | 92.0 | 91.2 | 90.4 | 89.5 | 88.7 | 87.8 |
| 45          | 94.7 | 96.0 | 96.5 | 96.5 | 96.5 | 96.3 | 96.0 | 95.8 | 95.4 | 94.9 | 94.3 | 93.8 | 93.2 | 92.5 | 91.8 | 91.0 | 90.3 | 89.5 | 88.6 | 87.8 |
| 50          | 93.2 | 94.8 | 95.3 | 95.6 | 95.6 | 95.5 | 95.4 | 95.2 | 94.8 | 94.4 | 93.9 | 93.4 | 92.8 | 92.2 | 91.6 | 90.9 | 90.1 | 89.4 | 88.6 | 87.8 |
| 55          | 91.6 | 93.4 | 94.2 | 94.5 | 94.7 | 94.7 | 94.7 | 94.5 | 94.2 | 93.9 | 93.4 | 93.0 | 92.5 | 91.9 | 91.3 | 90.7 | 90.0 | 89.3 | 88.5 | 87.8 |
| 60          | 90.1 | 92.0 | 93.0 | 93.5 | 93.8 | 93.9 | 93.9 | 93.8 | 93.5 | 93.2 | 92.9 | 92.5 | 92.0 | 91.6 | 91.0 | 90.4 | 89.8 | 89.2 | 88.5 | 87.8 |
| 65          | 88.9 | 90.8 | 91.8 | 92.4 | 92.8 | 93.0 | 93.1 | 93.0 | 92.8 | 92.6 | 92.3 | 92.0 | 91.6 | 91.2 | 90.7 | 90.2 | 89.6 | 89.1 | 88.4 | 87.8 |
| 70          | 87.8 | 89.6 | 90.7 | 91.4 | 91.8 | 92.1 | 92.1 | 92.1 | 92.0 | 91.8 | 91.6 | 91.4 | 91.1 | 90.7 | 90.3 | 89.9 | 89.4 | 88.9 | 88.4 | 87.8 |
| 75          | 86.9 | 88.6 | 89.6 | 90.3 | 90.8 | 91.0 | 91.1 | 91.1 | 91.1 | 91.0 | 90.9 | 90.7 | 90.5 | 90.2 | 89.9 | 89.5 | 89.2 | 88.7 | 88.3 | 87.8 |
| 80          | 86.4 | 87.7 | 88.6 | 89.2 | 89.6 | 89.9 | 90.0 | 90.1 | 90.2 | 90.2 | 90.1 | 90.0 | 89.8 | 89.7 | 89.4 | 89.2 | 88.9 | 88.5 | 88.2 | 87.8 |
| 85          | 85.9 | 86.9 | 87.5 | 88.0 | 88.4 | 88.7 | 88.9 | 89.1 | 89.2 | 89.3 | 89.3 | 89.2 | 89.2 | 89.1 | 88.9 | 88.8 | 88.6 | 88.3 | 88.1 | 87.8 |
| 90          | 85.6 | 86.2 | 86.7 | 87.1 | 87.5 | 87.8 | 88.0 | 88.1 | 88.3 | 88.4 | 88.4 | 88.4 | 88.4 | 88.4 | 88.4 | 88.3 | 88.2 | 88.1 | 87.9 | 87.8 |
| 95          | 86.1 | 86.4 | 86.6 | 86.8 | 87.0 | 87.1 | 87.3 | 87.4 | 87.5 | 87.6 | 87.7 | 87.7 | 87.8 | 87.8 | 87.8 | 87.8 | 87.8 | 87.8 | 87.8 | 87.8 |
| 98          | 87.1 | 87.2 | 87.2 | 87.3 | 87.3 | 87.4 | 87.4 | 87.5 | 87.5 | 87.6 | 87.6 | 87.6 | 87.7 | 87.7 | 87.7 | 87.7 | 87.7 | 87.8 | 87.8 | 87.8 |

### Mean Annual Mass Removal Efficiencies for 2.75-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 98.9 | 99.1 | 99.1 | 99.1 | 98.9 | 98.6 | 98.2 | 97.8 | 97.3 | 96.7 | 96.2 | 95.5 | 94.9 | 94.2 | 93.5 | 92.8 | 92.0 | 91.2 | 90.4 | 89.6 |
| 35          | 98.1 | 98.5 | 98.6 | 98.6 | 98.4 | 98.1 | 97.7 | 97.4 | 96.9 | 96.4 | 95.9 | 95.3 | 94.7 | 94.1 | 93.4 | 92.7 | 91.9 | 91.2 | 90.4 | 89.6 |
| 40          | 97.0 | 97.7 | 97.9 | 97.9 | 97.8 | 97.5 | 97.2 | 96.9 | 96.5 | 96.1 | 95.6 | 95.0 | 94.5 | 93.9 | 93.2 | 92.5 | 91.8 | 91.1 | 90.3 | 89.6 |
| 45          | 95.6 | 96.7 | 97.1 | 97.1 | 97.1 | 96.9 | 96.6 | 96.4 | 96.1 | 95.7 | 95.2 | 94.7 | 94.2 | 93.6 | 93.0 | 92.4 | 91.7 | 91.0 | 90.3 | 89.6 |
| 50          | 94.3 | 95.6 | 96.1 | 96.3 | 96.3 | 96.2 | 96.0 | 95.8 | 95.6 | 95.3 | 94.9 | 94.4 | 93.9 | 93.4 | 92.8 | 92.2 | 91.6 | 91.0 | 90.3 | 89.6 |
| 55          | 92.9 | 94.4 | 95.0 | 95.3 | 95.4 | 95.4 | 95.4 | 95.3 | 95.1 | 94.8 | 94.4 | 94.0 | 93.6 | 93.1 | 92.6 | 92.1 | 91.5 | 90.9 | 90.2 | 89.6 |
| 60          | 91.6 | 93.2 | 93.9 | 94.3 | 94.6 | 94.7 | 94.7 | 94.6 | 94.5 | 94.2 | 93.9 | 93.6 | 93.2 | 92.8 | 92.3 | 91.8 | 91.3 | 90.8 | 90.2 | 89.6 |
| 65          | 90.3 | 92.0 | 92.8 | 93.4 | 93.7 | 93.9 | 94.0 | 93.9 | 93.8 | 93.6 | 93.4 | 93.1 | 92.8 | 92.4 | 92.0 | 91.6 | 91.1 | 90.6 | 90.1 | 89.6 |
| 70          | 89.3 | 90.9 | 91.8 | 92.4 | 92.8 | 93.1 | 93.2 | 93.2 | 93.1 | 93.0 | 92.8 | 92.6 | 92.3 | 92.0 | 91.7 | 91.3 | 90.9 | 90.5 | 90.1 | 89.6 |
| 75          | 88.5 | 89.9 | 90.9 | 91.5 | 91.9 | 92.2 | 92.3 | 92.4 | 92.3 | 92.2 | 92.1 | 92.0 | 91.8 | 91.6 | 91.3 | 91.0 | 90.7 | 90.4 | 90.0 | 89.6 |
| 80          | 88.1 | 89.2 | 90.0 | 90.6 | 91.0 | 91.2 | 91.4 | 91.5 | 91.5 | 91.5 | 91.4 | 91.4 | 91.3 | 91.1 | 90.9 | 90.7 | 90.5 | 90.2 | 89.9 | 89.6 |
| 85          | 87.8 | 88.6 | 89.2 | 89.6 | 90.0 | 90.2 | 90.4 | 90.5 | 90.6 | 90.7 | 90.7 | 90.7 | 90.7 | 90.6 | 90.5 | 90.3 | 90.2 | 90.0 | 89.8 | 89.6 |
| 90          | 87.5 | 88.0 | 88.4 | 88.8 | 89.1 | 89.3 | 89.5 | 89.7 | 89.8 | 89.9 | 90.0 | 90.0 | 90.0 | 90.0 | 90.0 | 89.9 | 89.9 | 89.8 | 89.7 | 89.6 |
| 95          | 87.9 | 88.2 | 88.4 | 88.6 | 88.7 | 88.9 | 89.0 | 89.1 | 89.2 | 89.3 | 89.4 | 89.4 | 89.5 | 89.5 | 89.5 | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 |
| 98          | 88.9 | 88.9 | 89.0 | 89.0 | 89.1 | 89.1 | 89.2 | 89.2 | 89.3 | 89.3 | 89.4 | 89.4 | 89.4 | 89.5 | 89.5 | 89.5 | 89.5 | 89.5 | 89.6 | 89.6 |

### Mean Annual Mass Removal Efficiencies for 3.00-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.1 | 99.3 | 99.3 | 99.2 | 99.1 | 98.9 | 98.6 | 98.2 | 97.8 | 97.3 | 96.8 | 96.3 | 95.7 | 95.1 | 94.5 | 93.8 | 93.2 | 92.5 | 91.8 | 91.0 |
| 35          | 98.4 | 98.8 | 98.9 | 98.8 | 98.7 | 98.5 | 98.2 | 97.8 | 97.5 | 97.0 | 96.6 | 96.1 | 95.5 | 94.9 | 94.4 | 93.7 | 93.1 | 92.4 | 91.7 | 91.0 |
| 40          | 97.5 | 98.1 | 98.3 | 98.3 | 98.2 | 98.0 | 97.7 | 97.4 | 97.1 | 96.7 | 96.3 | 95.8 | 95.3 | 94.8 | 94.2 | 93.6 | 93.0 | 92.4 | 91.7 | 91.0 |
| 45          | 96.4 | 97.3 | 97.6 | 97.6 | 97.6 | 97.4 | 97.2 | 96.9 | 96.7 | 96.4 | 96.0 | 95.5 | 95.1 | 94.6 | 94.0 | 93.5 | 92.9 | 92.3 | 91.7 | 91.0 |
| 50          | 95.2 | 96.3 | 96.7 | 96.9 | 96.9 | 96.8 | 96.6 | 96.4 | 96.2 | 96.0 | 95.6 | 95.2 | 94.8 | 94.3 | 93.9 | 93.4 | 92.8 | 92.2 | 91.6 | 91.0 |
| 55          | 94.0 | 95.3 | 95.8 | 96.0 | 96.1 | 96.1 | 96.0 | 95.9 | 95.7 | 95.5 | 95.2 | 94.9 | 94.5 | 94.1 | 93.6 | 93.2 | 92.7 | 92.2 | 91.6 | 91.0 |
| 60          | 92.8 | 94.1 | 94.8 | 95.1 | 95.3 | 95.4 | 95.4 | 95.3 | 95.2 | 95.0 | 94.8 | 94.5 | 94.1 | 93.8 | 93.4 | 93.0 | 92.5 | 92.1 | 91.6 | 91.0 |
| 65          | 91.7 | 93.0 | 93.8 | 94.2 | 94.5 | 94.6 | 94.7 | 94.7 | 94.6 | 94.5 | 94.3 | 94.0 | 93.8 | 93.5 | 93.1 | 92.8 | 92.4 | 91.9 | 91.5 | 91.0 |
| 70          | 90.7 | 92.0 | 92.8 | 93.3 | 93.7 | 93.9 | 94.0 | 94.1 | 94.0 | 93.9 | 93.8 | 93.6 | 93.3 | 93.1 | 92.8 | 92.5 | 92.2 | 91.8 | 91.4 | 91.0 |
| 75          | 89.9 | 91.1 | 91.9 | 92.5 | 92.9 | 93.2 | 93.3 | 93.3 | 93.3 | 93.3 | 93.2 | 93.0 | 92.9 | 92.7 | 92.5 | 92.3 | 92.0 | 91.7 | 91.4 | 91.0 |
| 80          | 89.4 | 90.5 | 91.2 | 91.7 | 92.1 | 92.3 | 92.5 | 92.6 | 92.6 | 92.6 | 92.5 | 92.5 | 92.4 | 92.3 | 92.1 | 92.0 | 91.8 | 91.5 | 91.3 | 91.0 |
| 85          | 89.3 | 90.0 | 90.5 | 90.9 | 91.3 | 91.5 | 91.6 | 91.8 | 91.8 | 91.9 | 91.9 | 91.9 | 91.9 | 91.8 | 91.7 | 91.6 | 91.5 | 91.4 | 91.2 | 91.0 |
| 90          | 89.1 | 89.6 | 89.9 | 90.2 | 90.5 | 90.7 | 90.9 | 91.0 | 91.1 | 91.2 | 91.3 | 91.3 | 91.3 | 91.4 | 91.3 | 91.3 | 91.3 | 91.2 | 91.1 | 91.0 |
| 95          | 89.5 | 89.7 | 89.9 | 90.0 | 90.2 | 90.3 | 90.4 | 90.5 | 90.6 | 90.7 | 90.8 | 90.8 | 90.9 | 90.9 | 91.0 | 91.0 | 91.0 | 91.0 | 91.0 | 91.0 |
| 98          | 90.3 | 90.4 | 90.5 | 90.5 | 90.6 | 90.6 | 90.6 | 90.7 | 90.7 | 90.8 | 90.8 | 90.8 | 90.9 | 90.9 | 90.9 | 90.9 | 91.0 | 91.0 | 91.0 | 91.0 |

### Mean Annual Mass Removal Efficiencies for 3.25-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.3 | 99.4 | 99.5 | 99.4 | 99.3 | 99.1 | 98.9 | 98.6 | 98.2 | 97.8 | 97.4 | 96.9 | 96.4 | 95.8 | 95.3 | 94.7 | 94.1 | 93.5 | 92.9 | 92.2 |
| 35          | 98.7 | 99.0 | 99.1 | 99.0 | 99.0 | 98.8 | 98.5 | 98.2 | 97.9 | 97.5 | 97.1 | 96.7 | 96.2 | 95.7 | 95.2 | 94.6 | 94.1 | 93.5 | 92.9 | 92.2 |
| 40          | 98.0 | 98.4 | 98.6 | 98.6 | 98.5 | 98.4 | 98.1 | 97.8 | 97.5 | 97.2 | 96.9 | 96.5 | 96.0 | 95.5 | 95.0 | 94.5 | 94.0 | 93.4 | 92.8 | 92.2 |
| 45          | 97.0 | 97.7 | 98.0 | 98.0 | 98.0 | 97.8 | 97.7 | 97.4 | 97.1 | 96.9 | 96.6 | 96.2 | 95.8 | 95.3 | 94.9 | 94.4 | 93.9 | 93.4 | 92.8 | 92.2 |
| 50          | 96.0 | 96.9 | 97.3 | 97.4 | 97.4 | 97.3 | 97.1 | 96.9 | 96.7 | 96.5 | 96.3 | 95.9 | 95.5 | 95.1 | 94.7 | 94.3 | 93.8 | 93.3 | 92.8 | 92.2 |
| 55          | 94.9 | 96.0 | 96.4 | 96.6 | 96.7 | 96.7 | 96.6 | 96.4 | 96.3 | 96.1 | 95.9 | 95.6 | 95.3 | 94.9 | 94.5 | 94.1 | 93.7 | 93.2 | 92.7 | 92.2 |
| 60          | 93.9 | 95.0 | 95.5 | 95.8 | 96.0 | 96.0 | 96.0 | 95.9 | 95.8 | 95.7 | 95.5 | 95.2 | 94.9 | 94.6 | 94.3 | 93.9 | 93.5 | 93.1 | 92.7 | 92.2 |
| 65          | 92.8 | 94.0 | 94.6 | 95.0 | 95.2 | 95.3 | 95.4 | 95.4 | 95.3 | 95.2 | 95.0 | 94.8 | 94.6 | 94.3 | 94.0 | 93.7 | 93.4 | 93.0 | 92.6 | 92.2 |
| 70          | 91.9 | 93.0 | 93.7 | 94.1 | 94.4 | 94.6 | 94.8 | 94.8 | 94.8 | 94.7 | 94.6 | 94.4 | 94.2 | 94.0 | 93.8 | 93.5 | 93.2 | 92.9 | 92.6 | 92.2 |
| 75          | 91.1 | 92.2 | 92.9 | 93.4 | 93.7 | 94.0 | 94.1 | 94.2 | 94.2 | 94.1 | 94.1 | 94.0 | 93.8 | 93.6 | 93.5 | 93.3 | 93.0 | 92.8 | 92.5 | 92.2 |
| 80          | 90.6 | 91.5 | 92.2 | 92.7 | 93.0 | 93.3 | 93.4 | 93.5 | 93.5 | 93.6 | 93.5 | 93.4 | 93.4 | 93.3 | 93.2 | 93.0 | 92.8 | 92.6 | 92.4 | 92.2 |
| 85          | 90.5 | 91.2 | 91.7 | 92.0 | 92.3 | 92.5 | 92.7 | 92.8 | 92.9 | 92.9 | 92.9 | 92.9 | 92.9 | 92.9 | 92.8 | 92.7 | 92.6 | 92.5 | 92.4 | 92.2 |
| 90          | 90.5 | 90.9 | 91.2 | 91.5 | 91.7 | 91.9 | 92.0 | 92.1 | 92.2 | 92.3 | 92.4 | 92.4 | 92.4 | 92.5 | 92.4 | 92.4 | 92.4 | 92.3 | 92.3 | 92.2 |
| 95          | 90.7 | 90.9 | 91.1 | 91.2 | 91.4 | 91.5 | 91.6 | 91.7 | 91.8 | 91.9 | 92.0 | 92.0 | 92.1 | 92.1 | 92.1 | 92.2 | 92.2 | 92.2 | 92.2 | 92.2 |
| 98          | 91.6 | 91.6 | 91.7 | 91.7 | 91.8 | 91.8 | 91.8 | 91.9 | 91.9 | 92.0 | 92.0 | 92.0 | 92.1 | 92.1 | 92.1 | 92.1 | 92.2 | 92.2 | 92.2 | 92.2 |

### Mean Annual Mass Removal Efficiencies for 3.50-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.5 | 99.6 | 99.6 | 99.5 | 99.4 | 99.3 | 99.1 | 98.9 | 98.5 | 98.2 | 97.8 | 97.4 | 96.9 | 96.5 | 96.0 | 95.4 | 94.9 | 94.4 | 93.8 | 93.2 |
| 35          | 98.9 | 99.2 | 99.2 | 99.2 | 99.1 | 99.0 | 98.8 | 98.6 | 98.3 | 97.9 | 97.6 | 97.2 | 96.8 | 96.3 | 95.8 | 95.4 | 94.9 | 94.3 | 93.8 | 93.2 |
| 40          | 98.3 | 98.7 | 98.8 | 98.8 | 98.8 | 98.7 | 98.5 | 98.2 | 97.9 | 97.6 | 97.3 | 97.0 | 96.6 | 96.2 | 95.7 | 95.3 | 94.8 | 94.3 | 93.8 | 93.2 |
| 45          | 97.5 | 98.1 | 98.3 | 98.4 | 98.3 | 98.2 | 98.0 | 97.8 | 97.6 | 97.3 | 97.1 | 96.8 | 96.4 | 96.0 | 95.6 | 95.1 | 94.7 | 94.2 | 93.7 | 93.2 |
| 50          | 96.6 | 97.4 | 97.7 | 97.8 | 97.8 | 97.7 | 97.6 | 97.4 | 97.2 | 97.0 | 96.7 | 96.5 | 96.1 | 95.8 | 95.4 | 95.0 | 94.6 | 94.2 | 93.7 | 93.2 |
| 55          | 95.7 | 96.6 | 97.0 | 97.2 | 97.2 | 97.2 | 97.1 | 96.9 | 96.8 | 96.6 | 96.4 | 96.2 | 95.9 | 95.6 | 95.2 | 94.9 | 94.5 | 94.1 | 93.7 | 93.2 |
| 60          | 94.8 | 95.8 | 96.2 | 96.4 | 96.5 | 96.5 | 96.5 | 96.4 | 96.3 | 96.2 | 96.1 | 95.9 | 95.6 | 95.3 | 95.0 | 94.7 | 94.4 | 94.0 | 93.6 | 93.2 |
| 65          | 93.8 | 94.8 | 95.4 | 95.7 | 95.8 | 95.9 | 95.9 | 95.9 | 95.9 | 95.8 | 95.7 | 95.5 | 95.3 | 95.1 | 94.8 | 94.5 | 94.2 | 93.9 | 93.6 | 93.2 |
| 70          | 93.0 | 94.0 | 94.5 | 94.9 | 95.1 | 95.3 | 95.4 | 95.4 | 95.4 | 95.4 | 95.3 | 95.1 | 95.0 | 94.8 | 94.5 | 94.3 | 94.1 | 93.8 | 93.5 | 93.2 |
| 75          | 92.2 | 93.1 | 93.7 | 94.1 | 94.4 | 94.7 | 94.8 | 94.9 | 94.9 | 94.9 | 94.8 | 94.7 | 94.6 | 94.4 | 94.3 | 94.1 | 93.9 | 93.7 | 93.5 | 93.2 |
| 80          | 91.7 | 92.5 | 93.1 | 93.5 | 93.8 | 94.1 | 94.2 | 94.3 | 94.3 | 94.3 | 94.3 | 94.3 | 94.2 | 94.1 | 94.0 | 93.9 | 93.7 | 93.6 | 93.4 | 93.2 |
| 85          | 91.5 | 92.1 | 92.6 | 93.0 | 93.2 | 93.4 | 93.6 | 93.7 | 93.7 | 93.8 | 93.8 | 93.8 | 93.8 | 93.7 | 93.7 | 93.6 | 93.6 | 93.5 | 93.3 | 93.2 |
| 90          | 91.6 | 91.9 | 92.2 | 92.5 | 92.7 | 92.9 | 93.0 | 93.1 | 93.2 | 93.2 | 93.3 | 93.3 | 93.4 | 93.4 | 93.4 | 93.4 | 93.4 | 93.3 | 93.3 | 93.2 |
| 95          | 91.9 | 92.0 | 92.2 | 92.3 | 92.4 | 92.5 | 92.6 | 92.7 | 92.8 | 92.9 | 92.9 | 93.0 | 93.1 | 93.1 | 93.1 | 93.2 | 93.2 | 93.2 | 93.2 | 93.2 |
| 98          | 92.6 | 92.6 | 92.7 | 92.7 | 92.8 | 92.8 | 92.9 | 92.9 | 92.9 | 93.0 | 93.0 | 93.0 | 93.1 | 93.1 | 93.1 | 93.1 | 93.2 | 93.2 | 93.2 | 93.2 |

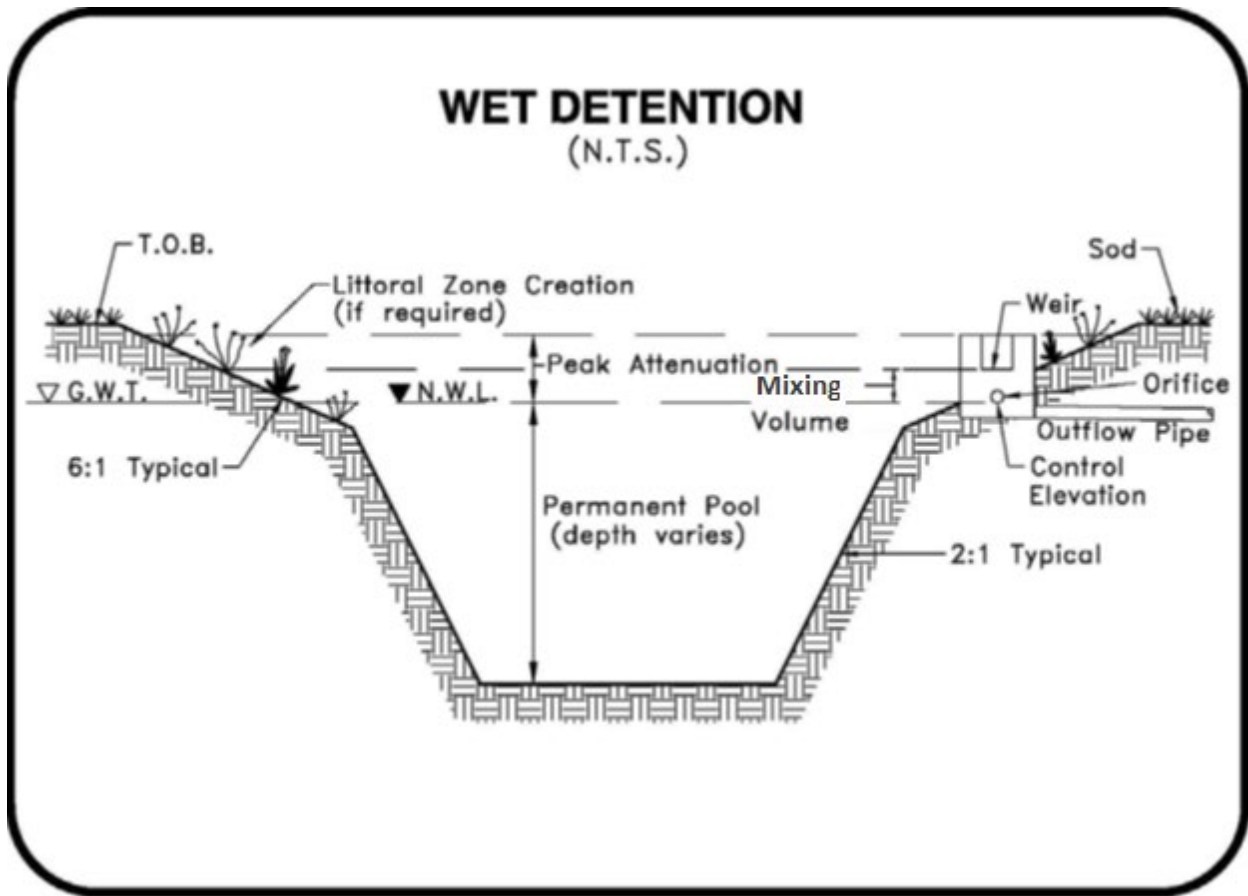
### Mean Annual Mass Removal Efficiencies for 3.75-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.7 | 99.7 | 99.7 | 99.6 | 99.5 | 99.4 | 99.3 | 99.1 | 98.8 | 98.5 | 98.2 | 97.8 | 97.4 | 97.0 | 96.5 | 96.1 | 95.6 | 95.1 | 94.6 | 94.1 |
| 35          | 99.1 | 99.3 | 99.4 | 99.3 | 99.3 | 99.2 | 99.0 | 98.8 | 98.6 | 98.3 | 98.0 | 97.6 | 97.3 | 96.9 | 96.4 | 96.0 | 95.5 | 95.1 | 94.6 | 94.1 |
| 40          | 98.6 | 98.9 | 99.0 | 99.0 | 99.0 | 98.9 | 98.7 | 98.5 | 98.3 | 98.0 | 97.7 | 97.4 | 97.1 | 96.7 | 96.3 | 95.9 | 95.4 | 95.0 | 94.5 | 94.1 |
| 45          | 97.9 | 98.4 | 98.6 | 98.6 | 98.6 | 98.5 | 98.4 | 98.2 | 98.0 | 97.7 | 97.5 | 97.2 | 96.9 | 96.5 | 96.2 | 95.8 | 95.4 | 95.0 | 94.5 | 94.1 |
| 50          | 97.1 | 97.8 | 98.1 | 98.2 | 98.2 | 98.1 | 98.0 | 97.8 | 97.6 | 97.4 | 97.2 | 96.9 | 96.7 | 96.4 | 96.0 | 95.7 | 95.3 | 94.9 | 94.5 | 94.1 |
| 55          | 96.4 | 97.1 | 97.5 | 97.6 | 97.6 | 97.6 | 97.5 | 97.4 | 97.2 | 97.0 | 96.9 | 96.7 | 96.4 | 96.2 | 95.9 | 95.5 | 95.2 | 94.8 | 94.5 | 94.1 |
| 60          | 95.5 | 96.4 | 96.8 | 96.9 | 97.0 | 97.0 | 97.0 | 96.9 | 96.8 | 96.7 | 96.6 | 96.4 | 96.2 | 95.9 | 95.7 | 95.4 | 95.1 | 94.7 | 94.4 | 94.1 |
| 65          | 94.7 | 95.5 | 96.0 | 96.3 | 96.4 | 96.5 | 96.4 | 96.4 | 96.4 | 96.3 | 96.2 | 96.1 | 95.9 | 95.7 | 95.5 | 95.2 | 94.9 | 94.7 | 94.4 | 94.1 |
| 70          | 93.9 | 94.7 | 95.3 | 95.5 | 95.7 | 95.8 | 95.9 | 95.9 | 95.9 | 95.9 | 95.9 | 95.7 | 95.6 | 95.4 | 95.2 | 95.0 | 94.8 | 94.6 | 94.3 | 94.1 |
| 75          | 93.2 | 94.0 | 94.5 | 94.8 | 95.1 | 95.2 | 95.4 | 95.5 | 95.5 | 95.5 | 95.4 | 95.4 | 95.3 | 95.1 | 95.0 | 94.8 | 94.7 | 94.5 | 94.3 | 94.1 |
| 80          | 92.6 | 93.3 | 93.8 | 94.2 | 94.5 | 94.7 | 94.9 | 95.0 | 95.0 | 95.0 | 95.0 | 95.0 | 94.9 | 94.8 | 94.7 | 94.6 | 94.5 | 94.4 | 94.2 | 94.1 |
| 85          | 92.5 | 93.0 | 93.4 | 93.8 | 94.0 | 94.2 | 94.3 | 94.4 | 94.5 | 94.5 | 94.5 | 94.6 | 94.5 | 94.5 | 94.4 | 94.4 | 94.3 | 94.3 | 94.2 | 94.1 |
| 90          | 92.6 | 92.9 | 93.1 | 93.3 | 93.5 | 93.7 | 93.8 | 93.9 | 94.0 | 94.1 | 94.1 | 94.1 | 94.2 | 94.2 | 94.2 | 94.2 | 94.2 | 94.1 | 94.1 | 94.1 |
| 95          | 92.9 | 93.0 | 93.1 | 93.2 | 93.3 | 93.4 | 93.5 | 93.6 | 93.7 | 93.7 | 93.8 | 93.8 | 93.9 | 93.9 | 94.0 | 94.0 | 94.0 | 94.0 | 94.0 | 94.1 |
| 98          | 93.5 | 93.5 | 93.6 | 93.6 | 93.6 | 93.7 | 93.7 | 93.8 | 93.8 | 93.8 | 93.9 | 93.9 | 93.9 | 93.9 | 94.0 | 94.0 | 94.0 | 94.0 | 94.0 | 94.1 |

### Mean Annual Mass Removal Efficiencies for 4.00-inches of Retention for Zone 5 by Percent DCIA

| Non DCIA CN | 5    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90   | 95   | 100  |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30          | 99.8 | 99.8 | 99.7 | 99.7 | 99.6 | 99.5 | 99.4 | 99.2 | 99.0 | 98.8 | 98.5 | 98.1 | 97.8 | 97.4 | 97.0 | 96.6 | 96.2 | 95.7 | 95.2 | 94.8 |
| 35          | 99.3 | 99.5 | 99.5 | 99.5 | 99.4 | 99.3 | 99.2 | 99.0 | 98.8 | 98.6 | 98.3 | 98.0 | 97.7 | 97.3 | 96.9 | 96.5 | 96.1 | 95.7 | 95.2 | 94.8 |
| 40          | 98.8 | 99.1 | 99.2 | 99.2 | 99.1 | 99.1 | 99.0 | 98.8 | 98.6 | 98.3 | 98.1 | 97.8 | 97.5 | 97.2 | 96.8 | 96.4 | 96.0 | 95.6 | 95.2 | 94.8 |
| 45          | 98.3 | 98.6 | 98.8 | 98.8 | 98.8 | 98.8 | 98.6 | 98.5 | 98.3 | 98.1 | 97.8 | 97.6 | 97.3 | 97.0 | 96.7 | 96.3 | 96.0 | 95.6 | 95.2 | 94.8 |
| 50          | 97.6 | 98.1 | 98.4 | 98.4 | 98.5 | 98.4 | 98.3 | 98.1 | 98.0 | 97.8 | 97.5 | 97.3 | 97.1 | 96.8 | 96.5 | 96.2 | 95.9 | 95.5 | 95.1 | 94.8 |
| 55          | 96.9 | 97.6 | 97.8 | 98.0 | 98.0 | 97.9 | 97.9 | 97.7 | 97.6 | 97.4 | 97.3 | 97.1 | 96.9 | 96.7 | 96.4 | 96.1 | 95.8 | 95.4 | 95.1 | 94.8 |
| 60          | 96.2 | 96.9 | 97.2 | 97.4 | 97.5 | 97.5 | 97.4 | 97.3 | 97.2 | 97.1 | 97.0 | 96.8 | 96.7 | 96.4 | 96.2 | 96.0 | 95.7 | 95.4 | 95.1 | 94.8 |
| 65          | 95.5 | 96.2 | 96.6 | 96.8 | 96.9 | 96.9 | 96.9 | 96.9 | 96.8 | 96.8 | 96.7 | 96.6 | 96.4 | 96.2 | 96.0 | 95.8 | 95.6 | 95.3 | 95.0 | 94.8 |
| 70          | 94.7 | 95.4 | 95.9 | 96.2 | 96.3 | 96.4 | 96.4 | 96.4 | 96.4 | 96.4 | 96.3 | 96.3 | 96.1 | 96.0 | 95.8 | 95.6 | 95.4 | 95.2 | 95.0 | 94.8 |
| 75          | 94.1 | 94.8 | 95.2 | 95.5 | 95.7 | 95.8 | 95.9 | 96.0 | 96.0 | 96.0 | 96.0 | 95.9 | 95.8 | 95.7 | 95.6 | 95.5 | 95.3 | 95.1 | 95.0 | 94.8 |
| 80          | 93.5 | 94.1 | 94.5 | 94.9 | 95.1 | 95.3 | 95.4 | 95.5 | 95.6 | 95.6 | 95.6 | 95.6 | 95.5 | 95.4 | 95.4 | 95.3 | 95.1 | 95.0 | 94.9 | 94.8 |
| 85          | 93.3 | 93.8 | 94.1 | 94.4 | 94.7 | 94.8 | 95.0 | 95.1 | 95.1 | 95.2 | 95.2 | 95.2 | 95.2 | 95.2 | 95.1 | 95.1 | 95.0 | 94.9 | 94.9 | 94.8 |
| 90          | 93.4 | 93.7 | 93.9 | 94.1 | 94.3 | 94.4 | 94.5 | 94.6 | 94.7 | 94.8 | 94.8 | 94.8 | 94.8 | 94.9 | 94.9 | 94.9 | 94.8 | 94.8 | 94.8 | 94.8 |
| 95          | 93.7 | 93.8 | 93.9 | 94.0 | 94.1 | 94.2 | 94.3 | 94.3 | 94.4 | 94.5 | 94.5 | 94.6 | 94.6 | 94.6 | 94.7 | 94.7 | 94.7 | 94.7 | 94.8 | 94.8 |
| 98          | 94.2 | 94.3 | 94.3 | 94.3 | 94.4 | 94.4 | 94.4 | 94.5 | 94.5 | 94.5 | 94.6 | 94.6 | 94.6 | 94.6 | 94.7 | 94.7 | 94.7 | 94.7 | 94.8 | 94.8 |

## Wet Detention



The most significant factor impacting the performance efficiency of a wet detention pond is the residence time within the system - specifically, the volume of the permanent pool with respect to the volume of runoff entering the pond. Since the specified treatment volumes are negligible in comparison to the permanent pool volume contained within the wet detention pond, the treatment volume criteria primarily regulates the drawdown characteristics of the wet detention pond and has little impact on the overall water quality performance efficiency of the system.

Residence time within a wet detention pond is determined by the relationship between the permanent pool volume and the annual runoff inputs, as follows:

$$\text{Average Annual Detention Time, } t_d(\text{days}) = \frac{PPV}{RO} \times \frac{365 \text{ days}}{\text{year}}$$

where:

PPV = permanent pool volume (ac-ft)

RO = annual runoff inputs (ac-ft/yr)

For purposes of this calculation, the permanent pool volume is considered to include the total volume of water within the pond below the control elevation.

TP percent removal equation

$$\text{Percent TP Removal} = 40.13 + 6.372 * \ln(t_d) + 0.213 * (\ln(t_d))^2$$

$$t_d = \text{Average Annual Residence Time (days)}$$

TN percent removal equation

$$\text{Percent TN Removal} = \frac{43.75 * t_d}{(4.38 + t_d)}$$

$$t_d = \text{Average Annual Residence Time (days)}$$

Limits to Average Annual Residence Time throughout the State

Maximum Average Annual Residence Time: 200 Days

Maximum Treatment Efficiency for TP at 200 days: 79.9

Maximum Treatment Efficiency for TN at 200 days: 42.8

Designers may use a longer maximum residence time if they provide evidence to support it.

## Detention with Engineered Media and Filtration

The treatment efficiency for these systems is calculated based on the following equation:

$$\begin{aligned} & \textit{Treatment efficiency for Detention Pond with Filtration} \\ &= (\textit{Detention efficiency for Volume of the water Detained in the system}) \\ &+ (\textit{Volume of water filtered and not detained} \\ &\quad * \textit{Treatment Efficiency of Media}) \end{aligned}$$

## Green Stormwater Infrastructure

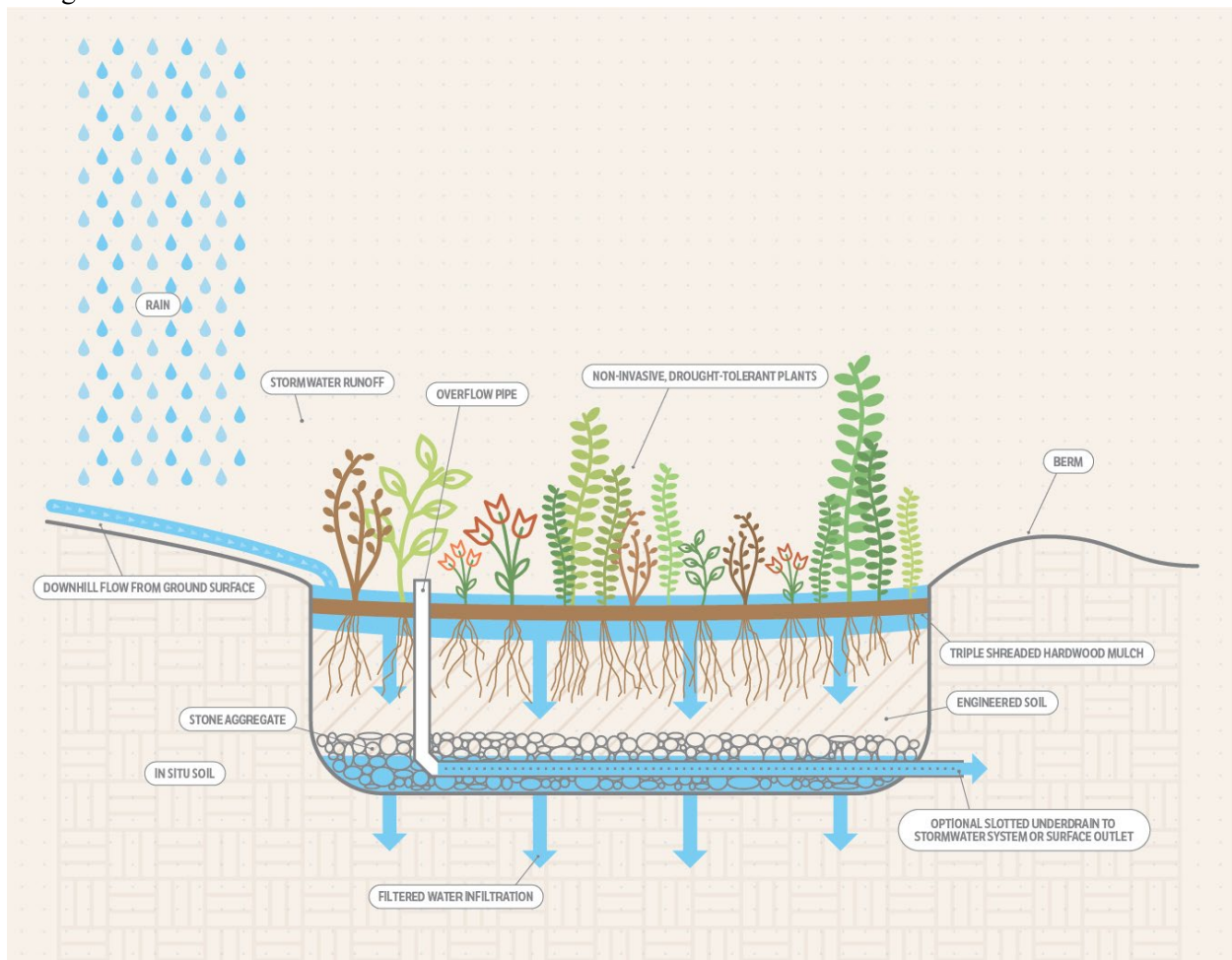
GSI and LID reduces pollution and treats stormwater by retaining rainfall near its source instead of directing it to a centralized pond or treatment system. When applied early in the design process, low impact design techniques can reduce stormwater runoff volume and pollutants generated from project sites. Thus, the use of GSI and LID may reduce stormwater treatment BMP size requirements. GSI and LID, depending on the technology, can also treat stormwater similar to a traditional BMP by treating TN and TP as a retention system.

### Swale

Swales are defined in Chapter 403.803(14), Florida Statutes, as follows: “Swale means a manmade trench which:

1. Has a top width to depth ratio of the cross-section equal to or greater than 6:1, or side slopes equal to or flatter than 3 feet horizontal to 1-foot vertical;
  2. Contains contiguous areas of standing or flowing water only following a rainfall event;
  3. Is planted with or has stabilized vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake; and
  4. Is designed to take into account the soil erodibility, soil percolation, slope, slope length, and drainage area so as to prevent erosion and reduce pollutant concentration of any discharge.”
1. Swales are online retention systems and their treatment effectiveness is directly related to the amount of the annual stormwater volume that is infiltrated. Swales designed for stormwater treatment can be classified into two categories:
- Swales with swale blocks or raised driveway culverts
  - Swales without swale blocks or raised driveway culverts
2. The nutrient reduction capability of these systems can be calculated in the same way as [Dry Retention System](#).

## Raingarden/Bioretention Cell

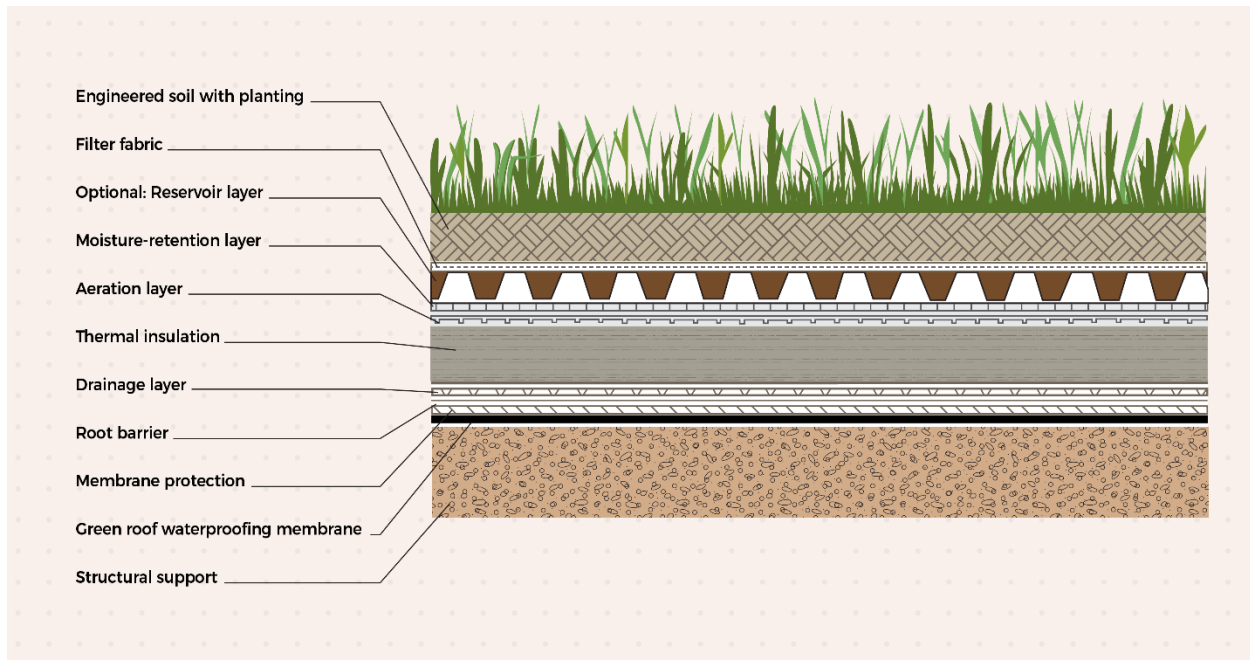


Bioretention cells, or commonly referred to as rain gardens, are shallow depressions with resilient plants that can handle temporary inundation/flooding and periods of drought. They allow stormwater to collect and soak directly into the soil.

Rain gardens vary in size and complexity. They can be planted to provide a food source for butterflies and other wildlife and can make a beautiful addition to the landscape.

The nutrient reduction capability of these systems can be calculated in the same way as [Dry Retention System](#).

## Green Roof

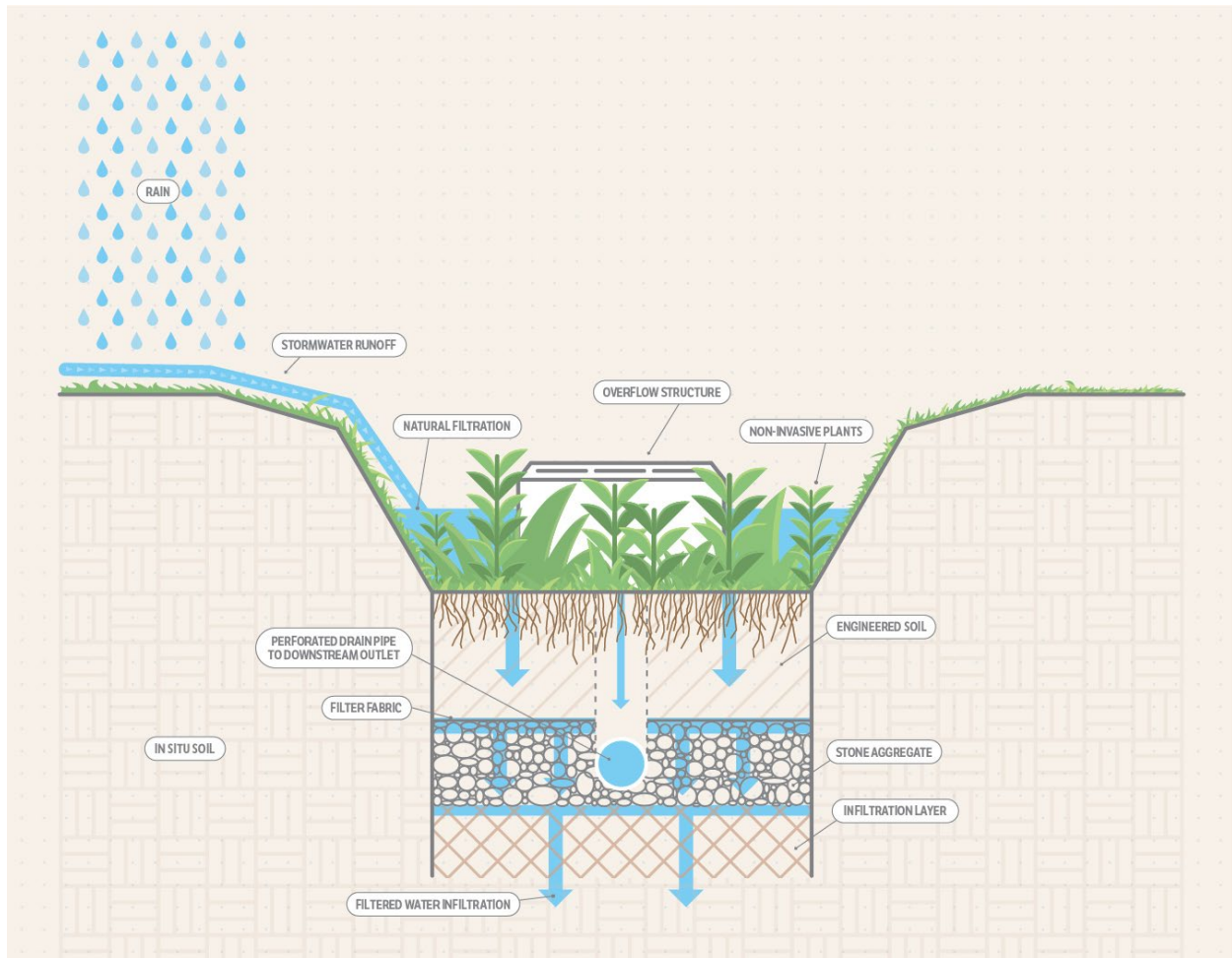


A green roof is a vegetated roof system where rainwater is taken up by plants and transpired into the air to reduce rainwater runoff from the roof. Green roofs provide an extra layer of insulation that reduces heating and cooling costs and are likely to extend the life of the roof by up to 10-20 years. Green roof vegetation enhances the building's appearance, improves air quality and reduces the urban heat island effect.

Well-designed green roofs include subsystems for drainage, plant nourishment and support, and protect underlying waterproofing systems. Green roofs maintain growing conditions and manage heavy rainfall without sustaining damage from high winds, erosion or pooling water. Green roof engineered soil meets specific requirements, including grain-size, air spaces and moisture retention to store rainfall and support plants that meet site-specific “right plant-right place” requirements.

The nutrient reduction capability of these systems can be calculated in the same way as [Dry Retention System](#).

## Bio Swale



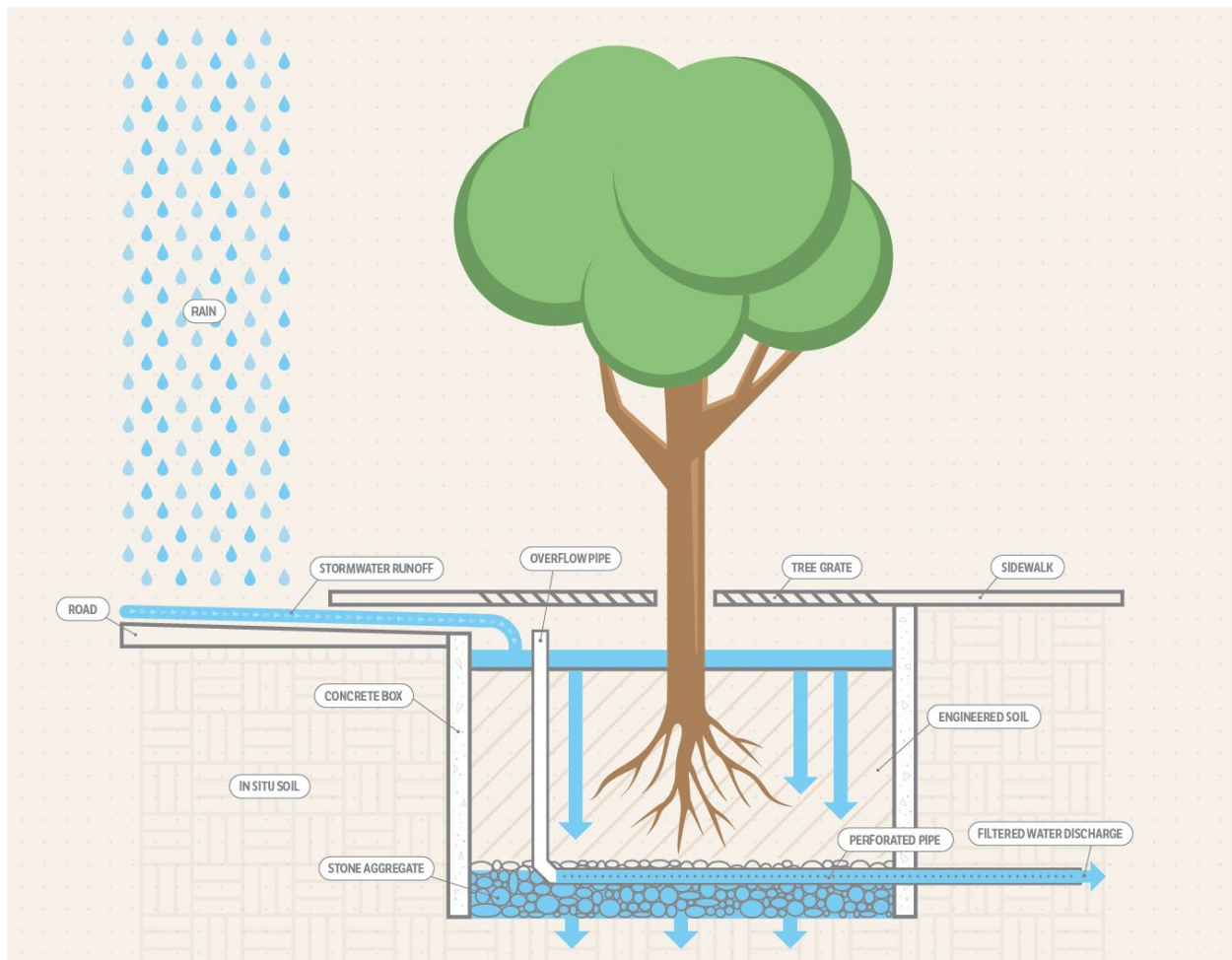
A Bioswale is an alternative to concrete gutters and storm sewers for directing stormwater away from roadways or structures. They use vegetated low-lying areas and specialized soil mixes to treat, absorb and convey lower volumes of stormwater runoff to larger treatment systems.

In many ways, bioswales imitate the function of small natural creeks or streams. Because they are linear, bioswales are effective when placed along streets and within parking lots. Essentially a shallow trench or ditch, bioswales can be cost-effective to implement and can help slow foot traffic near businesses.

Bioswales provide landscaping that, depending on the plant species chosen, may create habitats for birds, butterflies and local wildlife.

The nutrient reduction capability of these systems can be calculated in the same way as [Dry Retention System](#).

## Tree Well

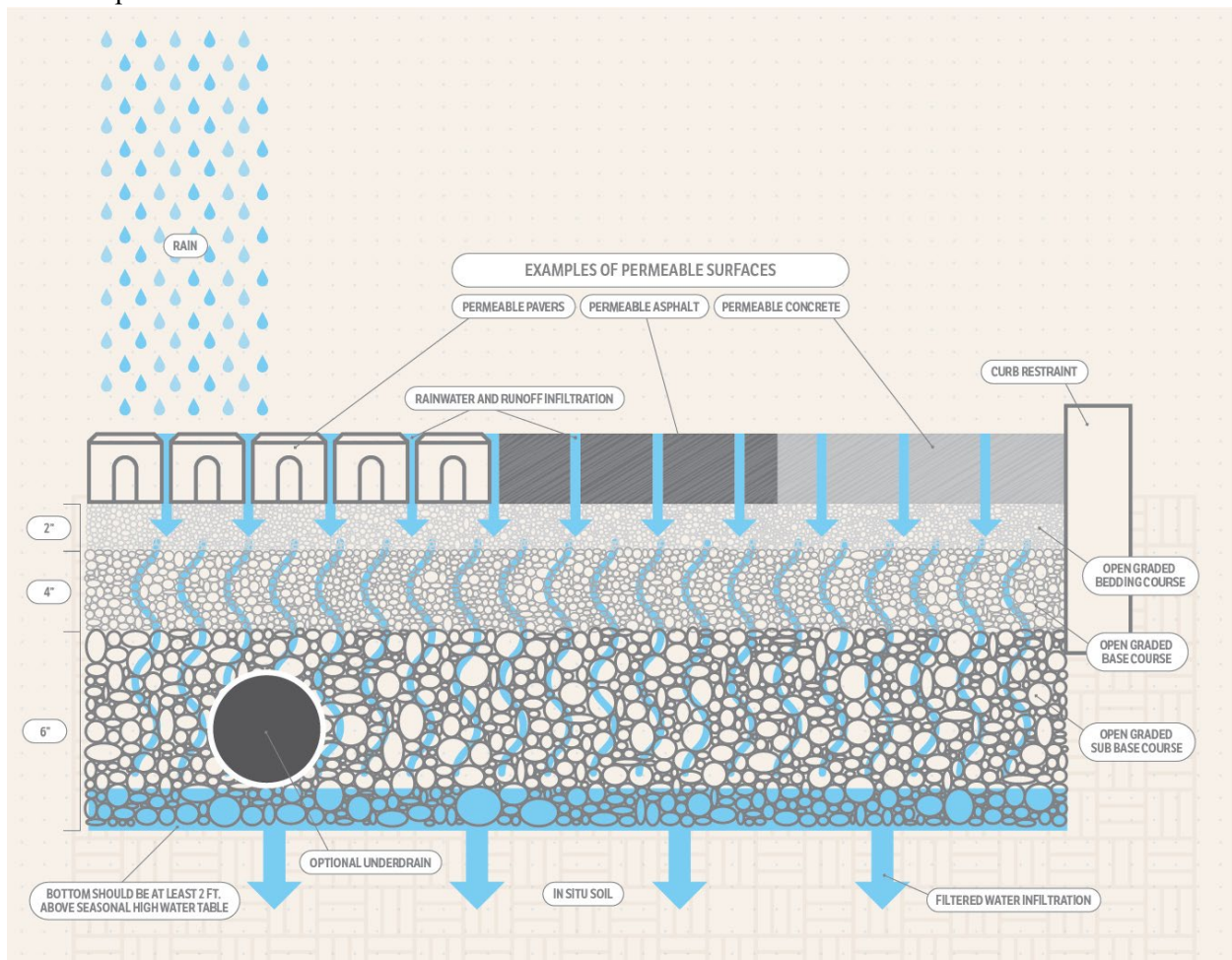


Tree boxes provide direct filtration of runoff while also intercepting rain as it falls onto the leaves and branches of the non-invasive plant life. Tree boxes also reduce the urban heat island effect, offer shady relief from the sun and draw foot traffic to nearby business based on their aesthetically pleasing nature.

The boxes are typically installed on the street side of sidewalks, with long, narrow storage volumes below the pavement. Runoff is eliminated through a combination of trees taking up water (and nutrients), percolating into the ground and discharging to stormwater systems. Pollutants are removed as they pass through the soil media in the “box” and as trees absorb and filter pollutants.

The nutrient reduction capability of these systems can be calculated in the same way as [Dry Retention System](#).

## Pervious pavement



Permeable pavement, which can be composed of pervious concrete, porous asphalt or interlocking pavers, quickly percolate rainwater where it falls as well as runoff from adjacent areas, allowing it to slowly soak into ground.

Parking lots, which make up a substantial portion of developed land areas, can be retrofitted or built with pervious surfaces from the start to significantly reduce runoff volumes.

Pervious pavement can be constructed to be similar in appearance to conventional asphalt surfacing, while pavers can be used to create intricate pavement designs. The implementation of pervious pavement of all types is often particularly cost-effective in places with high land values and recurrent nuisance flooding.

The nutrient reduction capability of these systems can be calculated in the same way as [Dry Retention System](#).