APPENDIX A

Fish Tissue Contamination Study of Wagner Creek Project Sample Collection Plans, Methods and Protocols

Fish Tissue Contamination Study of Wagner Creek, Miami, Florida Evaluation of Potential Dioxin Contamination and Bioaccumulation in Bottom Feeding and 'Catch' Species

Project Sample Collection Plans, Methods and Protocols

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Natural Resources Division, Miami, FL
and
Florida Department Of Health (FDOH)
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I. PURPOSE

The purpose of the project is to evaluate the extent to which (if at all) dioxin contaminants, a suspected human carcinogen, previously documented to be in the sediments of Wagner Creek, have been incorporated into the fish communities inhabiting the creek, particularly those species that may be taken as food sources (i.e., 'catch species'). This is of concern as consumption of these fish by local fishers, will provide a pathway for the potential human ingestion. Additionally the project sampling will seek to evaluate if increased concentrations of the contaminant exist in 'predator' species (i.e., fish that other fish feeding on bottom organisms), and thus create an increased risk to human health and safety. Information from the tissue contaminant analysis will be used by the Florida Department of Health to conduct an assessment of the human health risk, and the need for issuance of any 'Advisories' limiting or banning the consumption of fish from the Wagner Creek.

II. BACKGROUND

Wagner Creek is an approximately 2 mile long tributary to the Miami River, in Miami, Florida. The creek passes through a densely commercial, institutional and urbanized portion of the City of Miami, and joins with the Miami River, approximately 1.5 miles upstream of the River's connection with Biscayne Bay. The northern 0.5 mile of the creek has been culverted, leaving approximately 1.5 miles 'open water' along the creek. The lower (southern) one-third of the open water (approximately, 0.5 miles) is a navigable waterway (the Seybold Canal), and connects to the Miami River. The upper two-thirds of the Creek contains canalized reaches and has highly restricted access, with little or no designated public access. Access to the river is by private residences (backyards) of residences on the creek, and to a lesser extent at or adjacent to bridges (4) that cross the Creek.

Due to the exchange with the Miami River, this region exhibits salinity characteristics of an estuarine system, with moderate-to-high salinities near the mouth of the Creek, low to fresh water salinities in the middle reaches, and freshwater in the upper portions.

The Wagner Creek drainage basin drains a highly urbanized and commercial region of the city. The Creek is bordered by, and receives drainage from various industrial, institutional (i.e., hospitals, care centers), and governmental (federal, state and county) facilities as well as residential areas. Local commercial fishermen's and private resident's boats are docked along the navigable (lower) portion of the Creek.

The quality of the water reaching the creek has, and is being affected by the density of development and varied land use adjacent to the creek. Through the 1950's and into the 1960's many of the homes along the waterway had sanitary systems with direct outfalls to the Creek. Similarly, municipal and industrial facilities had waste outfalls into the Creek. One such connection was from the City of Miami's municipal incinerator, located on NW 20 St and NW 12 Ave. The ash pits of the plant were connected to the storm drain system the connected to Wagner Creek at the north end of the 'open water' segment. Starting in the 1960's numerous efforts were initiated to minimize impact to the creek. A sanitary collection system was installed and connection mandated. Separate stormwater systems were installed, stormwater systems upgraded, and non-permitted interconnections between stormwater systems and sanitary systems identified and disconnected. These efforts continue today, and although significant improvements in water quality have been documented, multiple water quality parameters in the Creek do not meet county or state water quality standards or criteria.

Miami-Dade Department of Environmental Resources Management (DERM) and the South Florida Water Management District (SFWMD) have monitored the water quality of Wagner Creek since 1987. Although improvement has been noted in many of the parameters monitored, data indicate that surface water samples from Wagner Creek consistently fail to meet state or county surface water standards and criteria for Total Coliform and Fecal Coliform bacteria (i.e., 76% to 100% of the samples).

Dioxin and dioxin like compounds are not soluble in water. Rather these compounds often associate with silt and particulates and accumulate in the sediments of the receiving waters. Although investigations have documented related compounds (Poly-Chlorinated Biphenyls [PCB's]) in the Miami River and Wagner Creek (Long et al, 1999, Schmale, 1991; Miami-Dade DERM, 1993; Gulf Engineers and Consultants 1993; Seal et al, 1994), dioxins have not been specifically tested for in the sediments in this region. Recent sampling along the Wagner Creek has revealed levels of dioxin in the soils adjacent to, and sediments of the creek. The highest levels (~150 pg/g) occur in the northern most open water segment of the creek (NW 20th St, west of 14th Ave). The sediment concentrations of dioxins decrease to ~45 pg/g at the midpoint of the creek, and ~15 pg/g at the upstream end of the Seybold Canal, approximately 1 mile from the highest concentrations (EE&G, 2002).

Based on the presence and concentration of dioxin in the sediments, Miami-Dade County DERM and the Florida Department of Health (FDOH) have planned a screening survey to determine if there is evidence of contamination of biological communities within Wagner Creek by the dioxin contaminants. Of specific concern is the potential for dioxin

contaminants to enter the food chain, via fish having contact with the sediments or by consumption of contaminated food-sources living in or on the bottom. Additionally there is concern of potential 'biomagnification' (increased concentration of contaminants in fish species feeding on contaminated bottom feeding fish) of the contaminant in other fish species inhabiting the river.

III. MONITORING STRATEGY

Little information is available on fish populations of Wagner Creek, nor has there been any assessment of dioxin contamination of biological communities. The information concerning species of fish within the Creek is based on observations of DERM staff while surveying various segments of Wagner Creek, and anecdotal information from residents that have conducted, or know of fishing activities on the Creek.

This study will collect samples from 4 locations along the 1.5 mile length of the Creek. The monitoring strategy is to sample fish species within "reaches" of the Creek that represent a potential contamination gradient. Four reaches have been identified that represent a gradient from the highest (e.g., inland-most [northwestern end]) to lowest (at the mouth of the creek), levels of contamination in the sediments of the Creek (Figure 1). The monitoring strategy is to obtain sufficient number of like size-class fish to generate replicate composite samples of a bottom feeding species and either a high trophic level, or 'catch' species of the local fisherman. The selection of sampling gear is intended to increase the potential for the target species. Utilization of fish traps should increase the potential for capture of bottom feeding fish. The use of the trammel nets will increase the potential for capture of higher trophic level/'catch' species, that are less apt to associate with the bottom.

Target Species:

The predetermined selection of a specific 'target species' is complicated by multiple factors.

- Little information is known about fish populations within Wagner Creek.
- Observations and information relayed through local fisherman indicate the species diversity and density decrease dramatically upstream of the 14th Street bridge.
- Selection of a single target species to represent all reaches of the Creek is difficult due to the magnitude of the salinity gradient along the Creek.
- The decreased water quality within this upper portions of the water body severely decreases the probability of collecting any species in the northern (most contaminated reach) of the creek.

Fish species known to inhabit Wagner Creek has been compiled from observations made by DERM personnel and residents along the river. Various species have been identified (although not necessarily commonly encountered) including: the Snook, (*Centropomus undecimalis*) a high trophic level predetor species, Oscar (*Astronotus ocellatus* – mid-level predator), and various freshwater potential 'pan fish' species such as the Mayan Cichlid (*Cichlasoma urophthalmus* - mid-level predator), Oscar (*Astronotus ocellatus*),

Jaguar Guapote (*Cichlasoma managuense* - mid-level predator), Black Acara (*Cichlasoma bimaculatum* – omnivore/mid-level predator), Striped Mullet *(Mugil cephalus* - bottom feeder), Spotted Tilapia (*Tilapia mariae* – bottom feeder), and the Yellow Fin Mojarra (*Gerres cinereus* – bottom feeder). All species are potential 'catch' of local recreational fishers, and mullet represent the known bottom feeders in the creek. Additional bottom feeders (i.e., catfish) may be identified during sampling. The snook is rarely seen, and it is not expected that sufficient numbers of the fish are available for this study.

The intent will be to obtain a single species that can be found throughout the Creek for both the bottom feeder and top feeder. The best candidate at this time is the striped mullet. The species selected for higher trophic level/'catch species', may depend on availability of species in the Creek, and two species (one for the lower creek, and one for the upper creek) may have to be selected.

Target Analytes

Target Analytes were selected based on known contaminants and potential 'associates', as well as recommendation of the United States Environmental Protection Agency (US EPA) guidance document for assessment of contaminants in fish tissues (US EPA 2000). Recommended analytes include congeners of 'Dioxins and Furans', Poly-Aromatic Hydrocarbons (PAH's), and Poly-Chlorinated Biphenyls (PCB). The US EPA (2000) recommends that analysis for the Dioxins/Furans group should contain 17 specific compound (Table 1). Additionally, based on previous land usage and past sediment sample analyses within the region, specific heavy metals have been selected for analysis as well (Table 1).

IV. METHODOLOGY.

All methods stated below are consistent with the US EPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1; Fish Sampling and Analysis, Third Addition (US EPA, 2000)

Sampling Sites

A total of 4 Sampling sites will be used along the Wagner Creek (inclusive of the Seybold Canal), one in each 'Reach' identified below. The locations will represent a gradient of contaminant concentrations in sediments, with Reach-1 having the highest, and Reach 4 having the lowest associated sediment contaminant concentrations. The reaches are describe below, and illustrated in Figure 1

1. **Wagner Creek Reach-1 (WCR-1)** – Northwestern most reach of 'open' creek, between NW 20th Street (west of NW 14th Ave) to NW 17th Street (just east of NW 14th Ave).
2. **Wagner Creek Reach-2 (WCR-2)** – the Reach between NW 17th Street, just east of NW 14th Ave, and NW 14th Street and NW 12 Ave

3. **Wagner Creek Reach-3 (WCR-3)** - the Reach between NW 14th Street, and NW 12th Ave, and NW 11th Street and NW 9th Court
4. **Wagner Creek Reach-4 (WCR-4)** - the Reach between NW 11th Street, and NW 9th Court, and the Miami River (NW 5th Street and NW 7th Ave)

Location of sampling gear for each Reach will be:

- Reach-1 (WCR1): East side of NW 14th Ave at (theoretical) NW18th St.
- Reach-2 (WCR2): South side of NW14th Street east of NW12th Ave
- Reach-3 (WCR3): North side of 11th Street, at NW 9th Court
- Reach-4 (WCR4): North side of NW 7th Street, west of NW 7th Ave

Sampling Strategy

Fish Collection. Due to the anticipated low density of fish species, and the meager information regarding overall fish community composition a combination of equipment will be used to catch target species. Fish traps and hook and line will initially be used at each station. If after two days of sampling, sufficient numbers of fish are not obtained, the entanglement (trammel/gill) nets will be used to increase the potential of catching sufficient numbers of fish. Replicate composite samples will be collected from stations representing a documented gradient of sediment contamination, and analyzed for the Target Analytes.

Sampling will continue at each site until a sufficient number of individual fish of each species have been collected to generate 2 composite samples for each of two species at each site. When a sufficient number of fish for any species from any site has been collected fishing efforts for that species will cease, and any additional catches of that species at that site, will be returned immediately to the Creek. If sufficient numbers of fish have been collected for all samples required at a given site, fishing efforts at that site will cease.

Number of samples and replicates:

A minimum of 250g (~ 0.5 lbs) of flesh will be required within a composite sample to test for the analytes listed in Table 1. The sampling will collect 2 composite samples from each location, of a bottom feeder and either a 'catch' species or higher tropic level species[1]. Each composite sample will have 12 fish (i.e., 24 individuals of each of two species from each site).

Sample processing and analysis.

Tissue samples will be of 'skin-on fillets' and homogenization and compositing of the samples will be in compliance with methods described in US EPA (2000). Analyte detection limits are described in Table 2. Sample Preparation and analyses will be

[1] The same species will be collected at each site, where possible. Due to the significant difference in salinities along the 'Creek', it is not anticipated that a single bottom feeder, nor a single higher tropic, or 'catch' species will be available from all stations.

conducted in accordance with the laboratories NELAC and state approved certifications and procedures.

V. GEAR USAGE

NOTE: *Gear usage requires use of gear-specific Personal Protective Equipment (PPE) as detailed in the Site Safety Plan Addendum pg. 15.. No eating, drinking or contact with edible or consumable products should occur while an individual is wearing their Personal Protective Equipment. Equipment should be decontaminated and disinfected (as necessary) prior to consuming beverages or foods.*

1. Fish Trap use:
   - 1.1. One 12"(H) X 24"(W) X 36(D), 1" wire mesh fish trap will be deployed at each station
     - 1.1.1. (Station WCR3 will have two traps, as the width of the creek is substantially wider at the location).
   - 1.2. Trap Deployment: Traps will be deployed on early morning, and remain for a 12 hour period (7 AM to 7 PM).
     - 1.2.1. Don appropriate Personal Protective Equipment (PPE) (see the Site Safety Plan Addendum pg. 15).
     - 1.2.2. Move trap (with attached retrieval cable) to area of deployment (center of bridge at WCR-1, WCR-2, WCR-3, and creek bank at WCR-4).
     - 1.2.3. Attach trap cable to cable loop on bridge or structure to be used to 'secure' trap.
     - 1.2.4. Lift trap over railing, and lower (slowly) into water, until the trap rests on bottom of creek.
     - 1.2.5. Decontaminate and Remove PPE
     - 1.2.6. Record time of placement, and any observations in the field log (NOTE: *An individual other than the individual processing the samples should conduct recording of information. This will minimize the potential spread of contamination at the sampling work site.)*
   - 1.3. Trap Checking: The traps will be checked every 4 hours, any.
     - 1.3.1. Don appropriate PPE (See the Site Safety Plan Addendum pg. 15)
     - 1.3.2. Grasp cable connected to trap,
     - 1.3.3. Slowly raise trap to surface to see if fish are in trap.
       - 1.3.3.1. If fish to be processed are in the trap, slowly lower the trap to the bottom, don necessary PPE and continue with step 1.4.
       - 1.3.3.2. If no fish are in the trap, or fish that are not going to be processed (i.e., too small, wrong species), and the sufficient room is in the trap, lower the trap to the bottom:
         - 1.3.3.2.1.1. Decontaminate and Remove PPE
     - 1.3.4. Record time of check, and observations in the field log. (NOTE: *An individual other than the individual processing the samples should conduct recording of information. This will minimize the potential spread of contamination at the sampling work site.)*
       - 1.3.4.1.1.1.

1.4. Trap Retrieval: If target species are present in the trap when checked, traps are to be removed and target species processed, the bait checked and replaced as necessary, and the traps re-deployed.
  1.4.1. Don appropriate PPE (See the Site Safety Plan Addendum pg. 15)
  1.4.2. When removing the traps from the water, the traps will be "yo-yo'd" (pulled repeated up and down in the water column, to remove any remnant sediments from the trap) before removing from the water.
  1.4.3. With a helper, pull trap over railing, disconnect connect cable from cable-loop on bridge, and bring trap off bridge to 'staging area'
  1.4.4. Open trap and return all not target species to the water as soon as possible.
  1.4.5. Process target species as per Section B
  1.4.6. Decontaminate and Remove PPE
  1.4.7. Record time of check, and observations in the field log. (NOTE: *An individual other than the individual processing the samples should conduct recording of information. This will minimize the potential spread of contamination at the sampling work site.)*
1.5. If possible, the traps will remain overnight and checked early (7 AM) the following morning.

2. Hook and Line use:
  2.1. Two individuals will rotate through the stations using hook and line to catch fish.
  2.2. Each station will be fished for a period of time that will allow all sites to be fished during the period between checking traps.
  2.3. Varied bait types should be attempted at each site.
  2.4. Appropriate PPE must be worn during retrieval and processing of the fish and (see the Site Safety Plan Addendum pg. 15).
    2.4.1. If a fish is hooked and is to be removed, one individual will don appropriate PPE and remove the fish.
    2.4.2. Processing of the fish will follow steps outlined in Section VI.
  2.5. Fishing from bridges should be avoided. All areas have access point to the creek adjacent to the bridges. Hook & line fishing should be conducted from the those access points.

3. Trammel/gill net use:
  3.1. Entanglement nets are to be used only if approved by the project manager, and only if insufficient numbers of target specimens have been obtained after two days of attempted catch with hook and line and traps.
  3.2. Appropriate PPE (see the Site Safety Plan Addendum pg. 15) is to be donned prior to deployment/retrieval of the nets.
  3.3. Nets will be position to be angled across the river (as opposed to perpendicular to the shoreline) to minimize entraining debris.
  3.4. Project personnel will be on-site at those stations where nets are deployed.
  3.5. The net will be surveyed for catch minimally every ½ hour.
    3.5.1. As the depth of the water is less than 5 feet in all but one of the stations, the nets may be visually surveyed in the water for catch. If visual survey is not possible, the net must be retrieved to survey potential catch

3.5.2. If 'catch' is verified during visual survey, or if a visual survey is not possible, the net will be 'pulled' and catch removed.

3.5.3. If a large specimen is entrained in the net, causing significant motion and potential tangling of the net, the observers will 'pull' the net as soon as possible to remove the catch, and reset the net.

3.6. Net Deployment/Retrieval:

3.6.1. Net Deployment

3.6.1.1. Don appropriate PPE (see the Site Safety Plan Addendum pg. 15)

3.6.1.2.Net is to be placed stretched and hung over the bridge or shoreline where it is to be placed.

3.6.1.3. One end pulled upstream to a distance to allow a straight lay of the net (no pockets, significant 'bows'), and at an angle not to exceed a 45 degree angle from the shore (net should be more in line with the axis of the creek)

3.6.1.4. The 'bridge' end of the net is lowered such that the bottom (weighted) is in contact with the creek bottom, and secured to the bridge. The 'upstream' end is secured to a upland post, or other secure location.

3.6.1.5. Decontaminate and Remove PPE

3.6.1.6. Record time of check, and observations in the field log. (NOTE: *An individual other than the individual processing the samples should conduct recording of information. This will minimize the potential spread of contamination at the sampling work site.)*

3.6.2. Net Retrieval

3.6.2.1. Don appropriate PPE (see the Site Safety Plan Addendum pg. 15)

3.6.2.2. Release 'bridge' end of the net.

3.6.2.3. Slowly gather and lift net off bottom, swaying the bottom portion of the net in the water to 'waft' off any accumulated sediments

3.6.2.4. As 'catch' appear, detangle fish from net.

3.6.2.4.1. If catch is a target species place specimen in pan on ice

3.6.2.4.2. If catch is not a target species return the specimen to the water (if alive). If not a target species and the specimen is dead, hold for later disposal.

3.6.2.5. Once the entire net has been retrieved and all catch has been removed, re-deploy the net as in Section 3.6.1.

3.6.2.6. Process catch of target species as per section B

3.6.2.7. Decontaminate and Remove PPE

3.6.2.8. Record time of check/catch removal, and observations in the field log. (NOTE: *An individual other than the individual processing the samples should conduct recording of information. This will minimize the potential spread of contamination at the sampling work site.)*

VI. SAMPLE HANDLING: FIELD PROCESSING, FILLETING, PACKING AND SHIPPING OF SPECIMENS:

NOTE: *No eating, drinking or contact with edible or consumable products should occur while an individual is wearing their Personal Protective Equipment. Equipment should be decontaminated and disinfected (as necessary) prior to consuming beverages or foods.*

A. Removal, Sorting, Handling and Recording of Specimens
(NOTE: *An individual other than the individual processing the samples should conduct recording of information. This will minimize the potential spread of contamination at the sampling work site.)*

1. Insure use of appropriate PPE (see the Site Safety Plan Addendum pg. 15)
2. Care must be taken during removal of specimens from equipment and gear (nets, traps, hook and line). Puncturing of the hand protection is possible if fish are handled incorrectly.
   - 2.1. When first handling a fish (removal from trap, net, or hook), grasp fish by area in front of, or behind dorsal (top) fin.
   - 2.2. To avoid a puncture wound from the dorsal fin, place distal edge of palm (pinky finger side) on the head of the fish. Lightly grasp the fish and slide your hand down the length of the fish. This will lay and hold the dorsal fin down.
   - 2.3. Detangle, de-hook, or remove the fish from the equipment.
3. *Removal of fish* from the collection gear and preliminary sorting.
   - 3.1. Return all non-target species to the water while removing fish from sampling gear as soon as possible
   - 3.2. Record and enumerate all species caught (including non-target species)
     - 3.2.1. estimates of small numerous non-target species (i.e., sail-fin molly, small cichlids) is acceptable.
   - 3.3. Rinse specimens to be processed in de-ionized water.
   - 3.4. Identify fish to species, and place into sorting tray(s), grouped by species
4. *Record, measure, wrap* and label specimens to be used in analysis
   - 4.1. Record specimen ID number and information in field log
   - 4.2. Measure total length (mm) of fish. Total length is defined as the length from the tip of the snout to the tip of the tail
   - 4.3. Wrap the specimen (individually) in heavy aluminum foil
   - 4.4. Complete "Sample Identification Label" for the specimen and affix (tape) it to the outside of the wrapped specimen
   - 4.5. Place the specimen in a water-tight bag (Zip-lock)
   - 4.6. Complete the "Chain-of-Custody (COC) Tag" and affix (tape) it to the outside of the Zip-lock bag.
   - 4.7. Place the bag with the wrapped, labeled specimen on ice in a cooler.
4. Repeat 2a-g for each specimen collected.
5. Decontaminate and Remove PPE
6. Record time of check/catch removal, and observations in the field log. (NOTE: *An individual other than the individual processing the samples should conduct recording*

of information. This will minimize the potential spread of contamination at the sampling work site.)

B. Filleting of specimens & freezing for shipping

1. Filleting will not be conducted in the field, rather labeled specimens will be brought to an area that has a solid, stable work surface (i.e., Restoration & Enhancement equipment and work room, 140 West Flagler building).
2. Filleting will be conducted so as to control potential cross-contamination
   2.1. between composite samples, or
   2.2. between species being processed.
3. Don appropriate PPE (see the Site Safety Plan Addendum pg. 15)
4. Place stainless tray on solid work surface
5. Place double layer of heavy duty aluminum foil inside tray, so that the aluminum foil extends over the inner side walls of the tray.
6. Remove specimen from sample bag and place fish inside tray.
7. Use a clean (decontaminated) fillet knife for each species and for each composite sample
   7.1. Fillet knife are to be decontaminated between fish.
      7.1.1. Knives will be scrubbed with an Alconox/Liqui-nox solution,
      7.1.2. Rinsed with deionized water,
      7.1.3. Rinsed with isopropyl alcohol and allowed to air dry
8. Specimens should come into contact with non-contaminating surfaces only. Fish should be filleted on glass or PTFE cutting boards that are cleaned properly between fish or on surfaces covered with heavy duty aluminum foil that is changed between fish .
   8.1. Care must be taken to avoid contaminating fillet tissues with material released from inadvertent puncture of internal organs.
      8.1.1. If the fillet tissue is contaminated by materials released from the inadvertent puncture of the internal organs during resection, the fillet tissue should be rinsed in contaminant-free, deionized distilled water and blotted dry. A notation should be made in the sample processing record.
   8.2. Ideally, fish should be filleted while ice crystals are still present in the muscle tissue. Therefore, if fish have been frozen, they should not be allowed to thaw completely prior to filleting. Fish should be thawed only to the point where it becomes possible to make an incision into the flesh (U.S. EPA, 1991d). Clean, high-quality stainless steel, ceramic, or titanium utensils should be used to remove one or both fillets from each fish, as necessary. The general procedure recommended for filleting fish is illustrated in Figure 7-3 (U.S. EPA, 1991d).
   8.3. The belly flap should be included in each fillet.
   8.4. Any dark muscle tissue in the vicinity of the lateral line should not be separated from the light muscle tissue that constitutes the rest of the muscle tissue mass.
   8.5. Bones still present in the tissue after filleting should be removed carefully (U.S. EPA, 1991d).
   8.6. If both fillets are removed from a fish, they can be combined or kept separate for duplicate QC analysis, analysis of different analytes, or archival of one fillet.

8.7. Fillets are to be wrapped in heavy duty aluminum foil and labeled with the sample identification number, the sample type (e.g., "F" for fillet), and the date of resection.

8.8. All fillets from a composite sample should be placed in a plastic bag labeled with the composite identification number, the individual sample identification numbers, and the date of resection.

C. Packaging of samples for shipping to the Laboratory

1. Don appropriate PPE (see the Site Safety Plan Addendum pg. 15.)
2. Collation of samples for composite samples
   2.1. Sample in a composite should have equivalent representation of the range of size of fish collected
      2.1.1. Preferably, the smallest fish will be no less than 70% of the length of the largest fish
   2.2. Separate fish for composite samples, distributing the size range as equally as possible
   2.3. Record specimen numbers for each composite on the Chain of Custody Record
   2.4. Bag all specimens for a given composite sample into a large plastic bag (double bag if necessary to help insure containment of sample).
   2.5. Attach a label to the outside of the bag with the composite samples, identifying the composite sample number
3. Pack composite samples into shipping cooler.
   3.1. Insure sufficient ice is below the composite sample, and the composite sample is 'spread' to allow greatest contact with the ice.
   3.2. Layer samples and ice to insure sufficient ice will remain in the cooler to last through the shipping time (up to than 24 hours).
   3.3. Place all Chain of Custody sheet(s) in a zip-lock bag and tape the inside top of the cooler.
   3.4. Minimally double tape (using Duct Tape or packaging tape) both around the lid of the cooler, as well as around (top to bottom) the cooler itself
   3.5. Affix shipping label to cooler
   3.6. Transport DERM laboratory for shipping to laboratory.
4. Remove and decontaminate/discard PPE

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Table 1. Target Analytes recommended as by the US EPA: Groups and 'congeners' to be evaluated in the fish tissue analysis, and their relative Toxicity Equivalency Factors.

	Toxic Equivalency Factor (TEF-98)*		Toxic Equivalency Factor (TEF-98)*
DIOXINs		**FURANS**	
2,3,7,8-TCDD	1.0	2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDD	1.0	1,2,3,7,8-PeCDF	0.05
1,2,3,4,7,8-HxCDD	0.1	2,3,4,7,8-PeCDF	0.5
1,2,3,6,7,8-HxCDD	0.1	1,2,3,4,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDD	0.01	1,2,3,7,8,9-HxCDF	0.1
OCDD	0.0001	2,3,4,6,7,8-HxCDF	0.1
		1,2,3,4,6,7,8-HpCDF	0.01
		1,2,3,4,7,8,9-HpCDF	0.01
		OCDF	0.0001

PCB's (CB = -Chlorinated Biphenyl) recommended as Target Analytes by the US EPA

2,4' diCB			
2,2',5 triCB		2,2',3,3',4,4' hexaCB	
2,4,4' triCB		2,2',3,4,4',5' hexaCB	0.0005
		2,2',3,5,5',6 hexaCB	
2,2'3,5' tetraCB		2,2',4,4',5,5' hexaCB	
2,2'4,5' tetraCB			
2,2',5,5' tetraCB		2,2',3,3',4,4',5 heptaCB	
2,3',4,4' tetraCB		2,2',3,4,4',5,5' heptaCB	
		2,2',3,4,4',5',6 heptaCB	
2,2',3,4',5 pentaCB			
2,2',4,5,5' pentaCB			
2,3,3',4,4' pentaCB	0.0001		
2,3,4,4',5 pentaCB	0.0001		

METALS:

Arsenic	Cadmium
Chromium	Lead
Mercury	

Abbreviations for Table 1

HpCDD = Heptachlorodibenzo-*p*-dioxin;	PeCDD = Pentachlorodibenzo-*p*-dioxin
HpCDF = Heptachlorodibenzofuran	PeCDF = Pentachlorodibenzofuran
HxCDD = Hexachlorodibenzo-*p*-dioxin	TCDD = Tetrachlorodibenzo-*p*-dioxin
HxCDF = Hexachlorodibenzofuran	TCDF = Tetrachlorodibenzofuran
OCDD = Octo-chlorodibenzo-*p*-dioxin	OCDF = Octo-chlorodibenzofuran

* Van den Berg et al., 1998

ANALYTE DETECTION LIMITS
(STL LABORATORIES – KNOXVILLE TENNESSEE)

Metals: estimated RL's (mg/Kg) are:

Arsenic	=	10,
Cadmium	=	5.0,
Lead	=	3.0,
Mercury	=	0.3

PCB congener (Method 8082) RL's are:

All except 2,4,4,' triCB	=	1.0 ug/Kg
2,4,4'triCB	=	10 ug/Kg

Dioxin RL's in ng/Kg are as follows:
Dioxins/Furans by HRGC/HRMS EPA Methods 1613-B

Congener	Minimum Levels (ML)[see note below]
2,3,7,8-TCDD	1.0
1,2,3,7,8-PeCDD	5.0
1,2,3,4,7,8-HxCDD	5.0
1,2,3,6,7,8-HxCDD	5.0
1,2,3,7,8,9-HxCDD	5.0
1,2,3,4,6,7,8-HPCDD	5.0
OCDD	10
2,3,7,8-TCDF	1.0
1,2,3,7,8-PECDF	5.0
2,3,4,7,8-PECDF	5.0
1,2,3,4,7,8-HXCDF	5.0
1,2,3,6,7,8-HXCDF	5.0
2,3,4,6,7,8-HXCDF	5.0
1,2,3,7,8,9-HXCDF	5.0
1,2,3,4,6,7,8-HPCDF	5.0
1,2,3,4,7,8,9-HPCDF	5.0
OCDF	10

NOTE: Method 8290 and 1613B reference the Minimum Level (ML). The qualitative definition of the ML is "the lowest level at which the analytical system must give a reliable signal and an acceptable calibration point". The ML was introduced in EPA Methods 1624 and 1625 in 1980 and was promulgated in these methods in 1984 at 40 CFR Part 136, Appendix A.

The USEPA Engineering and Assessment Division has established guidance for setting the ML which is a level set 2-3 times the interlaboratory method mdls established for the methods during validation.

Unlike the way 40 CFR Part 136A is often used (i.e., as a measure of individual laboratory performance) the MLs established for 8290 and 1613 were established from data at multiple laboratories to assess method performance.

The lab will report all detections down to the smallest allowable peaks (i.e., 2.5 times the average noise for 3 consecutive scans). The Estimated Detection Limit (EDL) is also provided for each analyte. This is a value calculated to estimate the concentration in the sample that would meet the minimum signal-to-noise requirement (2.5 times the intensity of the average noise level). The EDL does not exactly equal the smallest amount reported. This is primarily due to differences in the way the two values are calculated. The EDL is calculated using peak intensity, whereas the sample concentration is calculated on the basis of area. The ratio between the two varies with concentration.

Any detections below the ML are qualified by a J flag.

Estimated Detection Limits.

If no peaks are present in the region of the ion chromatogram where the compounds of interest are expected to elute, the EDL for that compound is calculated and reported. The EDL reflects the amount of the particular analyte that would be required to cause a positive result for the particular analysis.

Table 2. Wagner Creek Fish Contamination Special Study – 2003. Potential Catch Species, Common Names and Two-letter Acronyms to be used in Generation of Specimen Identification Numbers

Species name	**Common Name**	**Acronym**
Cichlasoma bimaculatum	(Black Acara)	CB
Cichlasoma managuense	(Jaguar Guapote)	CM
Tilapia mariae	(Spotted Tilapia)	TM
Chichlasoma urophthalmus	(Mayan Cichlid)	CU
Astronotus ocellatus	(Oscar)	AO
Mugil cephalus	(Stripped/Black Mullet)	MC
Mugil gyrans	(Fantail Mullet)	MG
Centropomus undecimalis	(Common Snook)	CS
Centropomus pectinatus	(Tarpon Snook)	CP
Sphoeroides testudineus	(Checkered Puffer)	ST
Gerres cinereus	(Yellowfin Mojarra)	GC
Diapterus plumieri	(Striped Mojarra)	DP

Figure 1. Location of Miami-Dade County water quality monitoring stations, and sampling 'Reaches' along Wagner Creek

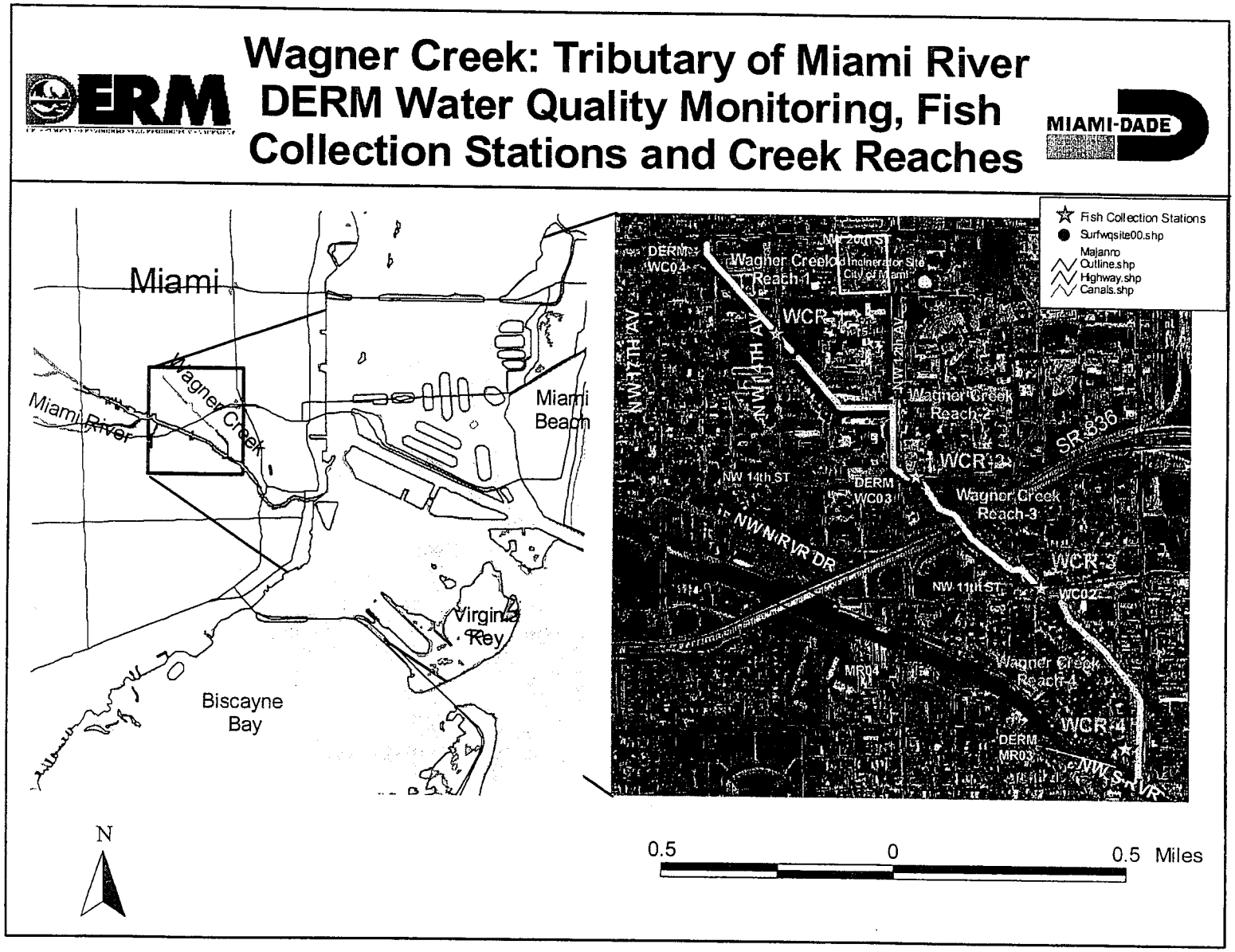
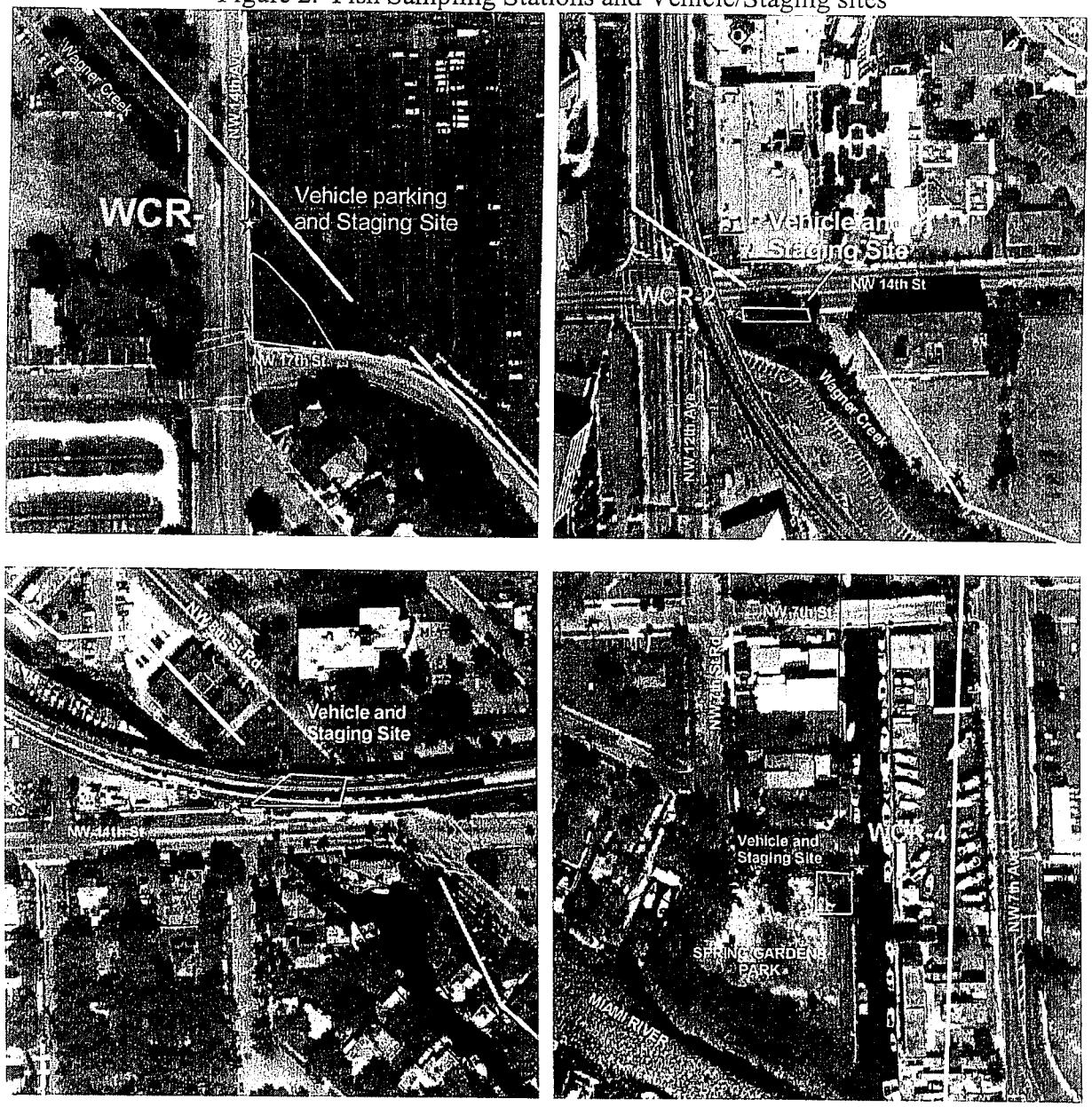


Figure 2. Fish Sampling Stations and Vehicle/Staging sites



WAGNER CREEK FISH TISSUE COLLECTION PROJECT:
SITE SAFETY PLAN ADDENDUM

Due to the potential hazards that are or may be present at the sampling site, the following precautions and Personal Protective Equipment shall be used to minimize potential adverse effects. Evaluation of risks associated with this sampling have identified the following potential hazards:

1. Contact with water with bacteria (Total and Fecal Coliform) levels above state and county water quality standards. Exposure may be from wetted cables, nets, traps, or splashing associated with deployment or retrieval of these items.
2. Contact with small amounts of sediments with levels of dioxins, PCB's, and heavy metals that in excess of established state sediment guidelines. Exposure may be from residual sediments on nets and traps that are contacted during retrieval, deployment and removal of catch from the equipment, but at levels below established acceptable contact limits.
3. Work being conducting adjacent to roadways and from bridges.
   3.1. All bridges have pedestrian walkways and work will not block or extend into roadway.

No road or lane closures are required to conduct needed work documentation of elevated

Personal Protective Equipment

A. Personal Protective Equipment (PPE) requirements for sampling activities.
NOTE: *No eating, drinking or contact with edible or consumable products should occur while an individual is wearing their Personal Protective Equipment. Equipment should be decontaminated and disinfected (as necessary) prior to consuming beverages or foods.*

During gear removal & deployment, sample processing, packaging and handling, all participants will wear "Level D" personal protective equipment at all times. Level D includes: long pants, long-sleeved shirt and safety shoes Evaluation of risks associated with this sampling have identified the following potential hazards:

4. Contact with water with bacteria (Total and Fecal Coliform) levels above state and county water quality standards. Exposure may be from wetted cables, nets, traps, or splashing associated with deployment or retrieval of these items.
5. Contact with small amounts of sediments with levels of dioxins, PCB's, and heavy metals that in excess of established state sediment guidelines. Exposure may be from residual sediments on nets and traps that are contacted during retrieval, deployment and removal of catch from the equipment, but at levels below established acceptable contact limits.
6. Work being conducting adjacent to roadways and from bridges.
   6.1. All bridges have pedestrian walkways and work will not block or extend into roadway.
   6.2. No road or lane closures are required to conduct needed work

The potential for contact with water is highest, and contact with sediments is minimal to avoidable (depending on the activity being conducted). Methods utilized, and PPE selected are sufficient to protect from these hazards. PPE for activities identified in the 'METHODS' section are presented below, by activity

B. PPE for Study Activities.

General PPE for activities include (abbreviation in parenthesis):

1. Disposable Vinyl-Nitrile or Latex 'innergloves' (i.e., innergloves)
2. 22 mil 19 inch Best NitriSolve Nitrile 'over' Gloves (i.e., overgloves)
3. 'Kevlar' cut resistant gloves (cut resistant gloves)
4. 8 mil 54" long, full sleeve vinyl coat aprons (i.e., apron)
5. 12 inches high disposable Latex overboots, (i.e., overboots)
6. Disposable full-face splash shields (i.e., face shield)
7. Impact resistant/UV-A/UV-B eye protection. (i.e., eye protection)
8. High-visibility safety vest.

Activity dependant PPE

1. Fish Trap Checking, Deployment and Retrieval
   - 1.1. During ***Trap Checking*** (i.e., raising trap to surface of water to see if any catch is present and/or needs to be removed.
     - 1.1.1. Overgloves, innergloves and eye protection will be worn
     - 1.1.2. High-visibility safety vest will be worn if working within 15 feet of a roadway
   - 1.2. During ***Trap Deployment and Retrieval***
     - 1.2.1. Innergloves, overgloves, apron, face shield, eye protection and overboots will be worn
     - 1.2.2. High-visibility safety vest will be worn if working within 15 feet of a roadway

2. Hook and Line Fishing
   - 2.1. During actual ***fishing***, overboots and eye protection will be worn, and an high-visibility safety vest will be worn if working within 15 feet of a roadway
   - 2.2. During ***catch removal*** innergloves, overgloves, apron, face shield, eye protection and overboots will be worn.

3. Entanglement Net Checking, Deployment and Retrieval
   - 3.1. ***Net Checking***:
     - 3.1.1. Visual checking. If the net can be visually surveyed without contact with the water, an orange safety vest will be used if surveying from a bridge.
     - 3.1.2. If the net must be removed for the survey, the protection will be the same as for Deployment and Retrieval
   - **3.2. Net *Deployment and Retrieval***
     - 3.2.1. Innergloves, overgloves, apron, face shield, eye protection and overboots will be worn
     - 3.2.2. High-visibility safety vest will be worn if working within 15 feet of a roadway

4. 'Catch' or specimen processing - Field.
   - 4.1. During ***specimen removal from equipment, initial washing and sorting***:
     - 4.1.1. All sampling locations have area adjacent to the sampling station to allow processing of samples. Thus, processing (washing, sorting, measuring, recording) of samples should *NOT* be conducted on the bridges.
     - 4.1.2. Innergloves, overgloves, apron, face shield, eye protection and overboots will be worn.
   - 4.2. ***Specimen measuring, labeling, bagging and tagging***.

4.2.1. Overgloves, innergloves and eye protection will be worn

5. 'Catch' or specimen processing – Filleting/Packing for shipping.
   5.1. Innergloves, outer gloves, cut-resistant (Kevlar) gloves, apron, and face shield, will be worn while filleting specimens.
   5.2. Latex (or nitrile) glove may be worn over the cut-resistant gloves.
      5.2.1. the Latex gloves will be changed after processing (filleting, wrapping and processing) each fish.
   5.3. Innergloves and outer gloves will be worn at all times while handling samples, specimens or fillets.

Personal Protection Equipment Field Decontamination Procedures.

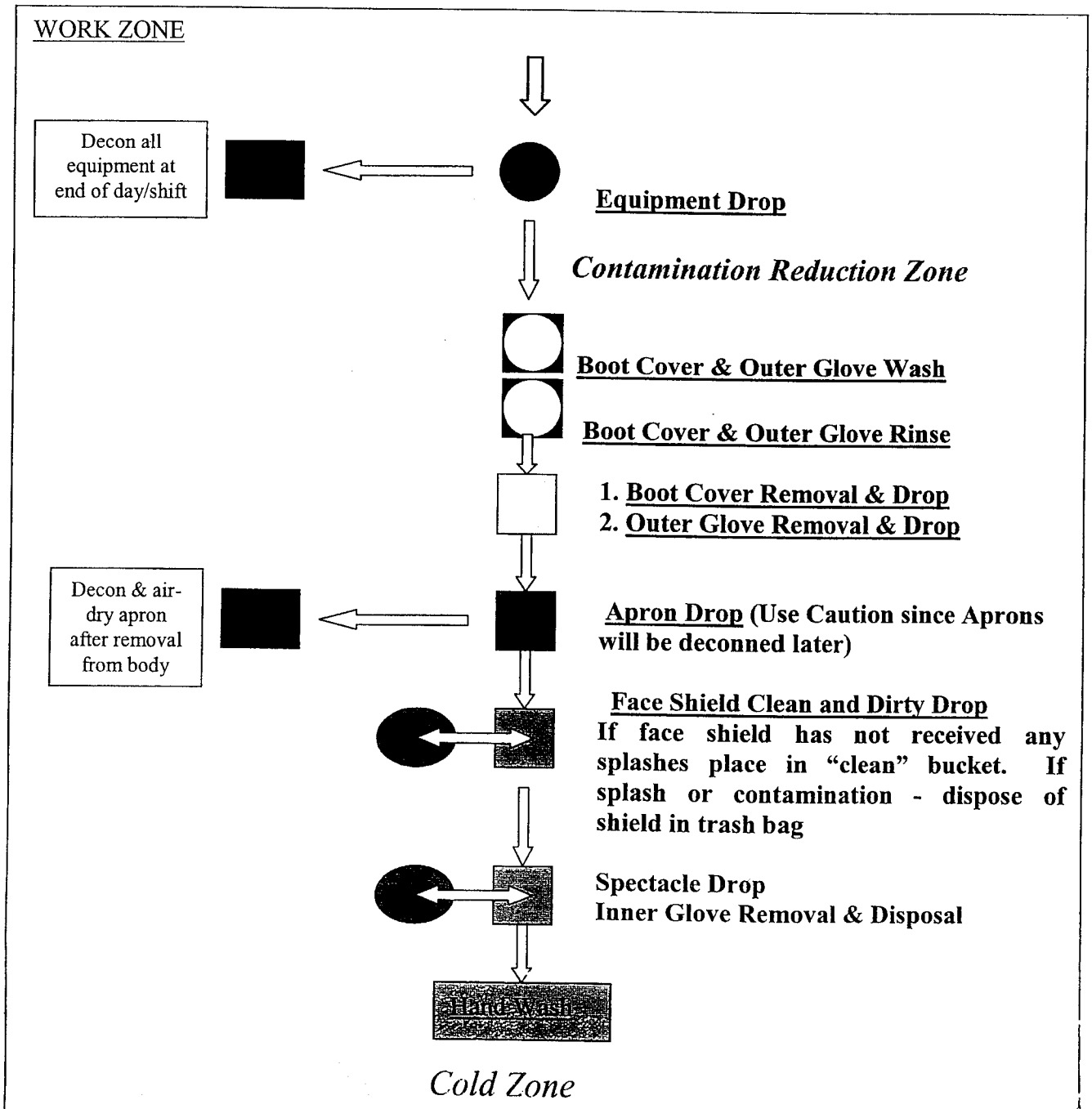
1. All PPE that is to used more than once, will be decontaminated using the following procedure.
   1.1. All contaminated PPE (i.e., had contact with water of sediments of the creek), will:
      1.1.1. Be washed with an Alconox Solution
      1.1.2. Rinsed with clean water
      1.1.3. Allowed to air dry.
   1.2. All disposable PPE, or PPE to be disposed of, shall be held in watertight bags until they can be disposed of in a proper manner

In addition to contaminant associated with water and minor sediment contact, additional hazards may exist. The following sections review those hazards and precautions to minimize their occurrence. The hazards include:

- Blood Borne Pathogens
- Heat Related Disorders
- Back Injuries
- Severe Weather Situations

Decontamination Process for Wagner Creek

- Decontamination of equipment and Personal Protective Equipment (PPE) is used to minimize worker contact with contaminants during removal of equipment from the work zone and from the removal of PPE.
- Decontamination activities should be confined to a designated area outside of the work zone and separate from the areas where food and drink may be consumed.
- All personnel clothing and equipment that may be contaminated must be decontaminated to remove any harmful chemicals or infectious organisms that may have adhered to them.
- Decontamination will consist of a combination of physical removal of contaminants, through scrubbing and rinsing and inactivation by use of detergent.
- Shower at the end of the work shift to ensure complete contaminant removal.
- Decontamination shall follow the path listed below:



Bloodborne Pathogens

There is the potential for encountering blood or body fluids, through contact with contaminated sharp objects. Sharps are defined as objects that can penetrate the skin including, but not limited to, needles, razor blades, and broken glass. Contaminated sharps are those items that are either known to be, or can reasonably-anticipated to be, contaminated with blood or body fluids; all needles shall be assumed to be contaminated sharps. Sharps are not to be picked up directly with the hands. Use tongs to clean up glass and other sharps. Uncontaminated broken glass, metal, or razor blades may be disposed of in either a hard plastic container or in a rigid cardboard box that can be sealed. All *contaminated* sharps are to be disposed of in the designated sharps containers. Sharps containers shall be maintained upright throughout use and not allowed to over-fill. Contaminated needles and other contaminated sharps are not to be bent, sheared, or purposely broken. If biomedical waste or significant quantities of contaminated sharps are found, cordon off the area and contact DERM's on-call inspector at 305-372-6955 and Donna Fries for further assistance.

Additionally, potential exposure to blood or body fluids may occur when rendering emergency first aid. When at all possible allow injured participant to render self-aid by providing the injured party with the appropriate first aid items. The Project Manager is responsible for ensuring that each site is equipped with a first aid kit containing at a minimum:

- gauze dressing pads
- triangular bandage
- Conforming gauze roll bandage
- first aid tape roll
- antiseptic cleansing wipes
- antibiotic ointment
- cold compress
- sterile eye wash
- plastic, vinyl or cloth bandages such as Band-Aid™
- CPR Mask
- Vinyl or Nitrile Gloves
- Eye Protection

The following PPE should be used for the designated situations:

- **Gloves:** Wear whenever hand contact with blood or other potentially infectious materials is possible.
- **Masks, Eye Protection and Face Shields:** Use in combination whenever splashes, spray or droplets of infectious materials are generated.
- **CPR Mouthpieces:** Use when CPR is given. Mouthpieces should have a one-way valve to prevent contamination from the victim.

Heat Disorders

High temperatures and humidity stress the body's ability to cool itself, and heat illness becomes a special concern during hot weather. Acclimation to working in hot environments is critical. Persons with heart problems or those on a low sodium diet, who work in hot environments, should consult a physician about what to do under these conditions.

There are three major forms of heat illnesses: **heat cramps**, **heat exhaustion**, and **heat stroke**, with heat stroke being a life-threatening condition. Knowing the symptoms and appropriate first aid for heat disorders is imperative for anyone who spends time outside.

Heat Cramps

Symptoms: Painful spasms usually in leg and abdominal muscles. Heavy sweating.
First Aid: Move to cooler location. Firm pressure on cramping muscles or gentle massage to relieve spasm. Give sips of water. If nausea occurs, discontinue.

Heat Exhaustion

Symptoms: Heavy sweating, weakness, skin cold, pale and clammy. Weak pulse. Normal temperature possible. Fainting, vomiting.
First Aid: Get victim to lie down in a cool place. Loosen clothing. Apply cool, wet cloths. Fan or move victim to air-conditioned place. Give sips of water. If nausea occurs, discontinue. If vomiting occurs, seek immediate medical attention. In most cases, treatment involves having the victim rest in a cool place and drink plenty of liquids. Victims with mild cases of heat exhaustion usually recover spontaneously with this treatment. Those with severe cases may require extended care for several days.

Heat Stroke

Symptoms: High body temperature (106+). Hot, dry skin. Rapid pulse. Possible unconsciousness. Victim will likely not sweat.

First Aid: **Heat stroke is a severe medical emergency. Call for emergency medical services or get the victim to a hospital immediately. Delay can be fatal. Move victim to a cooler environment, while awaiting rescue. Try a cool bath or sponging to reduce body temperature. Use extreme caution. Remove clothing. Use fans and/or air conditioners. DO NOT GIVE FLUIDS.**

Source: OSHA

Back Injury Prevention

Back Injuries are the most common type of injury in the workplace and are also a significant source of injury in the home. So whether you are lifting on the job or off the job, follow the National Safety Council's tips for preventing back injuries and strengthening your back. Remember to always consult your physician before starting any new exercise program.

You will work better if you start each day with slow stretches. These warm-ups let you ease comfortably into your workday and help you avoid injuries.

Leg and back warm-up

- Prop one foot on a chair or a stool for support.
- Take a deep breath.
  - Ease forward slowly -- keep your back slightly curved.
  - Blow slowly outward as you ease forward to a seven count.
  - Repeat seven times.
  - Switch and do the same with the other foot.

Backbend

- Stand with feet approximately 12" apart
- Support the small of the back with your hands
- Hold your stomach in firmly and take a deep breath
- Arch backwards – bend your head and neck as you go
- Breathe out for seven counts
- Repeat seven **times**

Source: National Safety Council

Severe Weather

Florida has twice as many lightning casualties (deaths & injuries) as any other state. Many people incur injuries or are killed because of misinformation or inappropriate behavior during thunderstorms. High winds, rainfall, and cloud cover often act as precursors to actual cloud-to-ground strikes. Many lightning casualties occur as the storm approaches or at the beginning of a storm, because people ignore these precursors. Also, many lightning casualties occur after the perceived threat has passed. Generally, the lightning threat diminishes with time after the last sound of thunder, but may persist for more than 30 minutes. When thunderstorms are in the area but not overhead, the lightning threat can exist even when it is sunny, not raining, or when clear sky is visible.

In the event of severe weather, go to a safe area immediately, such as inside a sturdy building. A hard top automobile with the windows up can also offer fair protection.

APPENDIX B

General Information – PCBs, Metals and Dioxins in Fish and the Environment

PCBs

Polychlorinated biphenyls (PCBs) are no longer produced in the United States. The products were not single chemicals but mixtures of related chemicals that are still found in the environment. Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children. PCBs are known to cause cancer in animals. PCBs have been found in at least 500 of the 1,598 National Priorities List sites identified by the Environmental Protection Agency (EPA). PCB manufacturing stopped in 1977 because there was evidence that PCB buildup in the environment could cause illness (ATDSR 2000).

PCBs are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Arochlor. PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils.

PCBs entered the air, water, and soil during their manufacture, use, and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs. PCBs can still be released to the environment from hazardous waste sites; illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes in incinerators. PCBs do not readily break down in the environment and thus may remain there for a very long time. PCBs can travel long distances in the air and deposit in areas far from their release. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs bind strongly to soil. Small organisms and fish in water take up PCBs. Other animals that eat these aquatic animals as food also take them up. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water (ATSDR 2001). Between 1969 and 1976, the Food and Drug FDA and the U.S. Department of Agriculture (USDA) monitored PCBs in raw food. They found that fish products clearly contained the highest levels of PCBs (ATSDR 2000). Another study found an average PCB concentration of 0.892 parts per million (ppm) in 2,901 fish collected between 1972 and 1976 (Duggan et al. 1983)

Metals

Mercury is the only metal typically found in fish at levels that may cause health effects. Therefore, this health consultation only includes general information about mercury/ methylmercury.

Mercury

Several forms of mercury occur naturally in the environment. The most common natural forms are metallic mercury, mercuric sulfide (cinnabar ore), mercuric chloride, and methylmercury. Some microorganisms (bacteria and fungi) and natural processes can change the mercury in the environment from one form to another. The most common organic mercury compound that microorganisms and natural processes generate from other forms is methylmercury. Methylmercury can enter and accumulate in the food chain. Inorganic mercury does not accumulate up the food chain to any extent. Methylmercury is of particular concern because it can bioaccumulate in certain edible freshwater and saltwater fish and marine mammals to levels that are many times greater than levels in the surrounding water (ATSDR 1999).

When small fish eat the methylmercury with their food, it goes into their tissues. When larger fish eat smaller fish or other organisms containing methylmercury, most of the methylmercury originally present in the small fish will then be stored in the bodies of the larger fish. As a result, the larger and older fish living in contaminated waters bioaccumulate the highest amounts of methylmercury. Saltwater fish (especially sharks and swordfish) that live a long time and grow to a large size tend to have the highest levels of mercury in their bodies. By contrast, plants (e.g., corn, wheat, and peas) have low levels of mercury, even if grown in soils containing mercury at significantly higher than background levels (ATSDR 1999).

Approximately 80% of the mercury released from human activities is elemental mercury. It is released to the air, primarily from fossil fuel combustion, mining, and smelting, and from solid waste incineration. Some 15% is released to the soil from fertilizers, fungicides, and municipal solid waste (e.g. from waste containing discarded batteries, electrical switches, or thermometers). An additional 5% is released from industrial wastewater to water in the environment (ATDSR 1999).

With the exception of mercury ore deposits, the amount of mercury found naturally in any one place is usually very low. By contrast, the amount of mercury found in soil at a particular hazardous waste site because of human activity can be high (over 200,000 times natural levels). The mercury in air, water, and soil at hazardous waste sites can originate from both natural sources and human activity (ATSDR 1999).

Chlorinated Dibenzo-p-dioxins: General Information

Chlorinated dibenzo-p-dioxins (CDDs) are a family of 75 different compounds with varying harmful effects. CDDs are divided into eight groups of chemicals based on the number of chlorine atoms in the compound. A few examples are di-chlorinated dioxin (DCDD), tri-chlorinated dioxin (TrCDD) and tetra-chlorinated dioxin (TCDD). 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) has four chlorine atoms, one each in the 2, 3, 7, and 8 positions. Chlorine can attach to dibenzo-p-dioxins at any or all of eight positions on the dioxin molecule. Only molecules with four or more chlorine atoms and with chlorine at the 2,3,7 and 8 positions are particularly toxic. 2,3,7,8-TCDD is odorless. Whether the other CDDs are also odorless is unknown. CDDs are known to occur naturally; they are also produced by human activities. They

occur naturally from the incomplete combustion of organic material, such as from forest fires or volcanic activity. CDDs are not purposefully manufactured by industry, except in small amounts for research purposes. They are, however, unintentionally produced by industrial, municipal, and domestic incineration and combustion processes (ATSDR 1998).

If a person is exposed to CDDs, many factors determine whether they will be harmed. These factors include the dose (how much), the duration (how long), and the exposure route (eating, breathing, skin contact). Other factors are exposure to other chemicals, age, sex, diet, family traits, lifestyle, and state of health (ATSDR 1998).

CDDs are found everywhere in the environment, generally low levels. Most people are exposed to very small background levels of CDDs when they breathe air, consume food or milk, or have skin contact with CDD-contaminated materials (ATSDR 1998). CDDs enter the environment as mixtures containing a variety of individual components and impurities. They tend to be associated with ash, soil, or any surface with a high organic content, such as plant leaves. CDDs adhere strongly to soils and sediments. Estimates of the half-life of 2,3,7,8-TCDD on the soil surface range from 9 to 15 years, whereas the half-life in subsurface soil might range from 25 to 100 years (Paustenback et al.1992). Sunlight and atmospheric chemicals break down only a small portion of the CDDs.

Of the 126 waste sites on the EPA National Priorities List that contain CDDs, 2,3,7,8-TCDD has been detected at 91 of them (ATSDR 1998). People living around these sites could be exposed to above-background levels of 2,3,7,8-TCDD and other CDDs.

Chlorinated Dibenzofurans: General Information

Chlorinated dibenzofurans (CDFs) are a family of chemicals containing 1 to 8 chlorine atoms attached to the carbon atoms of the parent chemical, dibenzofuran. The CDF family contains 135 individual compounds (known as congeners) with varying harmful health and environmental effects. Of the 135 compounds, those that contain chlorine atoms at the 2,3,7,8 positions are especially harmful. Other than for research and development purposes, these chemicals are not deliberately produced by industry. Most CDFs are produced in very small amounts as unwanted impurities of certain products and processes utilizing chlorinated compounds. Only a few of the 135 CDF compounds have been produced in large enough quantities that their properties, such as color, smell, taste, and toxicity could be studied. The few CDF compounds that have been produced in those quantities are colorless solids. They do not dissolve in water easily. There is no known use for these chemicals. Most commonly, CDFs enter the body when one eats food contaminated with CDFs—in particular, fish and fish products, meat and meat products, and milk and milk products. Exposure to CDFs from drinking water is less than that from food (ATSDR 1994).

Like the CDDs, if a person is exposed to CDFs, many factors determine whether they will be harmed. These factors include the dose (how much), the duration (how long), and exposure route (eating, breathing, skin contact). Other factors are exposure to other chemicals, age, sex, diet, family traits, lifestyle, and state of health (ATSDR 1994).

Chlorinated Dibenzo-p-dioxins and Chlorinated Dibenzofurans

Chlorinated dibenzodioxins (CDDs) are found in the environment together with structurally related chlorinated dibenzofurans (CDFs). 2,3,7,8-TCDD is one of the most toxic and extensively studied of the CDDs and serves as a prototype for the toxicologically relevant or "dioxin-like" CDDs and CDFs. Based on results from animal studies, scientists have learned they can express the toxicity of dioxin-like CDDs and CDFs as a fraction of the toxicity attributed to 2,3,7,8-TCDD. For example, the toxicity of dioxin-like CDDs and CDFs can be ½ or $^{1}/_{10}$ or any fraction of 2,3,7,8-TCDD. Scientists call that fraction a Toxicity Equivalent Factor (TEF). CDD and CDF exposures are usually reported in Toxicity Equivalency Factors (TEFs). CDDs and CDFs are highly persistent compounds—they have been detected in air, water, soil, sediments, animals, and foods (ATSDR 1998).

The concentration of chlorinated dibenzodioxins (CDDs) in samples of air, water, or soil is often reported as parts per trillion. One part per trillion (ppt) is one part CDD per trillion parts of air, water, or soil. For the general population, more than 90% of the daily intake of CDDs, chlorinated dibenzofurans (CDFs), and other dioxin-like compounds comes from food—primarily meat, dairy products, and fish. The actual intake of CDDs from food for any one person, however, depends on the amount and type of food consumed and the level of contamination.

As stated, CDDs remain in the environment for a long time. Because CDDs do not dissolve easily in water, most will attach strongly to small particles of soil sediment or organic matter and eventually settle to the bottom of a water body. CDDs might also attach to microscopic plants and animals (plankton), which are eaten by larger animals, which are in turn eaten by even larger animals. This is known as a "food chain." Concentrations of chemicals such as the most toxic, 2,3,7,8-chlorine-substituted CDDs, which are difficult for the animals to break down, usually increase at each step in the food chain. This process, referred to as "biomagnification," is the reason why undetectable levels of CDDs in water can result in measurable concentrations in aquatic animals. The food chain is the main route by which CDD concentrations build up in larger fish, although some fish can accumulate CDDs by eating particle-containing CDDs directly off the bottom (ATSDR 1998). Concentrations of dioxins in aquatic organisms can be hundreds to thousands of times higher than the concentrations found in the surrounding waters or sediments (EPA 1999). Bioaccumulation factors vary among the congeners and generally increase with chlorine content up through the tetracongeners and then generally decrease with higher chlorine content (EPA 1999).

CDDs bioaccumulate in aquatic organisms, plants, and terrestrial animals. Finfish appear to selectively accumulate primarily 2,3,7,8-TCDD and other 2,3,7,8-substituted isomers in their tissues (Rappe et al. 1991).

Elevated levels of CDDs have been reported in fish, shellfish, birds, and mammals collected in areas surrounding chemical production facilities, hazardous waste sites, incinerators, and pulp/paper mills using the chlorine bleaching process. Sometimes these findings have resulted in closure of these areas to both commercial and recreational fishing. People who eat food from these contaminated areas are at risk of increased exposure to CDDs (ATSDR 1998).

Individuals who could be exposed to higher than average levels of dioxins include those who ingest food containing higher concentrations of dioxins than are found in the commercial food supply. These groups specifically include recreational and subsistence fishers who routinely consume large amounts of locally caught fish (EPA 1999).

Lipophilic (fat-loving) chemicals—such as dioxins—accumulate mainly in fatty tissues of fish (e.g., belly, flap, lateral line, subcutaneous and dorsal fat, dark muscle, gills, eye, brain and internal organs). Therefore, removal of fish internal organs and skin and trimming the fat before cooking will decrease exposure.