Open Water Information Architecture

System Requirements Document

Version 2.0

OWIA Technical Working Group

June 27, 2023

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1 Introduction

This document contains the functional and technical requirements for the *Open Water Information Architecture (OWIA)* and is called the *OWIA System Requirements Document (SRD)*. It has within it an Appendix:B Standards and Conventions that contains narrative explanations that are referred to within individual requirements where appropriate. This is done because the requirements are meant to be terse, declarative, testable statements that are not overloaded with narrative exposition. There are two companion documents to the SRD: (1) the subordinate document *OWIA Standard Operating Procedures (SOPs)* and the (2) parent document *California Council for Science and Technology (CCST) Stakeholder Use Case* document.

The SOPs are compliant with the requirements specified here yet written at a more detailed level of abstraction with examples of programming code or sometimes pseudo-code to exemplify the implementation details important to developers as well as precisely documenting the processing steps (i.e., procedures) used to operate on data. It is meant to be analogous to an *OWIA Programmer's Guide* and, as the OWIA implementation proceeds, there will be open-source code repositories with *minimal working examples (MWE)* for use in improvements and innovations to current procedures and applications implementing those procedures.

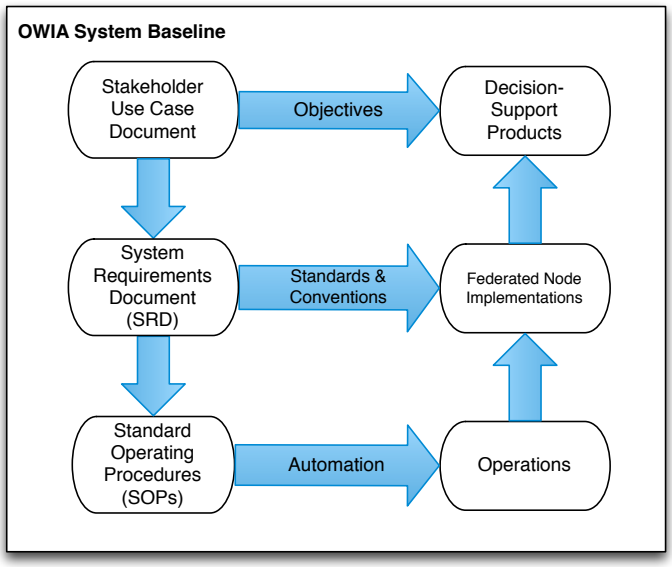

Figure 1: Relationship between system baseline documents and operations.

Each of these documents is intended for a technical audience although it is hoped that they are comprehensible to a motivated non-technical reader. There is a glossary in the back of the SRD to aid in navigating the technical language and as an effort to disambiguate some of the terms for which there may be competing and inconsistent definitions. In addition to these two, there is a third document that contains the stakeholder use cases used to develop the stakeholder objectives from each use case. These objectives are being used to define and constrain the requirements contained in the SRD and the procedures for satisfying them defined in the SOPs.

The SRD and SOPs are designed to provide a foundation for a community-based *OWIA* development of a federated set of cyberinfrastructure resources (i.e., computers, networks, data, metadata, and standards and conventions) that are interoperable and highly-automated to minimize labor as well as idiosyncratic anomalies. We therefore refer to them as the *baseline documents* (Figure 1). The objective of these baseline documents is to establish a framework for sustainable water resource management and to formalize that framework to a degree exemplified by other systems of standard methods such as those found in [7].

The federated nature of the OWIA extends to its (1) human governance structure as well as its (2) cyberinfrastructure (cf. Section 3 and Figure 3). Therefore we speak of the OWIA federation as including both these aspects and will differentiate the two parts contextually when using the term. The *open* aspect means open-access, open-source and open-architecture: encouraging innovation and automation while precluding the siloing and stove-piping that occurs when proprietary software and systems pose restrictive technology dependencies and requirements. The planning horizon is open-ended although intended to provide for a near-term operational system with an initial operating capability (IOC) within 1-2 years evolving to a final operating capability (FOC) over five (5) years that is operationally sustainable while responsive to technology innovation and risk minimization (i.e, cost, schedule, technical and operational) over its lifetime.

The approach is to follow standard system engineering practices [31] that: (1) define stakeholder ob-

jectives and, from these, (2) enumerate functional requirements in terms of functional components and major interfaces both of which are implementation-independent, and (3) enumerate technical requirements which specify fundamental technical features such as network transfer rates, storage capacities, reliability, maintainability and availability (RMA), interface dependencies and contingencies and similar quantitative or qualitative requirements at a level of specificity (or abstraction) that is more detailed than the functional requirements on which they are based. It is also designed to present an initial evaluation of some of the obvious design trade-studies to explicate and focus on the key risk areas related to technical, schedule, cost and operational risks.

This is an interative and recursive, hierarchical design approach (Figure 2) which prioritizes *Stakeholder Objectives, Functional Requirements, and Technical Requirements* respectively and cross-correlates them to each other via a *traceability matrices* (Section 4) to ensure that there are no *widows or orphans* in the sense that there are no unsupported Objectives or Functional Requirements (i.e., widows) as well as no lower-level design features that are not specified in the Functional Requirements (i.e., orphans). As a development methodology, the system engineering method used here is sometimes contrasted with the agile development method. Every methodology has pros and cons and the reason we use this approach for the OWIA is because we already know a great deal about what is needed to improve access-to and reuse-of the collective set of water resource data and the OWIA focus is on the data content. This is not primarily a process of discovery and prototyping of software applications. For a broader discussion of the pros and cons of alternative software development approaches, the reader is encouraged to consider the discussions provided in [27] and [31].

Finally, some historical perspective is helpful. This document is meant to integrate the thinking on water resource information broadly and digital data about water resources specifically. The OWIA concept developed independently of the AB1755 legislation [1][29] that is currently, as of this writing, driving many efforts across the State of California to comply with its mandates and schedule. Fortuitously, the development of the OWIA and the activation of AB1755-related efforts overlap strongly such that AB1755 requirements are a subset of the broader OWIA requirements. The implementation of the OWIA will satisfy the requirements of AB1755 and support the Sustainable Groundwater Management Act (SGMA) in such a way that we can treat AB1755 as an OWIA use-case as described in Appendix E. The OWIA concept is a reflection and integration of a wide range of on-going efforts especially those in the UC WATER Security and Sustainability Research Initiative and CITRIS [9], California Council on Science and Technology (CCST), the Center for Western Weather and Water Extremes (CW3E)[36], the San Diego Supercomputer Center (SDSC) [4, 16, 12, 18, 15, 39, 33, 14, 30, 5, 11, 34, 17, 6, 2, 13, 20] and the UC Santa Barbara Bren School. We expect to grow this community to include private California universities, national laboratories and private sector partners as we go.

2 Project Management Approach

Figure 2 depicts the overall management approach used for this project and graphically summarizes it in the context of a *system engineering framework*. The system engineering framework is a set of methods and procedures for specifying design constraints to minimize the risk that a sought-after system implementation will successfully perform its intended functions. The output of this process is a system design and implementation that is *verifiably compliant with the functional and technical requirements* for the system and which can be *validated against the stakeholder objectives*.

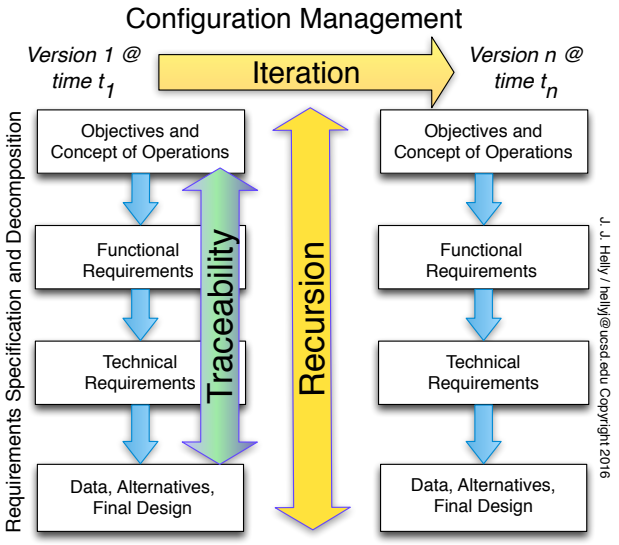

Figure 2: Conceptual representation of the system engineering process. *Reproduced from [19].*

2.1 The Differences Between Objectives, Functional Requirements, Technical Requirements and Design Alternatives

In designing and building any type of system the first step is to describe *what it is that you want to accomplish by building the system. These are the* ***objectives***. Sometimes these are called *stakeholder objectives*. They should be stated as simple declarative sentences focused on what the stakeholder wants the system to do. The language should be as non-technical as possible in order for the broadest understanding and consensus across the lay stakeholders who typically have diverse backgrounds and experience. On the other hand, the *functional requirements* are the translation of the objectives into engineering terms (i.e., functions using more precise technical language) describing how the objectives will be met. This is the first level of abstraction in specifying how the system will be implemented (Figure 2).

The articulation of objectives is often a stumbling block for stakeholders and developers alike because it poses a bit of chicken and egg or floor versus ceiling ambiguity. The way to get past this is focus on the description, often through workshops of stakeholders, of examples of usage without worrying very much whether something is an objective or a functional requirement. These can be re-factored by a *technical working group* once they are articulated. The most important thing is to articulate and document examples of how the system will be used. Once this process has an initial iteration, the system requirements document (SRD), can be maintained through configuration management of versions over time to provide accountability, via traceability tables, to the stakeholders as well as a path forward for developers and a contractually-applicable basis for acceptance testing for contract managers.

3 Concept of Operation

The OWIA system will be operated to produce standardized data of documented quality needed by stakeholders, as defined by the objectives, such as (1) figures, (2) tables, (3) statistics, and (4) analyses.

3.1 Definition of the OWIA System

The *OWIA system* is a federated collection of data systems, cooperating through a shared governance process, standards and conventions, standard interfaces (i.e., APIs, network protocols), and verifiable compliance with requirements. The system structure supports adherence to open-data standards and principles and guided by a set of functional requirements such as accessibility, interoperability, discoverability, and traceability.

Open-data means that the data are free to use, re-use, and redistribute with no restrictions on their use [41, 37]. A federated system does not require a central catalogue or a single interface to such a catalogue. Rather, the federation permits the formation of one or more common catalogues (cf. Figure 4, Curated Collections) as an implementation dependent on the requirement for standardized, published metadata.

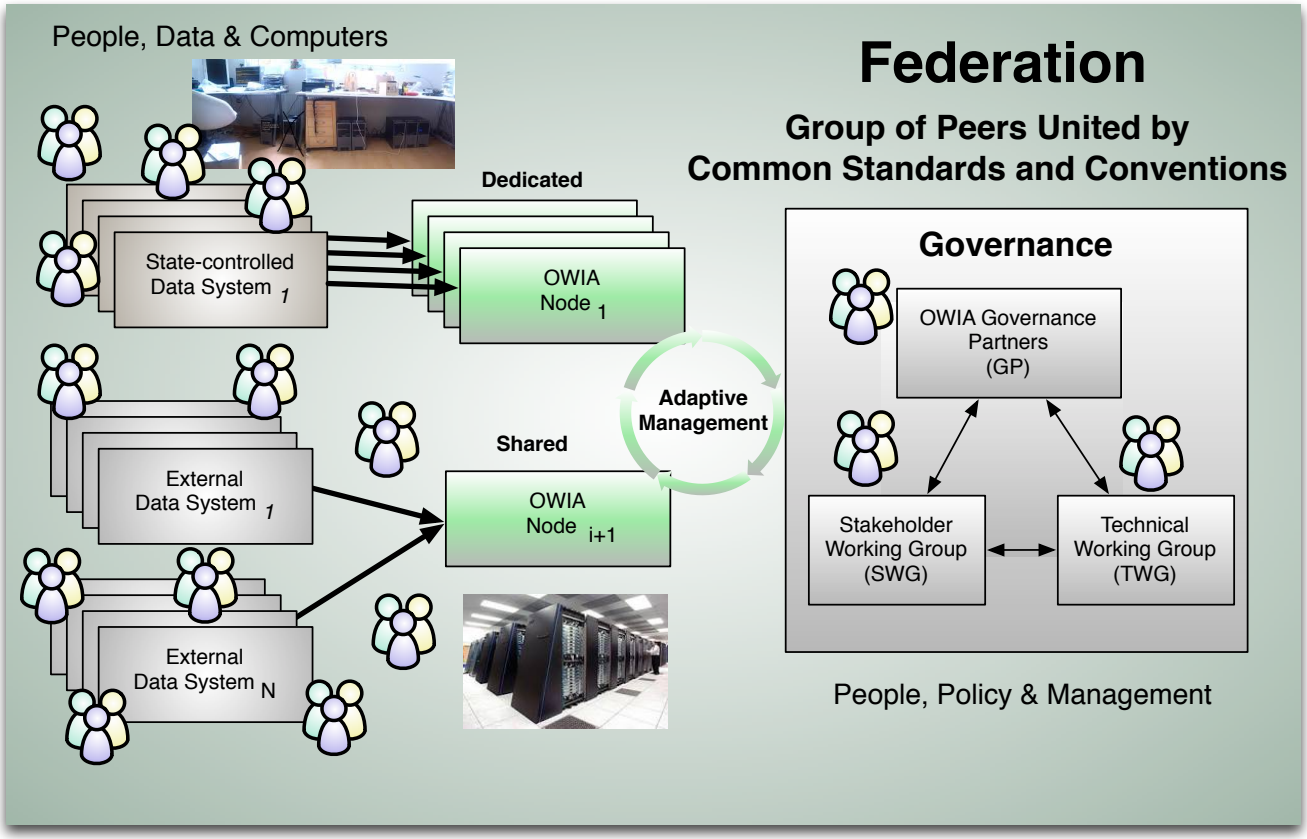

Figure 3: Illustration of the OWIA federation concept with a triumvirate governance structure of partners (OWIA-GP) supported by interacting stakeholder working group (SWG) and the technical working group (TWG). The federation is comprised of dedicated OWIA system implementations to enable individual data providers to independently integrate the OWIA system into their existing methods and procedures within their operations. Shared OWIA system implementations provide the flexibility for the harvesting of non-compliant data sources into an OWIA system implementation that will support the OWIA federation without insisting that the producers be OWIA compliant.

3.2 Governance

The OWIA governance structure is modeled on that of the Internet Engineering Task Force (IETF) [24]. The IETF governance structure is modified to reflect the exigencies of the needs of California stakeholders and the mission agencies responsible for management leadership: the OWIA Governance Partners (OWIA-GP).

The OWIA-GP are responsible for the direction of the system, policy, prioritization and resourcing of work, and curation of the OWIA system baseline. This group cooperates with Stakeholder Working Group (SWG) and the Technical Working Group (TWG) to ensure that the OWIA federation.

3.2.1 Technical Working Group (TWG)

The *Technical Working Group (TWG)* is responsible for the identifying, adopting, approving data standards, data publication approaches, and controlling functional and technical requirements.

3.2.2 Stakeholder Working Group (SWG)

The *Stakeholder Working Group (SWG)* is responsible for informing the OWIA Governance Partners of the intended uses of the OWIA system, and providing iterative feedback on the effectiveness of the system to meet their requirements.

4 Functional Requirements

4.1 FR-100-100: Data Acquisition

Manual and automated methods shall be provided for data acquisition. Data at the acquisition stage of OWIA processing shall be referred to as *Level 0* data.

4.1.1 FR-100-110: Manual

Manual data acquisition methods shall provide metadata conforming the the OWIA minimum metadata standard.

4.1.2 FR-100-120: Automated

Automated data acquisition methods shall provide metadata conforming to the OWIA minimum metadata standard.

4.2 FR-200-100: Quality Control

No data transformation shall require the use of proprietary software, methods or special-purpose computing platforms for data processing and transportation. Data that has received quality control processing according to OWIA standards and conventions shall be referred to as *Level 1* data.

4.2.1 FR-200-110: Verification

Data verification shall be accomplished according to OWIA standards and conventions (cf. Appendix A).

4.2.1.1 FR-200-120: Documentation Documentation shall be provided according to OWIA standards and conventions (cf. Appendix A).

4.2.1.2 FR-200-130: Reproducibility

All data products shall be verifiably reproducible by an anonymous second-party from the input data, metadata and the processing methods used to produce the data product.

4.2.1.3 FR-200-140: Data Traceability

All data products shall be traceable to their parent data sources to the extent that a data product composed of multiple input data sources shall be decomposable and traceable to its parents.

4.2.2 FR-200-150: Standardization

All data products shall conform to the OWIA standards and conventions (cf. Appendix A).

4.2.2.1 FR-200-160: Metadata Conventions

Metadata shall be provided according to OWIA standards and conventions (cf. Appendix A).

4.2.2.2 FR-200-160: File-naming Conventions

File-name shall be performed according to OWIA standards and conventions (cf. Appendix A).

4.2.3 FR-200-170: Interoperable Transformation

All data transformations shall be achievable with open-source, non-proprietary software, non-proprietary data formats and commodity computers.

4.2.3.1 FR-200-180: Separation of Data and Computation

Data and computation shall be separated between data files and stored procedures.

4.2.3.2 FR-200-190: Data Interoperability

All data products shall be interoperable across OWIA-supported computing platforms and be able to be operated on using non-proprietary, open-source software and commodity computers and communications systems to operate on them or transport them.

4.2.3.3 FR-200-200: Products or Resources

Data products shall be developed in accordance with the objectives as per section **??**.

4.3 FR-300-100: Publication

Data shall be published according to OWIA standards and conventions (cf. Appendix A).

4.3.1 FR-300-110: Cross-Referencing-Service

Data objects shall be registered with a cross-referencing service.

4.3.1.1 FR-300-120: Assignment of Digital Object Identifiers

A digital object identifier (DOI) shall be acquired for each Level 1 digital object according to the OWIA standards and conventions (cf. Appendix A).

4.3.2 FR-300-130: Packaging

Packaging shall conform to OWIA standards and conventions (cf. Appendix A).

4.3.2.1 FR-300-140: Compression Methods

Compression methds shall be non-lossy and conform to OWIA standards and conventions (cf. Appendix A).

4.3.2.2 FR-300-150: Archive File Formatting

Archive file formats shall be only those conforming with OWIA standards and conventions.

4.3.3 FR-300-160: Archival

Data shall be archived in trusted data archives with external interfaces to provide for data access and transportation to end-users and applications.

4.3.3.1 FR-300-170: Open Access Distribution

All data products shall be accessible using OWIA standard protocols or transportable external media where network transport is impossible or impractical.

4.4 FR-400-100: Data Traceability

Data traceability shall be provided according to OWIA standards and conventions (cf. Appendix A).

4.4.1 FR-400-110: Metadata Production

All data products shall have metadata provided with them sufficient to meet the OWIA minimum metadata standard.

4.4.2 FR-400-120: Intellectual Property Rights Management

Metadata shall be produced according to the OWIA standards and conventions (cf. Appendix A).

4.4.3 FR-400-130: Public Law Compliance

All data and metadata products shall comply with relevant public law requirements.

4.4.4 FR-400-140: Licensing

Licensing of data and metadata shall conform to OWIA standards and conventions (cf. Appendix A).

4.4.5 FR-400-150: Liability

Liability limitations shall be declared with each data object through the metadata in conformance with OWIA standards and conventions (cf. Appendix A).

4.4.6 FR-400-160: Searching

Minimal metadata shall be provided to meet OWIA standards and conventions for search and discovery.

4.4.6.1 FR-400-170: Cross-referencing System Integration

Cross-referencing system integration shall be based on a digital objects DOI.

4.4.6.2 FR-400-180: Search Engine Optimization

Search-engine optimization shall be based on the metadata associated with the DOI as a minimum.

4.4.7 FR-400-190: Version Control

Source code, data and metadata shall be version-controlled in conformance with OWIA standards and conventions (cf. Appendix A).

4.4.7.1 FR-400-200: Binary Data A version control method shall be provided for binary data products in accordance with OWIA standards and conventions (cf. Appendix A).

4.4.7.2 FR-400-210: Non-Binary Data A version control method shall be provided for non-binary data products in accordance with OWIA standards and convetions.

4.4.8 FR-400-220: Anomaly Reporting

There shall be a method for reporting of anomalies detected in the data products and there shall be a method of tracking the anomalies for resolution and notification of those that have obtained the anomalous data products that an anomaly has been reported and a method for determining the resolution of the anomaly.

4.5 FR-500-100: System Portability

System portability shall be provided such that any implementation of the OWIA system is portable to other platforms in conformance with OWIA standards and conventions (cf. Appendix A).

4.5.1 FR-500-110: Backup and Restore

Backup and restore capabiltiy shall be provided using interoperable procedures and systems according to OWIA standards and conventions (cf. Appendix A).

4.5.2 FR-500-120: Platform Portability

Platform portability shall be provided in conformance with OWIA standards and conventions (cf. Appendix A).

4.6 FR-600-100: External Interfaces

External interfaces shall be provided for data acquisition and open-access to data products.

4.6.1 FR-600-110: Data and Metadata Acquisition

External interfaces shall be provided supporting the data sources in Appendix **??**.

4.6.2 FR-600-120: Data and Metadata Distribution

External interfaces to end-users and applications shall be provided supporting those listed in **??**.

5 Technical Requirements

The technical requirements are subordinate and traceable to the functional requirements above and have a higher-level of engineering detail and more precise, more technical language. This is the first level sufficiently specific to require decision-making about engineering trade-offs and what types of hardware, software and data representations qualify to be included in an OWIA-node.

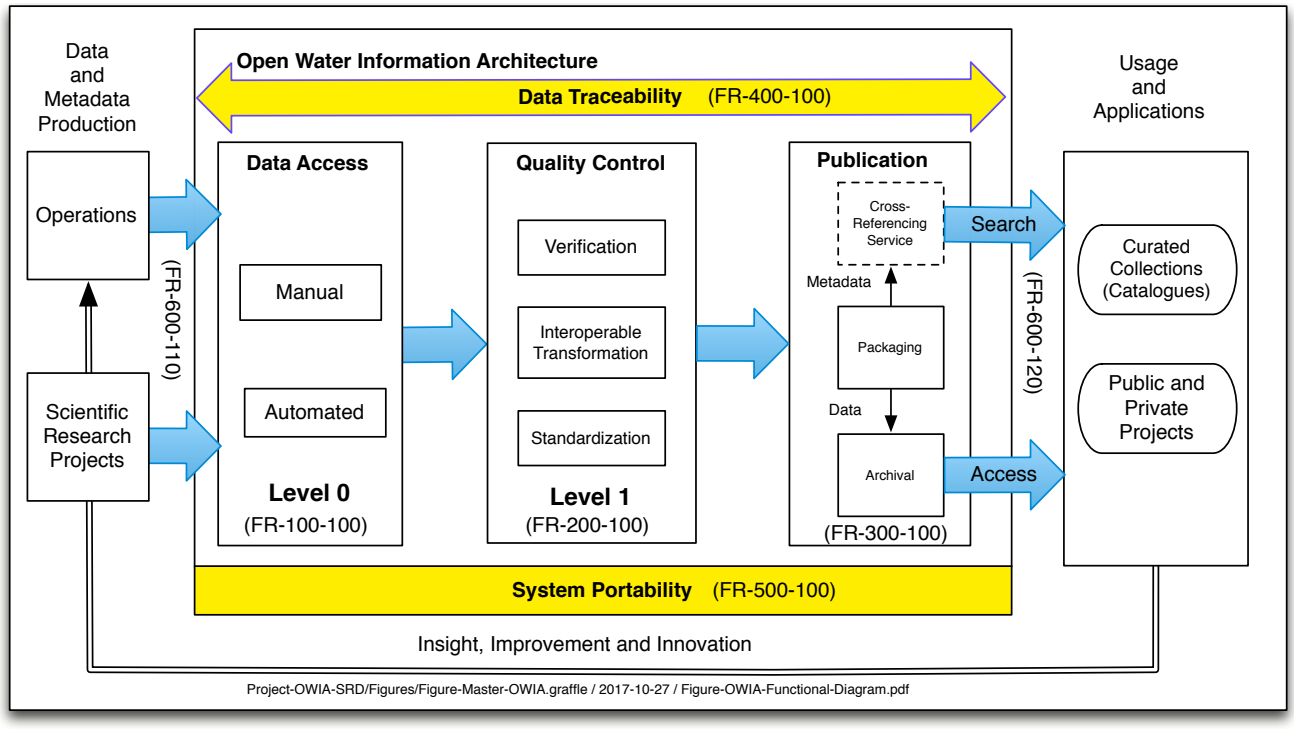

Figure 4: OWIA system (cf. section 3.1) functional block diagram. Parenthetical references point to the governing functional requirements.

Table 1: Definition of OWIA classes of datasets.

Dataset Class	Provenance	Transformation	Quality Control	Metadata	Published
Level 0	cf. Table 2	N/A	N/A	N/A	N/A
Level 1	Traceable to Level 0 parent	Interoperable	SOPs	Listing 1	DOI, Archived
Level 2	Traceable to multiple Level 1 parents (composite, decomposable)	Interoperable	SOPs	Listing 1	DOI, Archived

5.1 TR-100-100-00100: Data Acquisition Methods

5.1.1 TR-200-200-00100: Data Transformation Methods

All data transformations shall be accomplished with open-source, non-proprietary software and commodity computers for data processing and transportation.

5.1.2 TR-200-300-00100: Programming Languages

Data processing shall be realized through the use of stored procedures written in the GNU programming languages.

5.1.3 TR-200-400-00100: Data Interoperability

All data products shall be interoperable across OWIA-supported computing platforms and be able to be operated on using non-proprietary, open-source software and commodity computers and communications systems to operate on them or transport them.

5.1.4 TR-200-5000-00100: Products (List Derived Products traceable to Objectives)

5.1.5 TR-300-100-00100: Data Traceability

All data products shall be traceable to their parent data sources to the extent that a data product composed of multiple input data sources shall be decomposable and traceable to its parents.

5.1.6 TR-300-100-00200: Reproducibility of Data Products

All data products shall be verifiably reproducible by an anonymous second-party from the input data and the method used to produce the data product.

5.2 TR-400-100-00100: Standardization

5.2.1 TR-400-100-00200: Metadata

All data products shall have metadata provided with them sufficient to meet the OWIA minimum metadata standard.

5.2.1.1 TR-400-100-00300: Resolution of Metadata conflicts All conflicts in metadata standards and conventions shall be subject to the determination of the TWG.

5.2.1.2 TR-400-100-00400: Controlled Vocabulary All metadata shall be populated with controlled vocabulary drawn from the following standards.:

5.2.1.3 TR-400-100-00500: Climate and Forecasting Conventions Climate and Forecasting conventions shall be used when suitable.

5.2.1.4 TR-400-100-00600: Federal Geographic Data Committee (FGDC) Geospatial Metadata Standards And Guidelines FGDC standards and guidelines shall be used when suitable.

5.2.1.5 TR-400-100-00700: Open-Geospatial Consortium Standards and Guidelines Open-Geospatial Consortium standards and guidelines shall be used when suitable.

5.2.2 TR-400-100-00800: Mapping Standards

5.2.3 TR-400-100-00900: Numerical Accuracy and Precision Standards

5.2.4 TR-400-100-01000: Measures of Uncertainty

5.2.5 TR-400-100-01100: File Naming Convention

5.3 TR-600-100-00100: Data Publication

5.3.1 TR-600-100-00200: Methods

5.3.1.1 TR-600-100-00300: Assignment of Digital Object Identifiers

5.3.2 TR-600-100-00400: Metadata Production

5.3.3 TR-600-100-00500: Open Access Distribution

5.3.4 TR-600-100-00600: Intellectual Property Rights Management

All data products shall be accessible using OWIA standard protocols or transportable external media where network transport is impossible or impractical.

5.3.4.1 TR-600-100-00700: Public Law Compliance

5.3.4.2 TR-600-100-00800: Licensing

5.3.5 TR-600-100-00900: Discovery

5.3.5.1 TR-600-100-01000: Cross-referencing System Integration

5.3.5.2 TR-600-100-01100: Search Engine Optimization

5.3.6 TR-600-100-01200: Packaging

5.3.6.1 TR-600-100-01300: Compression Methods

5.3.6.2 TR-600-100-01400: Archive File Formatting

5.3.7 TR-600-100-01500: Version Control

5.3.7.1 TR-600-100-01600: Binary Data

5.3.7.2 TR-600-100-01700: Non-Binary Data

5.3.8 TR-600-100-01800: Anomaly Reporting

5.4 TR-600-100-00100: System Interoperability

5.4.1 TR-600-100-00200: Backup and Restore

5.4.2 TR-600-100-00300: Platform Portability

Appendix A Standards and Conventions

This document narrative descriptions of the standards and conventions referred to in the functional and technical requirements. The Internet Engineering Task Force is used as a reference and as the default for standards and conventions that are not otherwise superseded by those identified here. For the subset of standards and conventions that pertain only to web-related services and interfaces, we refer to the World-Wide Web Consortium (W3C) unless explicity superseded in this Appendix.

A.1 Operating Systems (OS)

All conventional operating systems may be employed. If there is an exceptional consideration or doubt about a particular OS or version, it should be submitted as a review item for explicit consideration by the TWG.

A.2 Metadata Schema

There are many important metadata standards that bear consideration. Examples include:

1. Ecological Metadata Language ([22], [30]),
2. Open Geospatial Metadata
3. FGDC

For that reason, the metadata schema recommended here is referred to as a multilateral metadata convention that supports the production of arbitrary metadata files to support compliance with the current and future complement of metadata interfaces: it is designed to be independent of any particular standard but compatible with most.

The metadata schema in Appendix B, Listing 1 is the default schema. It may be augmented. It is intended to be the basis of all metadata interoperability schemas derived from it for integration purposes as required to integrate with other systems and catalogues. This metadata schema is dependent on the controlled vocabulary standard described in section A.3.

A.3 Controlled Vocabulary

Controlled vocabulary is referenced to existing community standards where they exist. The OWIA will conform to the community standards listed here and these will be superseded by the OWIA Controlled Vocabulary when there is a conflict.

(1) CF Conventions and Metadata: Standard Names,
(2) World Meteorological Organization Practices,
(3) Open Geospatial Consortium WaterML 2.0,
(4) OWIA Standard Names (TBD).

A.4 Georeferencing

Most data within the OWIA federation will require georeferencing. The default reference for definitions of map projections, use of datums and related geospatial standards and conventions will be [38]. Snyder and EPSG, PROJ.4, GDAL.

A.5 Intellectual Property Rights

Data published by the OWIA federation is governed by at least one of the following licensing mechanisms:

(1) GNU Public License

(2) Creative Commons

A.6 Trusted Archives

Trusted archives are digital object repositories where data published within the OWIA community can be reliably found. These may not be the only locations but they are considered to be the primary authoritative sources of copies of digtial objects. The criteria used to determine trusted archive status are those of the
(1) USGS Acceptable Digital Repositories for USGS Scientific Publications and Data,
(2) CoreTrustSeal,
(3) DIN 31644 Information and documentation - Criteria for trustworthy digital archives, and
(4) ISO 16363:2012 Space data and information transfer systems - Audit and certification of trustworthy digital repositories.

OWIA trusted archives include:
(1) University of California (in discussion),
(2) California Department of Water Resources (TBD).

A.7 Digital Objects

Digital objects are anything that can be stored and retrieved from within the file system of an operating system. Streaming data presented to a display device are not considered to be digital objects since the data contained in the stream is not stored and cannot be directly used in reproducible analyses or unambiguously referred to or re-used. A suggested approach to employing data of this type is to checkpoint the stream into a file which can be used as a stored digital object.

A.8 File Formats and Data Encodings

Recommended file formats and data encodings are summarized in Table 2. The default standard for character encodings is UTF-8 [25] with extended ASCII as a secondary alternative.

Table 2: Classification of file formats, content and related interoperability features. References are supplied in brackets and listed in the bibliography.

OWIA Class	File Type	Structure	Encoding	Georeferencing	Controlled Vocabulary	Interoperability Tools
Level 1	Comma-separated Values (*.csv)	Record-oriented, Scalar (Integer, Float), Text	ASCII, UTF-8	EPSG [21], DAU-County, HUC10/12 [44]	OWIA, CF [3]	Any
	Spread-sheet (*.ods [43])	Record-oriented, Scalar (Integer, Float), Text	ASCII, UTF-8	EPSG	OWIA, CF	Any
	Geospatial (GDAL-supported)	Raster	Binary	EPSG	OWIA, CF	GDAL
		Vector	Any	EPSG	OWIA, CF	GDAL [8], ogr2ogr, QGIS [35], GRASS [10], GMT [45]
	NetCDF [42]	Multi-dimensional, self-documenting	Binary	EPSG [21], DAU-County, HUC10/12	OWIA, CF	NetCDF API, NCL, NCO [46], GMT
	Text-processing	Rich Text Format (rtf), free-text	Binary	N/A	OWIA, CF	OpenOffice, LibreOffice, rtf2latex, rtf2html
		TeX [40]	ASCII, UTF-8, human-readable	N/A	OWIA, CF	latex2rtf, latex2html, tex4ht
Level 0	Microsoft Excel Spreadsheets (*.xlsx, *.xls)	Cell, Worksheet	Binary	No	No	OpenOffice [32], LibreOffice [28]
	Microsoft Word Documents (*.docx, *.doc)	Free-text	Binary	No	No	OpenOffice, LibreOffice
	DBMS Export	Human-readable	ASCII, UTF-8 (*.txt)	No	No	None
	ESRI Geodatabase	Proprietary	Binary	No	No	QGIS (GDAL-enabled)
	NetCDF	Multi-dimensional, self-documenting	Binary	Any	Any	NetCDF API, NCL, NCO, GMT
Inadmissible	DBMS	Database Structure and Schema	Any	Any	Any	None
	Proprietary w/o Interoperability Tools	Proprietary	Any	Any	Any	None

A.9 Cross-referencing Services

Cross-referencing services are used to support global searching for digital objects published using the OWIA standards and conventions. The default system is the University of California's EZID service.

A.10 Commercial Search Services

Commercial search services using the WWW are typified by Google.

Appendix B Metadata Schema

Listing 1: The current metadata schema.

```
# ##############################################################################################
# Canonical Collection
# ##############################################################################################
OWIA_CanonicalCollection_ArchivistEmail,"VARCHAR(50000)","Required","1","OWIA","Manager Email"
OWIA_CanonicalCollection_ArchivistInstitution,"VARCHAR(50000)","Required","1","OWIA","Manager Institution"
OWIA_CanonicalCollection_ArchivistName,"VARCHAR(50000)","Required","1","OWIA","Manager Name"
OWIA_CanonicalCollection_ArchivistPhone,"VARCHAR(50000)","Required","1","OWIA","Manager Phone"
OWIA_CanonicalCollection_CollectionIdentifier,"VARCHAR(50000)","Required","1","OWIA","Collection Identifier"
OWIA_CanonicalCollection_ControlledVocabulary,"VARCHAR(50000)","Required","1","OWIA","Controlled Vocabulary"
OWIA_CanonicalCollection_Creator,"VARCHAR(50000)","Required","1","OWIA","Creator of collection"
OWIA_CanonicalCollection_Description,"VARCHAR(50000)","Required","1","OWIA","Thorough Description of collection"
OWIA_CanonicalCollection_Language,"VARCHAR(50000)","Required","1","OWIA","Language"
OWIA_CanonicalCollection_MTFVersion,"VARCHAR(50000)","Required","1","OWIA","MTFVersion"
OWIA_CanonicalCollection_Ontology,"VARCHAR(50000)","Required","1","OWIA","Ontology"
OWIA_CanonicalCollection_Publisher,"VARCHAR(50000)","Required","1","OWIA","Publisher of collection"
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# Canonical ADO
# ##############################################################################################
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OWIA_CanonicalADO_Description,"VARCHAR(50000)","Required","1","OWIA","Description including importance"
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# ##########################################################################
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# ##########################################################################
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#  CKAN per Greg Smith 2017-11-01
# ##########################################################################
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Appendix C Controlled-Vocabulary

[label=Table-Controlled-Vocabulary,caption=The current controlled vocabulary.]

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CategoryA,CategoryB,CategoryC,CategoryD
Agriculture,1,Applied Water,AG1
Agriculture,10a,Return Flow to Salt Sink,AG10A
Agriculture,10b,Return Flow for Delta Outflow,AG10B
Agriculture,11a,Return Flow to Developed Supply (Other DAUCO - within PA),AG11A
Agriculture,11b,Return Flow to Developed Supply (Other PA),AG11B
Agriculture,11c,Return Flow to Developed Supply (Other Region),AG11C
Agriculture,11d,Return Flow to Carryover Storage for Next Water Year within DAU,AG11D
Agriculture,12,Return Flows Evaporation and Evapotranspiration,AG12
Agriculture,13,Applied Water Use,AWUAG
Agriculture,14,Net Water Use (Applied Water -Reuse),NW1AG
Agriculture,15,Net Water Use (ETAW + Flow/Salt Sink + Outflow),NW2AG
Agriculture,16,Depletion,DEPAG
Agriculture,17,Conveyance Evaporation and ETAW,AG17
Agriculture,18a,Conveyance Return Flow to Oregon,AG18A
Agriculture,18b,Conveyance Return Flow to Nevada,AG18B
Agriculture,18c,Conveyance Return Flow to Mexico,AG18C
Agriculture,18d,Conveyance Deep Percolation to Oregon,AG18D
Agriculture,18e,Conveyance Deep Percolation to Nevada,AG18E
Agriculture,18f,Conveyance Deep Percolation to Mexico,AG18F
Agriculture,19a,Conveyance Return Flows to Salt Sink,AG19A
Agriculture,19b,Conveyance Return Flow for Delta Outflow,AG19B
Agriculture,2,Applied Water - Groundwater Recharge,AG2
Agriculture,20a,Conveyance Return Flow to Developed Supply (Other DAUCO - within PA),AG20A
Agriculture,20b,Conveyance Return Flow to Developed Supply (Other PA),AG20B
Agriculture,20c,Conveyance Return Flow to Developed Supply (Other Region),AG20C
Agriculture,21,Conveyance Seepage,AG21
Agriculture,22,Conveyance Deep Percolation,AG22
Agriculture,23,Conveyance Deep Percolation to Salt Sink,AG23
Agriculture,24,Conveyance Applied Water Use,AWUAGC
Agriculture,25,Conveyance Net Water Use (Applied Water -Reuse),NW1AGC
Agriculture,26,Conveyance Net Water Use (ETAW + Flow/Salt Sink + Outflow),NW2AGC
Agriculture,27,Conveyance Depletion,DEPAGC
Agriculture,3,Evapotranspiration of Applied Water,AG3
Agriculture,4,Evaporation and Evapotranspiration of Groundwater Recharge,AG4
Agriculture,5,Deep Percolation of Applied Water,AG5
Agriculture,6,Deep Percolation of Applied Water to Salt Sink,AG6
Agriculture,7,Deep Percolation of Groundwater Recharge,AG7
Agriculture,8,Reuse of Return Flows within DAUCO,AG8
Agriculture,9a,Return Flow to Oregon,AG9A
Agriculture,9b,Return Flow to Nevada,AG9B
Agriculture,9c,Return Flow to Mexico,AG9C
Agriculture,9d,Deep Percolation to Oregon,AG9D
Agriculture,9e,Deep Percolation to Nevada,AG9E
Agriculture,9f,Deep Percolation to Mexico,AG9F
Instream Flow Requirements,1,Applied Water,IFR1
Instream Flow Requirements,2,Reuse of Return Flows within DAUCO,IFR2
Instream Flow Requirements,3a,Return Flow to Salt Sink,IFR3A
Instream Flow Requirements,3b,"Return Flow to Oregon - Mexico - Nevada",IFR3B
Instream Flow Requirements,3c,Return Flow for Delta Outflow,IFR3C
Instream Flow Requirements,4a,Return Flow to Developed Supply (Other DAUCO - within PA),IFR4A
Instream Flow Requirements,4b,Return Flow to Developed Supply (Other PA),IFR4B
Instream Flow Requirements,4c,Return Flow to Developed Supply (Other Region),IFR4C
Instream Flow Requirements,5,Applied Water Use,AWUIFR
Instream Flow Requirements,6,Net Water Use (Applied Water -Reuse),NW1IFR
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Instream Flow Requirements,7,Net Water Use (ETAW + Flow/Salt Sink + Outflow),NW2IFR
Instream Flow Requirements,8,Depletion,DEPIFR
Managed Wetlands,1,Applied Water,MW1
Managed Wetlands,10,Return Flows Evaporation and Evapotranspiration,MW10
Managed Wetlands,11,Applied Water Use,AWUMW
Managed Wetlands,12,Net Water Use (Applied Water -Reuse),NW1MW
Managed Wetlands,13,Net Water Use (ETAW + Flow/Salt Sink + Outflow),NW2MW
Managed Wetlands,14,Depletion,DEPMW
Managed Wetlands,15,Conveyance Evaporation and ETAW,MW15
Managed Wetlands,16a,Conveyance Return Flow to Oregon,MW16A
Managed Wetlands,16b,Conveyance Return Flow to Nevada,MW16B
Managed Wetlands,16c,Conveyance Return Flow to Mexico,MW16C
Managed Wetlands,16d,Conveyance Deep Percolation to Oregon,MW16D
Managed Wetlands,16e,Conveyance Deep Percolation to Nevada,MW16E
Managed Wetlands,16f,Conveyance Deep Percolation to Mexico,MW16F
Managed Wetlands,17a,Conveyance Return Flows to Salt Sink,MW17A
Managed Wetlands,17b,Conveyance Return Flow for Delta Outflow,MW17B
Managed Wetlands,18a,Conveyance Return Flow to Developed Supply (Other DAUCO - within PA),MW18A
Managed Wetlands,18b,Conveyance Return Flow to Developed Supply (Other PA),MW18B
Managed Wetlands,18c,Conveyance Return Flow to Developed Supply (Other Region),MW18C
Managed Wetlands,19,Conveyance Seepage,MW19
Managed Wetlands,2,Evapotranspiration of Applied Water,MW2
Managed Wetlands,20,Conveyance Deep Percolation,MW20
Managed Wetlands,21,Conveyance Deep Percolation to Salt Sink,MW21
Managed Wetlands,22,Conveyance Applied Water Use,AWUMWC
Managed Wetlands,23,Conveyance Net Water Use (Applied Water -Reuse),NW1MWC
Managed Wetlands,24,Conveyance Net Water Use (ETAW + Flow/Salt Sink + Outflow),NW2MWC
Managed Wetlands,25,Conveyance Depletion,DEPMWC
Managed Wetlands,25,Conveyance Depletion,MW25
Managed Wetlands,3,Deep Percolation of Applied Water,MW3
Managed Wetlands,4,Deep Percolation of Applied Water to Salt Sink,MW4
Managed Wetlands,5,Deep Percolation of Groundwater Recharge,MW5
Managed Wetlands,6,Reuse of Return Flows within DAUCO,MW6
Managed Wetlands,7a,Return Flow to Oregon,MW7A
Managed Wetlands,7b,Return Flow to Nevada,MW7B
Managed Wetlands,7c,Return Flow to Mexico,MW7C
Managed Wetlands,7d,Deep Percolation to Oregon,MW7D
Managed Wetlands,7e,Deep Percolation to Nevada,MW7E
Managed Wetlands,7f,Deep Percolation to Mexico,MW7F
Managed Wetlands,8a,Return Flow to Salt Sink,MW8A
Managed Wetlands,8b,Return Flow for Delta Outflow,MW8B
Managed Wetlands,9a,Return Flow to Developed Supply (Other DAUCO - within PA),MW9A
Managed Wetlands,9b,Return Flow to Developed Supply (Other PA),MW9B
Managed Wetlands,9c,Return Flow to Developed Supply (Other Region),MW9C
Managed Wetlands,9d,Return Flow to Carryover Storage for Next Water Year within DAU,MW9D
Required Delta Outflow,1,Applied Water,RDO1
Required Delta Outflow,2,Return Flow for Delta Outflow,RDO2
Required Delta Outflow,3,Applied Water Use,AWURDO
Required Delta Outflow,4,Net Water Use (Applied Water -Reuse),NW1RDO
Required Delta Outflow,5,Net Water Use (ETAW + Flow/Salt Sink + Outflow),NW2RDO
Required Delta Outflow,6,Depletion,DEPRDO
Urban,1,Applied Water - Residential - Single Family Interior,URB1
Urban,10,Evapotranspiration of Applied Water,URB10
Urban,11,Evaporation and Evapotranspiration of Groundwater Recharge,URB11
Urban,12,Deep Percolation of Applied Water,URB12
Urban,13,Deep Percolation of Applied Water to Salt Sink,URB13
Urban,14,Deep Percolation of Groundwater Recharge,URB14
Urban,15a,Reuse of Return Flows within DAUCO,URB15A
Urban,15b,Urban - Wastewater Recycling,URB15B
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Urban,15c,Urban - Desalination,URB15C
Urban,16,Evaporation and Evapotranspiration of Wastewater,URB16
Urban,17a,Return Flow to Oregon,URB17A
Urban,17b,Return Flow to Nevada,URB17B
Urban,17c,Return Flow to Mexico,URB17C
Urban,17d,Deep Percolation to Oregon,URB17D
Urban,17e,Deep Percolation to Nevada,URB17E
Urban,17f,Deep Percolation to Mexico,URB17F
Urban,18a,Return Flow to Salt Sink,URB18A
Urban,18b,Return Flow for Delta Outflow,URB18B
Urban,19a,Return Flow to Developed Supply (Other DAUCO - within PA),URB19A
Urban,19b,Return Flow to Developed Supply (Other PA),URB19B
Urban,19c,Return Flow to Developed Supply (Other Region),URB19C
Urban,19d,Return Flow to Carryover Storage for Next Water Year within DAU,URB19D
Urban,2,Applied Water - Residential - Single Family Exterior,URB2
Urban,20,Return Flows Evaporation and Evapotranspiration,URB20
Urban,21,Applied Water Use,AWUURB
Urban,22,Net Water Use (Applied Water -Reuse),NW1URB
Urban,23,Net Water Use (ETAW + Flow/Salt Sink + Outflow),NW2URB
Urban,24,Depletion,DEPURB
Urban,25,Conveyance Evaporation and ETAW,URB25
Urban,26a,Conveyance Return Flow to Oregon,URB26A
Urban,26b,Conveyance Return Flow to Nevada,URB26B
Urban,26c,Conveyance Return Flow to Mexico,URB26C
Urban,26d,Conveyance Deep Percolation to Oregon,URB26D
Urban,26e,Conveyance Deep Percolation to Nevada,URB26E
Urban,26f,Conveyance Deep Percolation to Mexico,URB26F
Urban,27a,Conveyance Return Flows to Salt Sink,URB27A
Urban,27b,Conveyance Return Flow for Delta Outflow,URB27B
Urban,28a,Conveyance Return Flow to Developed Supply (Other DAUCO - within PA),URB28A
Urban,28b,Conveyance Return Flow to Developed Supply (Other PA),URB28B
Urban,28c,Conveyance Return Flow to Developed Supply (Other Region),URB28C
Urban,29,Conveyance Seepage,URB29
Urban,3,Applied Water - Residential - Multi Family Interior,URB3
Urban,30,Conveyance Deep Percolation,URB30
Urban,31,Conveyance Deep Percolation to Salt Sink,URB31
Urban,32,Conveyance Applied Water Use,AWUURBC
Urban,33,Conveyance Net Water Use (Applied Water - Reuse),NW1URBC
Urban,34,Conveyance Net Water Use (ETAW + Flow/Salt Sink + Outflow),NW2URBC
Urban,35,Conveyance Depletion,DEPURBC
Urban,4,Applied Water - Residential - Multi Family Exterior,URB4
Urban,5,Applied Water - Commercial Use,URB5
Urban,6,Applied Water - Industrial Use,URB6
Urban,7,Applied Water - Urban Large Landscape,URB7
Urban,8,Applied Water - Energy Production,URB8
Urban,9,Applied Water - Groundwater,URB9
Water Supplies,10a,Desalination - Urban,SPL10A
Water Supplies,10b,Desalination - Instream Flow Requirements,SPL10B
Water Supplies,10c,Desalination - Wild and Scenic Flows,SPL10C
Water Supplies,10d,Desalination - Required Delta Outflow,SPL10D
Water Supplies,11a,Colorado River Deliveries - Agriculture,SPL11A
Water Supplies,11b,Colorado River Deliveries - Managed Wetlands,SPL11B
Water Supplies,11c,Colorado River Deliveries - Urban,SPL11C
Water Supplies,11d,Colorado River Deliveries - Instream Flow Requirements,SPL11D
Water Supplies,11e,Colorado River Deliveries - Wild and Scenic Flows,SPL11E
Water Supplies,11f,Colorado River Deliveries - Required Delta Outflow,SPL11F
Water Supplies,12a,State Water Project Deliveries - Agriculture,SPL12A
Water Supplies,12b,State Water Project Deliveries - Managed Wetlands,SPL12B
Water Supplies,12c,State Water Project Deliveries - Urban,SPL12C
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Water Supplies,12d,State Water Project Deliveries – Instream Flow Requirements,SPL12D
Water Supplies,12e,State Water Project Deliveries – Wild and Scenic Flows,SPL12E
Water Supplies,12f,State Water Project Deliveries – Required Delta Outflow,SPL12F
Water Supplies,13a,Central Valley Project – Base Deliveries – Agriculture,SPL13A
Water Supplies,13b,Central Valley Project – Base Deliveries – Managed Wetlands,SPL13B
Water Supplies,13c,Central Valley Project – Base Deliveries – Urban,SPL13C
Water Supplies,13d,Central Valley Project – Base Deliveries – Instream Flow Requirements,SPL13D
Water Supplies,13e,Central Valley Project – Base Deliveries – Wild and Scenic Flows,SPL13E
Water Supplies,13f,Central Valley Project – Base Deliveries – Required Delta Outflow,SPL13F
Water Supplies,14a,Central Valley Project – Project Deliveries – Agriculture,SPL14A
Water Supplies,14b,Central Valley Project – Project Deliveries – Managed Wetlands,SPL14B
Water Supplies,14c,Central Valley Project – Project Deliveries – Urban,SPL14C
Water Supplies,14d,Central Valley Project – Project Deliveries – Instream Flow Requirements,SPL14D
Water Supplies,14e,Central Valley Project – Project Deliveries – Wild and Scenic Flows,SPL14E
Water Supplies,14f,Central Valley Project – Project Deliveries – Required Delta Outflow,SPL14F
Water Supplies,15a,Other Federal Deliveries – Agriculture,SPL15A
Water Supplies,15b,Other Federal Deliveries – Managed Wetlands,SPL15B
Water Supplies,15c,Other Federal Deliveries – Urban,SPL15C
Water Supplies,15d,Other Federal Deliveries – Instream Flow Requirements,SPL15D
Water Supplies,15e,Other Federal Deliveries – Wild and Scenic Flows,SPL15E
Water Supplies,15f,Other Federal Deliveries – Required Delta Outflow,SPL15F
Water Supplies,16a,Ocean Desalination – Agriculture,SPL16A
Water Supplies,16b,Ocean Desalination – Managed Wetlands,SPL16B
Water Supplies,16c,Ocean Desalination – Urban,SPL16C
Water Supplies,16d,Ocean Desalination – Instream Flow Requirements,SPL16D
Water Supplies,16e,Ocean Desalination – Wild and Scenic Flows,SPL16E
Water Supplies,16f,Ocean Desalination – Required Delta Outflow,SPL16F
Water Supplies,17a,Water from Refineries – Agriculture,SPL17A
Water Supplies,17b,Water from Refineries – Managed Wetlands,SPL17B
Water Supplies,17c,Water from Refineries – Urban,SPL17C
Water Supplies,17d,Water from Refineries – Instream Flow Requirements,SPL17D
Water Supplies,17e,Water from Refineries – Wild and Scenic Flows,SPL17E
Water Supplies,17f,Water from Refineries – Required Delta Outflow,SPL17F
Water Supplies,18a,Water Transfers – Regional – Agriculture,SPL18A
Water Supplies,18b,Water Transfers – Regional – Managed Wetlands,SPL18B
Water Supplies,18c,Water Transfers – Regional – Urban,SPL18C
Water Supplies,18d,Water Transfers – Regional – Instream Flow Requirements,SPL18D
Water Supplies,18e,Water Transfers – Regional – Wild and Scenic Flows,SPL18E
Water Supplies,18f,Water Transfers – Regional – Required Delta Outflow,SPL18F
Water Supplies,19a,Inter-basin Water Transfers – Agriculture,SPL19A
Water Supplies,19b,Inter-basin Water Transfers – Managed Wetlands,SPL19B
Water Supplies,19c,Inter-basin Water Transfers – Urban,SPL19C
Water Supplies,19d,Inter-basin Water Transfers – Instream Flow Requirements,SPL19D
Water Supplies,19e,Inter-basin Water Transfers – Wild and Scenic Flows,SPL19E
Water Supplies,19f,Inter-basin Water Transfers – Required Delta Outflow,SPL19F
Water Supplies,1a,Local Supplies – Agriculture,SPL1A
Water Supplies,1b,Local Supplies – Managed Wetlands,SPL1B
Water Supplies,1c,Local Supplies – Urban,SPL1C
Water Supplies,1d,Local Supplies – Instream Flow Requirements,SPL1D
Water Supplies,1e,Local Supplies – Wild and Scenic Flows,SPL1E
Water Supplies,1f,Local Supplies – Required Delta Outflow,SPL1F
Water Supplies,2a1,Return Flow from Other DAUCO– within PA – Agriculture,SPL2A1
Water Supplies,2a2,Return Flow from Other DAUCO– within PA – Managed Wetlands,SPL2A2
Water Supplies,2a3,Return Flow from Other DAUCO– within PA – Urban,SPL2A3
Water Supplies,2a4,Return Flow from Other DAUCO– within PA – Instream Flow Requirements,SPL2A4
Water Supplies,2a5,Return Flow from Other DAUCO– within PA – Wild and Scenic Flows,SPL2A5
Water Supplies,2a6,Return Flow from Other DAUCO– within PA – Required Delta Outflow,SPL2A6
Water Supplies,2b1,Return Flow from Other PA – Agriculture,SPL2B1
Water Supplies,2b2,Return Flow from Other PA – Managed Wetlands,SPL2B2
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Water Supplies,2b3,Return Flow from Other PA – Urban,SPL2B3
Water Supplies,2b4,Return Flow from Other PA – Instream Flow Requirements,SPL2B4
Water Supplies,2b5,Return Flow from Other PA – Wild and Scenic Flows,SPL2B5
Water Supplies,2b6,Return Flow from Other PA – Required Delta Outflow,SPL2B6
Water Supplies,2c1,Return Flow from Other Region – Agriculture,SPL2C1
Water Supplies,2c2,Return Flow from Other Region – Managed Wetlands,SPL2C2
Water Supplies,2c3,Return Flow from Other Region – Urban,SPL2C3
Water Supplies,2c4,Return Flow from Other Region – Instream Flow Requirements,SPL2C4
Water Supplies,2c5,Return Flow from Other Region – Wild and Scenic Flows,SPL2C5
Water Supplies,2c6,Return Flow from Other Region – Required Delta Outflow,SPL2C6
Water Supplies,2d1,Return Flow to Carryover Storage within DAU from Previous WY – Agriculture,SPL2D1
Water Supplies,2d2,Return Flow to Carryover Storage within DAU from Previous WY – Managed Wetlands,SI
Water Supplies,2d3,Return Flow to Carryover Storage within DAU from Previous WY – Urban,SPL2D3
Water Supplies,3a,Local Imports – Agriculture,SPL3A
Water Supplies,3b,Local Imports – Managed Wetlands,SPL3B
Water Supplies,3c,Local Imports – Urban,SPL3C
Water Supplies,3d,Local Imports – Instream Flow Requirements,SPL3D
Water Supplies,3e,Local Imports – Wild and Scenic Flows,SPL3E
Water Supplies,3f,Local Imports – Required Delta Outflow,SPL3F
Water Supplies,4a,Groundwater Extraction – Unadjudicated – Agriculture,SPL4A
Water Supplies,4b,Groundwater Extraction – Unadjudicated – Managed Wetlands,SPL4B
Water Supplies,4c,Groundwater Extraction – Unadjudicated – Urban,SPL4C
Water Supplies,4d,Groundwater Extraction – Unadjudicated – Instream Flow Requirements,SPL4D
Water Supplies,4e,Groundwater Extraction – Unadjudicated – Wild and Scenic Flows,SPL4E
Water Supplies,4f,Groundwater Extraction – Unadjudicated – Required Delta Outflow,SPL4F
Water Supplies,5a,Groundwater Extraction – Adjudicated – Agriculture,SPL5A
Water Supplies,5b,Groundwater Extraction – Adjudicated – Managed Wetlands,SPL5B
Water Supplies,5c,Groundwater Extraction – Adjudicated – Urban,SPL5C
Water Supplies,5d,Groundwater Extraction – Adjudicated – Instream Flow Requirements,SPL5D
Water Supplies,5e,Groundwater Extraction – Adjudicated – Wild and Scenic Flows,SPL5E
Water Supplies,5f,Groundwater Extraction – Adjudicated – Required Delta Outflow,SPL5F
Water Supplies,6a,Groundwater Extraction – Banked – Agriculture,SPL6A
Water Supplies,6b,Groundwater Extraction – Banked – Managed Wetlands,SPL6B
Water Supplies,6c,Groundwater Extraction – Banked – Urban,SPL6C
Water Supplies,6d,Groundwater Extraction – Banked – Instream Flow Requirements,SPL6D
Water Supplies,6e,Groundwater Extraction – Banked – Wild and Scenic Flows,SPL6E
Water Supplies,6f,Groundwater Extraction – Banked – Required Delta Outflow,SPL6F
Wild and Scenic River,1,Applied Water,WSR1
Wild and Scenic River,2,Reuse of Return Flows within DAUCO,WSR2
Wild and Scenic River,3a,Return Flow to Salt Sink,WSR3A
Wild and Scenic River,3b,"Return Flow to Oregon – Mexico – Nevada",WSR3B
Wild and Scenic River,3c,Return Flow for Delta Outflow,WSR3C
Wild and Scenic River,4a,Return Flow to Developed Supply (Other DAUCO – within PA),WSR4A
Wild and Scenic River,4b,Return Flow to Developed Supply (Other PA),WSR4B
Wild and Scenic River,4c,Return Flow to Developed Supply (Other Region),WSR4C
Wild and Scenic River,5,Applied Water Use,AWUWSR
Wild and Scenic River,6,Net Water Use (Applied Water – Reuse),NW1WSR
Wild and Scenic River,7,Net Water Use (ETAW + Flow/Salt Sink + Outflow),NW2WSR
Wild and Scenic River,8,Depletion,DEPWSR
Wild and Scenic Rivers,5,Applied Water Use,WSR5
Wild and Scenic Rivers,6,Net Water Use (Applied Water – Reuse),WSR6
Wild and Scenic Rivers,7,Net Water Use (ETAW + Flow/Salt Sink + Outflow),WSR7
Wild and Scenic Rivers,8,Depletion,WSR8
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Appendix D Data Sources

Appendix E Support for AB1755

The OWIA provides complete support for the open-data and transparency requirement of the AB1755 legislation. Table 4 summarizes the relationship between the functional requirments and the objectives stated in the AB1755 bill.

Table 3: Traceability of AB1755 objectives (columns) to OWIA SOPs by use case (rows).

Identifier	Name	Data Sharing	Documentation	Quality Control	Public Access	Open-source platforms and decision support tools
FR-100-100	Data Acquisition	X				
FR-100-110	*-Manual-	X				
FR-100-120	*-Automated-	X				
FR-200-100	Quality Control-*-	X		X		
FR-200-110	*-Verification-	X		X		
FR-200-120	*-*-Documentation	X	X	X		
FR-200-130	*-*-Reproducibility	X		X		
FR-200-140	*-*-Data Traceability	X		X		
FR-200-150	*-Standardization-	X	X	X		X
FR-200-160	*-*-File-naming Conventions	X	X	X		X
FR-200-170	*-Interoperable Transformation-	X		X		X
FR-200-180	*-*-Separation of Data and Computation	X		X		X
FR-200-190	*-*-Data Interoperability	X	X	X		X
FR-200-200	*-*-Products or Resources	X		X		X
FR-300-100	Publication-*-	X	X		X	
FR-300-110	*-Cross-Referencing-Service-	X	X		X	
FR-300-120	*-*-Assignment of Digital Object Identifiers	X	X		X	
FR-300-130	*-Packaging-	X			X	
FR-300-140	*-*-Compression Methods	X			X	
FR-300-150	*-*-Archive File Formatting	X			X	
FR-300-160	*-Archival-	X			X	
FR-300-170	*-*-Open Access Distribution	X			X	
FR-400-100	Data Traceability-*-	X	X		X	
FR-400-110	*-Metadata Production-	X	X		X	
FR-400-120	*-Intellectual Property Rights Management-	X	X		X	
FR-400-130	*-Public Law Compliance-	X	X		X	
FR-400-140	*-Licensing-	X	X		X	
FR-400-150	*-Liability-	X	X		X	
FR-400-160	*-Searching-	X			X	
FR-400-170	*-*-Cross-referencing System Integration	X			X	
FR-400-180	*-*-Search Engine Optimization	X			X	
FR-400-190	*-Version Control-	X	X			
FR-400-200	*-*-Binary Data	X	X			
FR-400-210	*-*-Non-Binary Data	X	X			
FR-400-220	*-Anomaly Reporting-	X	X			
FR-500-100	System Portability-*-					X
FR-500-110	*-Backup and Restore-					X
FR-500-120	*-Platform Portability-					X
FR-600-100	External Interfaces-*-	X				X
FR-600-110	*-Data and Metadata Acquisition-	X				X
FR-600-120	*-Data and Metadata Distribution-	X				X

Appendix F Traceability Tables

The traceability tables for *stakeholder objectives to functional requirements* and functional requirements to technical requirements are listed below in Tables 4 and **??**, respectively. These tables are provided to assist in the evaluation of change proposals and design approaches in order to understand more conveniently how any proposed change may ripple through the OWIA in unintended way and to provide a sound basis for engineering analysis of the interdependencies of the requirements both functional and technical as they bear upon project management and design decisions.

Table 4: Traceability Table: Objective O-1100-1000 to Functional Requirements. This is an example of what subordinate Technical Requirements might resolve to and is meant only to characterize what *Resolution* of Functional Requirements might look like in a Technical Proposal.

Functional Requirement	Label	Resolution
FR-100-100	Data Acquisition-*-NULL	
FR-100-110	*-Manual-NULL	Level 0: HTTP scraping (cf. Table **??** for UC001)
FR-100-120	*-Automated-NULL	Level 0: Stored procedures for updating
FR-200-100	Quality Control-*-NULL	
FR-200-110	*-Verification-NULL	Stored programs and transformation of Level 0 sources to OWIA standards, Compute checksums and version control a list of the checksums.
FR-200-120	*-*-Documentation	OWIA Standard Formats
FR-200-130	*-*-Reproducibility	Stored procedures and input data with descriptive metadata.
FR-200-140	*-*-Data Traceability	OWIA Level 0 metadata generation, OWIA standard Level 0 processing
FR-200-150	*-Standardization-NULL	OWIA Level 0 standard processing (verification of contents, anomaly detection, missing value coding)
FR-200-160	*-*-File-naming Conventions	OWIA Level 0 naming convention
FR-200-160	*-*-File-naming Conventions	Level 0 verification of data access and reproduction of quality control and standardization
FR-200-170	*-Interoperable Transformation-NULL	Level 0 metadata verification
FR-200-180	*-*-Separation of Data and Computation	
FR-200-190	*-*-Data Interoperability	EZID (External Interface)
FR-200-200	*-*-Products or Resources	(1) The water manager must identify potential source(s) of water, and for each determine the quantity and timing of water available for recharge and its cost. (2) To determine where the project should be located, the water manager must examine different options based on basin capacity and suitability of recharge areas; parcel data indicating available land and land values; and water quality implications based on current or past land use and the design of the project. (3) To determine the best method for recharge, basin characteristics such as subsurface characteristics, soil types, topography, current and planned land use, and basin capacity must be taken into account.
FR-300-100	Publication-*-NULL	Level 0 Metadata Production
FR-300-110	*-Cross-Referencing-Service-NULL	Transfer to Trusted Archive with public facing HTTPS server
FR-300-120	*-*-Assignment of Digital Object Identifiers	Identifier Assignment (e.g., EZID) via External Interface
FR-300-130	*-Packaging-NULL	AB1755
FR-300-140	*-*-Compression Methods	Lossless
FR-300-150	*-*-Archive File Formatting	tar.gz, zip
FR-300-160	*-Archival-NULL	Data shall be placed in a trusted archive for access and delivery using OWIA-compliant external interfaces.
FR-300-170	*-*-Open Access Distribution	ftp, http, rsync, scp, sftp, export
FR-400-100	Data Traceability-*-NULL	Via DOIs for parents and siblings.
FR-400-110	*-Metadata Production-NULL	Lossless
FR-400-120	*-Intellectual Property Rights Management-NULL	Attribution 4.0 International (CC BY 4.0), Attribution-NonCommercial 4.0 International (CC BY-NC 4.0)
FR-400-130	*-Public Law Compliance-NULL	AB1755
FR-400-140	*-Licensing-NULL	Compute checksums and version control a list of the checksums.
FR-400-150	*-Liability-NULL	OWIA-standard version control system
FR-400-160	*-Searching-NULL	OWIA bug tracking system
FR-400-170	*-*-Cross-referencing System Integration	Crossref, DataCite
FR-400-180	*-*-Search Engine Optimization	Google bots
FR-400-190	*-Version Control-NULL	Open-source systems verified on Linux, Windows, OSX

FR-400-200	*-*-Binary Data	Naming convention.
FR-400-210	*-*-Non-Binary Data	ASCII-based version control systems (e.g., git, svn, mercurial)
FR-400-220	*-Anomaly Reporting-NULL	Curatorial email address
FR-500-100	System Portability-*-NULL	Open-source operation on major operating systems.
FR-500-110	*-Backup and Restore-NULL	Rsync-based
FR-500-120	*-Platform Portability-NULL	Demonstrated operation across major platforms: Linux, OSX, Windows
FR-600-100	External Interfaces-*-NULL	Uniquely identified per the Interface Control Appendix.
FR-600-110	*-Data and Metadata Acquisition-NULL	Compliant with OWIA standards and conventions
FR-600-120	*-Data and Metadata Distribution-NULL	Compliant with OWIA standards and conventions

Glossary

federated See Federation 1

federation A federation is a group of data providers and users using jointly agreed-upon standards of operation in a collective fashion to ensure the interoperability of the resources they collectively hold and employ. The term may be used, for example, when describing the interoperation of distinct cyberinfrastructure networks with different internal structures. The term may also be used when human groups agree to collectively manage cyberinfrastructure development and operation using commonly held, and managed, requirements, standards and conventions, and operating procedures to ensure the interoperability of distinct cyberinfrastructure resources (cf. Wikipedia Definition). 1

Federation See federation 29

interoperability The ability of computer systems or software to exchange and make use of data (adapted from the Oxford English Dictionary). 29

procedures An established or official way of doing something (Oxford English Dictionary). 1, 29

protocol Protocols are methods of implementing a set of objectives and requirements in a systematic way. In computing, protocols mean both specific implementations of methods such as HTTP [26] and FTP [23] and, more generally as described by the *Internet Engineering Task Force*, protocols are sequences of processing steps that are also referred to as procedures [24]. 7

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